FISH AS FOOD IN AN AGE OF GLOBALIZATION

by

JENNIFER L. JACQUET

B.A., Western Washington University, 2002
M.S., Cornell University, 2004

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ABSTRACT

The human appetite for seafood has intensified and so has overfishing and damage to marine ecosystems. However, the true demand for seafood is often not captured in the national or United Nations Food and Agriculture Organization (FAO) statistics. The underreporting of catches is prevalent worldwide, which inevitably leads to mismanagement, and justifies data improvements via catch reconstructions.

For instance, marine fisheries catch reconstructions for 1950 to present for Mozambique and the United Republic of Tanzania show that the small-scale fisheries sectors in both countries are underreported. Overall, reconstructed marine fisheries catches for Mozambique and Tanzania were respectively 6.2 and 1.7 times greater than those reported by FAO. Similarly, shark catches have been underreported globally, and reconstruction of Ecuador's mainland shark landings for 1979 to 2004 shows that shark landings were an estimated 7,000 tonnes per year, or nearly half a million sharks, and 3.6 times greater than those reported by FAO from 1991 to 2004.

Over the past decades, as we realize fish catches are larger than officially reported and demand for seafood is outstripping the availability of wild resources, conservation groups have been attempting to change patterns of household consumption, particularly in North America and Europe. These groups aim to reduce overfishing and encourage sustainable fishing practices using tools like consumer awareness campaigns and seafood certification schemes. But many factors impede these efforts, such as the renaming and mislabeling of seafood, the absence of a significant price premium for certified seafood, and, most importantly, a lack of demonstrably improved conservation status for the species that are meant to be protected.

This dissertation presents market-based initiatives that may strengthen current initiatives, e.g. global adoption of chain of custody standards, working higher in the demand chain, connecting seafood to climate change, and diverting small fish away from the fishmeal industry into human food markets. Also, conservation groups should consider investing as much effort into the elimination of harmful fisheries subsidies, the primary perverse incentive encouraging excess fishing capacity, as they put into altering consumer behavior. Finally, conservationists can learn from the latest research on the psychology of savings and investment. If these market efforts complement more marine protected areas and regulations, it may be possible to ensure fish as food and wildlife for both current and future generations.

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STATEMENT OF CO-AUTHORSHIP

Apart from Chapters 1 and 11, all chapters have been prepared as stand-alone manuscripts for submission to a peer-reviewed journal. They are currently all either published, accepted, or at some state of review. I am the senior author on all papers and I assumed primary responsibility for the design, implementation, analysis, and writing of co-authored papers. I am the sole author on Chapters 2 and 10. The contributions of co-authors to Chapters 3-9 are summarized below.

Chapter 3 is co-authored with Helen Fox, Helena Motta, Amani Ngusaru, and Dirk Zeller. Helen Fox, Helena Motta, and Amani Ngusaru provided insights into local conservation concerns in Mozambique and Tanzania. Dirk Zeller provided guidance on all stages of the work.

Chapter 4 is co-authored with Juan Jose Alava, Pramod Ganapathiraju, Scott Henderson and Dirk Zeller. Juan Jose Alava provided the list and status of commonly caught shark species in Ecuadorian waters and Pramod Ganapathiraju provided the shark related apprehensions in Ecuador for 1991 to 2007, which I have not included here. Scott Henderson provided insights into local conservation concerns and policy recommendations related to shark finning in Ecuador. Dirk Zeller provided guidance on all stages of the work.

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1 INTRODUCTION

The earliest interactions between human beings and the marine environment are through the human appetite. Modern humans, i.e. *Homo sapiens* began consuming seafood at least 164,000 years ago on the shores of what is now South Africa, as evidenced by shell middens containing the remains of brown mussels, giant periwinkles, and whelks (Marean et al., 2007). Similar remains are known from 125,000-year-old middens along the Red Sea coast of East Africa, in what is now Eritrea, where humans enjoyed meals of oysters, crustaceans, and other shellfish (Walter et al., 2000). They also briefly consumed the flesh of the giant clam *Tridacna costata,* which they collected from the reefs. But their giant clambakes did not last. Shortly after human arrival, *T. costata* nearly disappears from the fossil record showing what may be the first documented case of eradication through overfishing (Richter et al., 2008).

The collective human appetite for seafood is the key reason for the overfishing crisis. Thus, the questions addressed in this dissertation center on a small but greedy organ: the human stomach. The details surrounding this basic statement are complicated, particularly as seafood has become increasingly profitable, markets have become increasingly globalized, and technology has facilitated fishing in every dimension of the sea. How we come to find ourselves in the midst of a fisheries crisis requires a historical perspective and brief synthesis of the results of the demand for seafood (Chapter 2).

Between 1996 and 2006, world exports of fish and fishery products for human consumption grew 57 percent (FAO, 2009). The increasingly global and profitable market for seafood is not without consequence on fish stocks or local communities that rely heavily on fish for food security (some people still rely on seafood for survival while others do not). Those who rely on fish for food have been marginalized, in part due to the fact that they are 1) often located in the developing world; and 2) catch seafood predominantly to feed their families rather than the market. This is the case in Mozambique, for instance, where women and children glean reefs and intertidal areas for mollusks, crustaceans, and other small fish primarily for home consumption but have not been considered in official fisheries catch statistics (Chapter 3). Part of understanding the role fish plays in food security is thus in the improvement of fisheries catch data.

Fisheries landings data are compiled by the Food and Agriculture Organization of the United Nations (FAO) and are fed by national statistics. These data have served as the primary tool for many global and regional fisheries studies, and are used to determine fish consumption, the value of fisheries to national economies, and the amount of surplus fisheries production. However, it is now recognized that these reported data are incomplete and often underestimate actual catches, particularly those caught by the small-scale and/or subsistence fishing sectors (see contributions in Zeller & Pauly, 2007).

To understand the true reliance on fish by developing world countries, Pauly (1998) outlines the rationale and method for reconstructing catches, which includes the incorporation of grey literature and anecdotes. I reconstructed catches for small-scale fisheries and re-examined this sector's role in food security for Mozambique and Tanzania (Chapter 3).

Understanding the fisheries of the developing world and the role of fish for food security is also important in light of increasing demand and importation of seafood by the developed world. In 2006, the top five seafood importing nations were Japan, the U.S., Spain, France, and Italy while China, Thailand, Chile, and Vietnam were among the top ten exporters (FAO, 2009). Many developed nations have become net importers of seafood as their fisheries fail to meet national demand due to the historical overexploitation of their fishing grounds. The demand (and often fishing boats) from developed countries reaches distant waters, such as the high seas and waters off tropical developing countries, where fish stocks are less exploited.

For instance, Asian demand for shark fin soup combined with overfishing in Asian waters has led to an increase in shark finning in distant waters, including those off the coast of South America. However, the national and international fisheries landings statistics do not adequately reflect the level of shark fishing. For Ecuador, I examined how foreign demand is affecting the local catches of sharks, and reconstructed shark captures by small-scale fishers on the mainland (Chapter 4). Also, after considering the various inadequacies in the catch data for Mozambique, Tanzania, and Ecuador as well as other regions of the world, I developed a typology for fisheries catch data that provides a framework for thinking about fisheries data reporting (Chapter 5).

Then this dissertation turns its helm toward conservation measures to solve overfishing and the insatiable demand for seafood. Because it is the appetite that lies at the root of the fisheries crisis, it is unsurprising that many conservation organizations believe it is through addressing this appetite that overfishing will be solved. A substantial effort has developed over the last two decades that attempts to affect consumer demand in the Western world through various awareness campaigns. In accordance with the call for evidence based conservation (Sutherland et al., 2004), I reviewed the range of these campaigns along with their strengths and weaknesses of these initiatives and compiled evidence for and against their success (Chapters 6 and 9). There are major impediments that undermine consumer campaigns, such as the renaming and mislabeling of seafood (Chapter 7) -- a type of cheating that is likely to become more prevalent as seafood demand and trade continues to grow.

If conservation groups support a market-based approach to allay overfishing (as opposed to more conventional conservation efforts such as catch/effort regulations and marine protected areas), then one would imagine that a primary concern would be the elimination of subsidies, which encourage excess fishing capacity (Sumaila and Pauly, 2006). At the same time scientists and economists have called for the elimination of harmful fisheries subsidies (Sumaila and Pauly, 2007), policy makers are also advised that fishing access and property rights should favor smaller-scale, place-based fisheries that use passive gears (Pauly and Maclean, 2003). At its 2003 session, the FAO Committee on Fisheries strongly advocated that “more efforts be made to support the small-scale fisheries sector” (FAO, 2005). But given the attention on consumers rather than the elimination of subsidies, which favor large-scale fisheries, I ask whether small-scale fisheries are being lost in the market-based push toward fisheries sustainability (Chapter 8).

After close examination of small-scale fisheries and market attempts at conservation, I propose a series of market approaches I believe will be more effective to conserve wild fish (Chapter 9). I also explore several ways in which the realm of conservation can learn from recent studies in behavioral economics (Chapter 10). This dissertation examines: issues of seafood security; how foreign demand for luxury products (i.e. shark fin soup) exacerbates fishing in the developing world; systems of reporting catches; measures to assuage demand in the developed world; and possible future directions for fisheries conservation. It is my hope that this interface between statistics, market demand, and conservation will provide insights into fish as food in an era of globalization.

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2 SILENT WATER: A BRIEF EXAMINATION OF THE MARINE FISHERIES CRISIS[1]

[1] A version of this chapter has been published. Jacquet, J. (2009) Silent Water: A Brief Examination of the Marine Fisheries Crisis. Environment, Development, and Sustainability 11: 255-263. All titles with gratitude to The Talking Heads.

In what is now the Republic of the Congo, a hungry man crouches at the edge of an ancient, overflowing river. He holds a spear carved from deer antlers and watches for the gentle movements of the giant river catfish, greater than two meters in length, that have come to spawn in this floodplain. This may be the world's first fisher; the time is the rainy season, 90,000 years ago (Yellen *et al.*, 1995).

This fisher is a hunter-gatherer, the dominant lifestyle until roughly 10,000 years ago, which Sahlins (1972) describes as the "Original Affluent Society." Sahlins (1972, p. 25) excerpts John Eyre's description of a hunter-gatherer village in remote Australia in 1845:

> At Moorunde, when the Murray annually inundates the flats, freshwater crayfish make their way to the surface of the ground…in such vast numbers that I have seen four hundred natives live upon them for weeks together, whilst the number spoiled or thrown away would have sustained four hundred more. An unlimited supply of fish is also procurable at the Murray about the beginning of December…The number [of fish] procured…in a few hours is incredible….

The hunting-gathering, fishing tradition still exists, especially in the developing world and in native communities, where small-scale fishers and their families rely heavily on fish for subsistence (e.g. Johannes, 1978; Johannes *et al.*, 2000). Fish is the last major group of wild animals exploited for food. But marine fisheries and the livelihoods that depend on them are threatened (Myers and Worm, 2003; Pauly *et al.*, 1998; Worm *et al.*, 2006). Accounts of former abundance, by Eyre and others (e.g., Jackson *et al.*, 2001, Roman and Palumbi, 2003, McClenachan *et al.*, 2006) now seem astounding. What happened to Eyre's fish? Focusing on the marine sector, from a Western cultural perspective, this paper briefly explores of the origins, present state, and future of the fisheries crisis.

And you may ask yourself—well, how did I get here?

About 1700 years ago, Christianity replaced pagan animism as the predominant axiom in Europe. The Judeo-Christian God preemptively responds to the fisheries crisis in the Bible's Genesis 1:28: humans "have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth." The Christian-based belief in domination over nature arguably had great implications for resource use and technological innovation throughout Europe and, later, North America (White, 1967), where the fishing industry would further expand. (The Judeo-Christian belief system accounts for early resource use philosophy but does less well explaining the foundations of resource domination in later years.)

Religion also influenced marine fisheries when, near the beginning of the 11th century, the Catholic Church made meatless Fridays compulsory for its members (Bell, 1968). Curiously, 'meat' did not include fish, for which demand then increased. Freshwater fish became scarce and coastal fishes such as herring and cod were sent inland (Barrett *et al.*, 2004). In Europe, religion essentially changed marine fishes from "catch to commodity" (Fagan, 2006).

But the open ocean remained an avoided frontier (especially as most Europeans considered the Earth to be flat) and fishing was limited to inshore stocks. Then, a shift occurred as the Middle Ages ended, and the to the Age of Discovery began. "The image of boats hugging the coast, almost a perfect metaphor for the tight mental horizon of the Middle Ages, was crumbling" (Berman, 1984, p. 41).

Europe looked to expand the geographical base of its economic operations, including the quest for new fishing grounds (Berman, 1984). During the 14th century, cod fishing expanded through the Northwest Atlantic (Barrett *et al.*, 2004). The first circumnavigation of the Earth, initiated by

Magellan in 1519 and completed in 1522, re-established the ancient knowledge that the Earth was round. With this discovery, the number of overseas voyages increased, and so did fishing.

After Magellan's voyage, a scientific revolution took place between the 16^{th} and 18^{th} centuries and science was defined around Bacon's reductionism rather than the holism of the Ancients. This approach would revolutionize science and mathematics and would later have profound implications for the whole of the environmental sciences. The culmination of the era was Newton's *Principia*. Incidentally, Newton's *Principia* was nearly not published because of a book about fish. The Royal Society backed out of their agreement with Newton due to financial disaster after the publication of *On the History of Fish* (Willughby, 1686). This pricey failure nearly cost timely mathematical explanations of the orbits of heavenly bodies, three laws of motion, and his universal law of gravitation (Bryson, 2003).

The scientific revolution began a transition from religion-dominated thought to cognitive reasoning. "Ever since their invention, the highest expression of objectivity in science has been quantification" (Roszak, 1973, p. 270). Mathematics would eventually provide the foundation for the fisheries models (e.g. maximum sustainable yield) used by quota-setting managers in the 20^{th} century (Smith, 1994).

Another element fundamental to modern science emerged at that time: the concept of nature in which the dominant analogy was a machine that generated regularity, permanence and predictability of the universe (Kearney, 1971). When not predictable, nature became at least intelligible, as documented by Charles Darwin's (1859) *The Origin of Species*. In 1883, a year after Darwin's death, T.H. Huxley, appointed to three British fishing commissions, gave a speech at the International Fisheries Exhibition in London. He explained why overfishing or "permanent exhaustion" was scientifically impossible and proclaimed that, "probably all the great sea fisheries are inexhaustible... nothing we do seriously affects the number of fish." Over the next century, humankind would test Huxley's hypothesis.

And you may tell yourself: my God, what have I done?

From the engine, to the steel hull, to the trawl, to ice, modern technology is conspicuously occidental (White, 1967) and technological advances in fisheries also originated in the Western world (though they would eventually spread to and be outdone by the East). The Industrial Revolution had immediate impacts on fishing. In the North Sea, steam ships equipped with otter trawls reported catches more than six times greater than those of sailing ships (Kurlansky, 1997).

By the 1850s, after fewer than 20 years of fishing for them, inshore stocks of halibut in the Western Atlantic had disappeared (Pauly and Maclean, 2003). It is now understood that industrial fisheries require only 10 to 15 years to reduce fish populations to one-tenth of their pre-fishing size (Myers and Worm, 2003). But in the 1890s, North Atlantic fishers experiencing lower catch rates asked naturalists to determine the cause. The field of fisheries science was born and so began the search for culpability in the fisheries dilemma (Pauly, 1994).

The open-access nature of ocean resources was one of the first characteristics faulted. "You are lost if you forget that the fruits of the earth belong to everyone and that the earth itself belongs to no one," writes Rousseau (1754, p. 109). But others argued the notion of the earth (and the seas) belonging to no one was the trouble. Hardin (1968), in his essay, "The Tragedy of the Commons," recognizes the fate of fisheries:

Likewise, the oceans of the world continue to suffer from the survival of the philosophy of the commons. Maritime nations still respond automatically to the shibboleth of the 'freedom of the seas.' Professing to believe in the 'inexhaustible resources of the oceans,' they bring species after species of fish and whales closer to extinction."

But while technology and the oceans' accessibility can be partially blamed, the majority of the world's fishers uses low-tech gear and is coast-bound. Yet, this group, the small-scale fishers, catches roughly the same amount as the industrial sector, which is possible because the small-scale sector employs nearly 25 times more people (Pauly, 2006).

In his 1798 essay on population, the Reverend Malthus outlines the impending doom of overpopulation outstripping food supply. This idea has since been adapted to developing world fisheries. Large coastal populations using destructive fishing practices produce a phenomenon Pauly (1997) describes as "Malthusian overfishing", which threatens fish stocks as well as food security. Though Schumacher (1973) contends that "Small is Beautiful", the small-scale fishing sector has also contributed to the marine fisheries crisis.

Around the time that Rachel Carson's (1951) *The Sea Around Us* won the National Book Award, the concept of maximum sustainable yield (MSY) became prevalent in Europe and North America. Soon after, in the late 1970s, Larkin (1977) wrote the epitaph for MSY, and managers began to make conservative quota recommendations. But the effects of the mathematization of fisheries management were still to come. "An institutional juggernaut had been set in motion" (Walters and Maguire, 1996, p.129) and the failure of fisheries science climaxed with the devastating collapse of northern cod in the early 1990s. Mathematics had a definitive role in the marine fisheries crisis.

Then there is a debate that really happened in the ocean realm: in the early 20th century, John Muir and Gifford Pinchot would come to embody the respective philosophies of preservation and conservation (Nash, 1982). But in terms of fisheries and the oceans, the preservationist approach was never fully considered. Globally, approximately 0.6 percent of the oceans are dedicated as marine protected areas (MPAs) (Wood, 2007) as compared to the 12 percent of terrestrial area that has been designated as protected (Chape *et al.*, 2005). Furthermore, only 0.01 percent of the oceans are actually closed to fishing (Pauly *et al.*, 2002)

Five years after Muir's death, the Smithsonian Institution ran an article in its annual report entitled, "The Sea As a Conservator of Wastes and a Reservoir of Food" (Moore, 1919). By the middle of the century, this strategy was expanded to include the dumping of radioactive wastes as an ecosystem service (Bryson, 2003). In 2004, 65 percent of the U.S. coastline (excluding Alaska), most of it on the eastern seaboard, was under fish advisories (EPA, 2004). Modern industrial pollutants have infiltrated the marine food web. Fisheries that had sustained people for thousands of years are, instead, now poisoning them (Booth and Zeller, 2005).

Into the blue again after the money is gone

Pitcher and Hart (1998, p. 218) write, "Alone among the social sciences (and often disavowed by them) only economics offers an internally consistent and rigorous mechanism for achieving cooperation." Pitcher and Hart are not alone; many scientists and managers have turned to the field of economics to understand and perhaps help alleviate the fisheries crisis. From an economic standpoint, a significant flaw in fisheries management is thought to stem from the lack of tenure right (Hardin, 1968). In the early 1980s, 200-mile exclusive economic zones (EEZs) were established for coastal nations, but economists argue for further privatization using mechanisms such as Individual Transferable Quotas (ITQs) and the elimination of flags of convenience.

Yet, Clark (1973) demonstrates that the overexploitation of fisheries is possible even under privatized fishing rights because private firms adopt high rates of discount. Sumaila and Walters (2005) address high discount rates with "intergenerational discounting," a method to better incorporate future generations in management decisions that will ultimately affect them. Sumaila (2004) demonstrates that, when considering the benefits to future generations, marine ecosystem restoration becomes economically viable.

But the biggest improvement in fisheries management could come from the elimination of perverse subsidies, which is necessary for any constructive environmental change (Holling, 2001; Meyers and Kent, 2001). Governments began subsidizing the expansion of fishing into the Northwest Atlantic, for instance, hundreds of years prior to official pronouncement that subsidies were complicit in cod's collapse (Walters and Maguire, 1996; Lear, 1998). Today's fisheries are still, in part, kept afloat with public tax money. In total, governments subsidize the global fishing fleet with US$30-34 billion annually (Sumaila and Pauly, 2006), which accounts for 35-40 percent of the landed value of fish (Sumaila *et al.*, 2007) or an average of about US$0.33 per kg of marine fish. This over-investment in fisheries in the short-term encourages excess capacity and overfishing. To compensate and reduce excess capacity, some governments buy back boats from the fishing industry, which is also a subsidy (Clark *et al.*, 2005). In addition to subsidization, the industrial fishing sector operates under an economic system that encourages externalities and corporate policy that, by legal definition, cannot take into account the public good (Bakan, 2004).

Perhaps because corporations have become so powerful, environmental non-governmental organizations (ENGOs) have recently gained influence, in some cases enough to challenge governments (Buttel, 1992). ENGOs now lobby governments for the expansion of MPAs, the delineation of exclusive fishing zones for small-scale fishers, and the outlawing (and enforcement) of destructive fishing practices, such as bottom trawling, discarding fish, and the use of dynamite.

Other ENGOs have forsaken government for grass roots efforts and engagement in "exemplary action," which emphasizes the presumed power of an individual as an ecological consumer (Eckersley, 1988). In terms of fisheries, this movement is best seen through the attempts to change seafood consumption patterns (e.g. seafood wallet cards, the Marine Stewardship Council eco-certification). However, consumer awareness attempts, though perhaps successful in raising awareness of seafood products, have unfortunately made no demonstrable impacts on the resource itself (Jacquet and Pauly, 2007).

You may ask yourself am I right? Am I wrong?

"Shallow ecologists think that reforming human relations toward nature can be done within the existing structures of society" (Naess, 1988). The philosophical application of deep ecology has occurred in the terrestrial realm but, so far, has not been substantially applied to the oceans. Perhaps this is, in part, due to the physical property of the ocean itself: it is difficult to see what we have done. But within the last decade or so, we have seen the 40,000 unemployed fishers after the collapse of the northern cod (Harder, 2003). We have seen jellyfish blooms around the world (Purcell *et al.*, 2001). We have seen innumerable scientific articles that prophesize a bleak future for marine fisheries--but not a future without hope (e.g. Pauly *et al.* 2003). Rebuilding marine ecosystems is possible. But to do so, is a fundamental change in prevailing basic assumptions required?

A new *Sea Ethic,* promoted by the Blue Ocean Institute, would help society create a relationship with the oceans in the manner that *A Sand County Almanac* (Leopold, 1949) did with the land.

In her chapter, “Save the Whales, Screw the Shrimp,” Williams (2001) challenges that preserving nature is a moral issue (and recognizes the pecking order in preservation with her title).

Other scientists see the capacity of more practical technical fixes, though they, too, require fundamental shifts in values. Dayton (1998), for instance, called for a reverse of the burden of proof; fishers should be required to demonstrate that their actions do *not* cause damage to marine ecosystems rather than requiring that resource managers prove that they do. Walters (1998) argued that our conceptual view of the seas should change. Currently, more than 99 percent of the world’s oceans are open to fishing; this should be reversed, and the oceans should be considered closed to fishing with small exceptions, i.e. fishery openings, as is the case with salmon in the Pacific Northwest. Russ and Zeller (2003) and Zeller (2005) likewise argued that fishing should be considered a privilege, rather than a right, and call for more marine closures with the aid of international ocean zoning.

Pauly (1995, 2007) identifies the constraints of the human lifetime in terms of fisheries. Each generation thinks that the ecosystem they were exposed to when they were young was more or less pristine and this, in part, is why resources are misused. He describes this phenomenon as “shifting baselines” and emphasizes the need to recognize and overcome our “collective amnesia”. To address the shifting baseline, many ecologists are incorporating history in their research to get a sense of former abundance (Schrope, 2006).

Lewis (1992) vehemently criticizes radical environmentalism as destructive to the environmental movement. Yet, whale populations are beginning to rebound largely because of early efforts by Greenpeace, which simultaneously communicated whale folklore and gruesome whale hunts. Their media efforts created a public outrage and an eventual moratorium on whaling. So far, campaigns of this kind have been less successful in terms of fisheries, though they do exist (e.g. WildAid's shark campaign; see Watts and Wu, 2005).

News of the fisheries crisis has begun to permeate popular culture. For instance, the recently published novel, *The Swarm* (Schätzing, 2006), describes in detail the changes happening in the world's oceans (the disappearance of whales and fish, for instance, and the subsequent takeover by toxic blooms and jellyfish). A terrific, science-fictional threat to humanity follows, which Worm (2006) calls "Armageddon in the oceans." Millions of Schätzing's novels have sold worldwide. In Germany, where it was initially published, *Der Schwarm* has led to an increase in marine science funding (Worm, 2006).

Roughly five hundred years after the dawn of science, religion might also, directly or indirectly, play a role in marine ecosystem restoration and the protection of fisheries (Dunham and Coward, 2000). Although the Catholic Church and many other religious entities have yet to exhibit enlightenment in terms of birth control and contraception (Bayes and Tohidi, 2001), there has been progress in fisheries. In 1966, Pope Paul VI, along with U.S. bishops, terminated obligatory 'meatless' Fridays, except during Lent (Bell, 1968). Recently, one religious group initiated a "What Would Jesus Drive?" campaign because "transportation is a moral issue". Will religious leaders likewise consider fisheries a moral issue and ask, "What Would Jesus Fish?"

Same as it ever was

But is a fundamental shift in values possible on a global scale? Moreover, would it substantially affect market demand? The U.S. now eats almost five times more fish than it did one hundred years ago (NMFS, 2006). Worldwide, per capita consumption of marine fishes has doubled since the 1960s (WHO, 2006). So, too, has the global population. How can marine fisheries feed the global appetite? They cannot.

Humans began farming on a global scale roughly 10,000 years ago and this lifestyle became predominant over the hunter-gatherer one (Quinn, 1992). Now the agricultural model of production is being applied to seafood. After the Papal decree of meatless Fridays, some European monasteries tried to establish artificial fishponds to meet fish demand. These ponds were unsuccessful as people found fish, instead, in the sea (Fagan, 2006). Now, one thousand years later, the oceans are nearly empty and the artificial ponds (many of which float at sea) are a reality. In the last decade, aquaculture production has doubled. In 2004, aquaculture produced nearly 40 percent of all fish consumed, or nearly 60 million tonnes (FAO, 2005).

Wilson (2002) writes about aquaculture, "What was free for the taking must now be manufactured." Eventually, fish biotechnology might entirely compensate for the decline in wild fish supply. In the meantime, though, many fish species raised in fish farms require wild, ocean-born fish for feed (Naylor *et al.*, 2000). In this way, aquaculture puts additional pressure on ocean fisheries.

Furthermore, aquaculture has many ethical dimensions, which include the loss of traditions and the ethical concern of domesticating wild fish. In the Sea of Sicily, *tonnaras* were complex systems of nets to catch tuna as well as a right of passage for the local men, who learned how to set the nets, sing songs about tuna, and speak an entire *tonnara* language (Maggio, 2000). Italy's last *tonnara* has closed and the songs are silent. Instead, juvenile tuna are captured at sea, slowly towed toward shore, and fattened in net pens off the Mediterranean coastline until they are sold (Volpe, 2005).

White (1967 p. 1203) writes, “All forms of life modify their contexts.” After more than 90,000 years of fishing, will the modification of the oceans include the virtual elimination of wild marine fisheries? The human appetite, from the first fisher to the six and a half billion potential seafood consumers alive today, is ultimately the root of the marine fisheries crisis. The human mind, equal in number and technically more impressive, is ultimately the decider of how we satiate the collective appetite for seafood and whether we do so with only ourselves in mind.

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3 FEW DATA BUT MANY FISH: MARINE SMALL-SCALE FISHERIES CATCHES FOR MOZAMBIQUE AND TANZANIA[1]

[1]A version of this chapter is in review. Jacquet, J., H. Fox, H. Motta, A. Ngusaru, and D. Zeller. Few data fut many fish: Marine Small-scale fisheries catches for Mozambique and Tanzania.

Introduction

To assess hunger and malnutrition by country, the United Nations Food and Agriculture Organization (FAO) requires the collection, analysis, interpretation, and dissemination of information relating to nutrition, food, and agriculture, including fisheries (Ward, 2004). The FAO FishStat database, which offers time series data on marine fisheries landings from 1950 to the present, is fed by national statistical data compiled by its member countries. Therefore, the quality of global FAO data depends on the capacity of statistical collection within these countries. FAO data have served as the primary tool in many global fisheries studies (e.g., Grainger and Garcia 1996; Garcia and Newton 1997; Pauly et al., 1998; Garcia and de Leiva Moreno, 2003) but they are recognized as deficient in many regions (e.g., Pauly 1998; Zeller and Pauly, 2007; Zeller et al., 2007), including Africa (van der Elst *et al.*, 2005; Tesfamichael & Pitcher, 2007).

Data reported by FAO are unfortunately not readily distinguishable by sector (e.g., commercial vs. subsistence). Domestic, small-scale fishing (both small-scale commercial as well as non-commercial subsistence) often contributes significantly to food security and nutritional needs of coastal communities, particularly in developing countries. However, small-scale fisheries have often been marginalized politically due to their socio-economic, physical, and political remoteness from urban centers (Pauly, 1997), resulting in under-representation in official statistics. Instead, government focus and support is often directed toward industrial fishing, which provides foreign exchange earnings. This dichotomy is thus also often reflected in reported data, and hence impacts interpretation of global analyses.

The role of small-scale fisheries in local economies and food security must be closely examined, particularly in Sub-Saharan Africa, the only region of the world where child malnutrition is predicted to increase rather than decline (Pinstrup-Andersen et al., 1999). In Mozambique and Tanzania, two of the poorest countries in the world, small-scale fisheries have long contributed to rural livelihoods and food security. Although this is recognized in some instances, it is not clear to what extent this is reflected in concrete policy level action. Clearly, these resources and their habitat need to be protected for local food security and livelihood purposes.

In both Mozambique and Tanzania, small-scale fisheries greatly resemble those from centuries ago and provide an important source of protein. Small-scale fishing takes place both from shore, and from canoes and dhow-type planked boats, mostly propelled by sails (Mngulwi, 2006), and almost exclusively in the nearshore waters of 40 m depth or less (UNEP, 2001). In the 19060s, industrial fishing began in the waters off Mozambique and Tanzania. Fishing vessels were often financed or entirely operated by European countries and allowed to operate in Mozambique and Tanzanian waters in exchange for foreign revenues. In the 1980s, for instance, shrimp became Mozambique's largest earner of foreign exchange after cashews (Anon., 1984). But not without a price.

Similar to the situation in West Africa (e.g., Marquette et al., 2002), Mozambican and Tanzanian industrial shrimp trawlers disobey legal requirements to stay offshore and fish in inshore areas as well. The trawlers damage the ocean bottom and destroy passive fishing gear set by small-scale fishers (Lopes and Gervásio, 1999). They also often discard large fractions of their catch as unwanted by-catch (e.g. Kaczynski and Fluharty, 2002). But species caught and discarded by shrimp fisheries often overlap directly with those resources that small-scale fisheries rely on (and almost never discard). In this sense, industrial fishing can threaten food security for the population.

In Mozambique, there are around 120,000 fishers and 658 small-scale landing sites, while in Tanzania there are an estimated 55,000 fishers and more than 400 landing sites for the mainland and Zanzibar combined (Jiddawi & Muhando, 1990; Shao et al., 2003; IDPPE, 2004). Underestimation of and difficulty in data collection for small-scale marine catches have been recognized repeatedly (e.g. Herrick *et al*., 1969; Anon., 1988; Mongi 1991; Charlier, 1994; Gillet, 1995; Guard et al., 2000). In both countries, general underreporting of small-scale catch is thought to be potentially substantial. The present study reconstructed total marine fisheries catches for both countries for the period 1950-2005 to derive a historic baseline and evaluate the overall magnitude of underreporting.

Material and methods

Marine fisheries catches have been successfully reconstructed in other regions of the world (Zeller et al., 2003; Pauly & Zeller 2007; Zeller et al., 2007). Here, we follow the basic conceptual framework and approach outlined by these studies to reconstruct historic marine fisheries catches for Mozambique and Tanzania. This required the collection of data and information from published and grey fisheries literature available for both countries (details can be found in Jacquet & Zeller 2007a, 2007b available at www.fisheries.ubc.ca/publications/reports/fcrr.php), combined with interpolations and clearly defined assumptions.

<u>Mozambique</u>

At the national level, Mozambique's fisheries are considered in three sub-sectors: industrial, semi-industrial, and artisanal or small-scale. For this paper, we combine the latter two sectors thus consider Mozambique's fisheries in two categories: small-scale and industrial, where the small-scale sector includes boat-based fisheries as well as 'collectors' (consisting of shore-based collectors and boat-based divers, most often for home consumption).

Small-scale sector

Time-series data on small-scale catches were not available, although unpublished reports provided estimates for the small-scale fleet for certain years (e.g. Krantz *et al.*, 1986; Charlier, 1994). However, these studies did not present details of their methods for estimation, nor did they appear to include the 'collector' component in catch estimates. Thus, they were considered as minimal estimates.

The data that were most comprehensive were the 2003 and 2004 national catch data as collected and reported by the Instituto Nacional de Investigação Pesqueira (IIP), which explicitly included estimated small-scale fisheries catches with a clearly described estimation method (IIP, 2003, 2004). While the 2004 data were derived from sampling 115 of the larger fishing centers, expansions were never made to the other 543 (smaller) centers (N. Faucher, Instituto Nacional de Desenvolvimento da Pesca de Pequena Escala, pers. comm.). The 2003 data included full coverage of three coastal provinces (Maputo, Sofala, and Zambezia), 70% coverage of two other coastal provinces (Nampula and Inhambane), and excluded the southern province of Gaza and the northern province of Cabo Delgado, which has the largest number of active boats and the second largest number of fishers (KPMG, 2006). This information was combined with the 2002 fisher census (IDPPE, 2004) to determine that, overall, approximately 62% of the total number of fishers were included in the national statistics (Table 3.1).

Therefore, it was assumed that the reported catch for 2003 and 2004, being 67,074 and 57,747 t respectively, was caught by 62% of all coastal fishers. Assuming proportionality, we increased the reported catches for 2003 and 2004 by 38% to derive '100% estimates' for these years.

This resulted in a reconstructed small-scale catch of 108,184 and 93,140 t for 2003 and 2004, respectively. Based on these adjusted total small-scale catches and the associated fisher population, we derived estimated per fisher catch rates of 2.47 and 2.09 $kg \cdot fisher^{-1} \cdot day^{-1}$ for 2003 and 2004, respectively.

Anecdotal evidence suggests that, due to additional fishing pressure from refugees, catch rates declined during the civil war, which lasted from 1975 to 1992 (Dutton and Zolho 1990; Lopes and Gervasio, 1999). A case study on the small-scale fishery of Inhaca Island (part of the province of Maputo) presented data from fisher interviews, and suggested that catch rates declined by 38% over the last 30 years from 29 to 11 $kg \cdot fisher^{-1} \cdot day^{-1}$ (de Boer et al., 2001). We applied this 38% inversely to the lower 2003 national catch rate of 2.47 $kg \cdot fisher^{-1} \cdot day^{-1}$ (derived above) to derive an estimated catch rate of 6.44 $kg \cdot fisher^{-1} \cdot day^{-1}$ at the start of the civil war in 1975. Thus, the national small-scale catch rate was assumed to decline from the estimated 6.44 $kg \cdot fisher^{-1} \cdot day^{-1}$ in 1975 to 2.47 $kg \cdot fisher^{-1} \cdot day^{-1}$ in 2003. To remain conservative, the catch rate was assumed constant (6.44 $kg \cdot fisher^{-1} \cdot day^{-1}$) for the 1950-1974 pre-war period (Figure 3.1).

Estimates of fisher populations were available for seven different years spanning 1965-2002 (Table 3.2), however, estimates prior to 1995 excluded collectors. Therefore, we took the average proportion of collectors to total fishers for 1995 and 2002 (45%), and applied this average proportion to estimate ‘collector’ populations for the earlier years (Table 3.2). The ratio of fishers plus collectors to the entire Mozambique population (based on interpolated census data available at www.populstat.info) was determined for these seven years, while ratios for the remaining years were estimated proportional to the whole population trends. We used this derived time-series of ratios to estimate numbers of fishers and collectors for 1950-2004 (Figure 3.2). Combining these derived fisher plus ‘collector’ estimates with the derived catch rates provided total small-scale catch estimates from 1950-2004.

Industrial sector

Historically, more resources have been allocated to monitoring and reporting the fisheries catch by the industrial sector. Thus, grey literature reports indicating industrial catch were accepted as reported (Table 3.3). For years when data were unavailable, catch estimates were interpolated linearly between adjacent periods, thus assuming that no direct correlation existed between industrial catch development and human population trend (see also Zeller et al*.,* 2006).

The increase in industrial shrimp fisheries in the 1970s (Anon. 1984) meant a corresponding increase in by-catch (landed) and discards (not landed). By-catch is likely under-reported, while discards are entirely absent from the reported data. Schultz (1997) reported an annual by-catch of 21,000 to 29,000 t between 1993 and 1996, while in 1982, shrimp fisheries discards were estimated at 15-20,000 t (Anon., 1982). However, it is thought this latter amount is conservative and was likely at least 25,000 t (Tenreiro de Almeida, former Secretary of State for Fisheries in the 1980s, pers. comm.) Thus, assuming 25,000 t of discards in 1982 and comparing this to total FAO reported shrimp catch of 8,900 t for 1982 resulted in a 2.8:1 ratio of discards to shrimp catch. This ratio was applied to the time series of reported shrimp catches to produce time series of estimated discards (Table 3.4). Total reconstructed catch was thus derived from estimates of small-scale catch plus industrial catch plus discards.

<u>Tanzania</u>

Examination of Tanzania's FAO statistics revealed that data for Zanzibar, a region of Tanzania comprised of two large offshore islands (with substantial fish catches), are missing from official statistics. This may be an artifact of the complexity and history of Tanzanian bureaucracy: mainland Tanzania and Zanzibar each have autonomous institutional and legal structures for managing fisheries, and thus separate systems of reporting. We estimated total catches for the mainland and Zanzibar separately, and combined these estimates to derive country totals.

Mainland Tanzania

For the mainland, we retained the data as reported by FAO for the years 1950-1969, which were the best estimates we could obtain. However, it is possible that catches from this period were under-estimated. A new data collection system implemented in Tanga (the northern most province) suggested that catches since the 1970s were at least 35% greater than previously reported (Verheij et al., 2004). Thus, we increased the 1970-2005 time series of reported marine fisheries catches for the mainland by 35%. This adjustment is likely conservative (Martin Guard, Eco2 Dive Centre, pers. comm.).

This adjusted time series of fisheries catches did not include any catches by collectors (shore-based collectors and boat-based divers). Mainland frame surveys estimated 576 and 796 collectors in 2001 and 2005, respectively. For 1970-2000, for which we had reliable number of fishers, we took the ratio of collectors to fishers from 2001 (3:100) and applied that to the 1970-2000 number of fisher time-series (Table 3.5). The numbers of collectors for 2002-2004 were estimated using linear interpolation between 2001 and 2005 reported numbers of collectors. To obtain estimates of ‘collector’ catch, we used the reported ‘collector’ catch rate and effort data for Matemwe, Zanzibar (4.0 $kg \cdot collector^{-1} \cdot day^{-1}$ for 240 days per year, see below; Jiddawi & Stanley, 1999). As there were no data on the number of fishers and number of collectors from 1950-1969, we took the estimated 1970 ‘collector’ catch as a ratio to fishers catch (0.8:100) and used this to conservatively estimate collected catches from 1950-1969. Total marine catch estimates for the mainland were thus obtained by combining the adjusted catch time series for fishers and the estimated catch time series for collectors.

Zanzibar

For Zanzibar (consisting of the two islands Unguja and Pemba), fisheries catches by boat-based fishers were available from 1980-2005 (missing data for 1989 were interpolated). For 1980 and 1981, however, the catch data were thought to represent only Unguja Island. Furthermore, for 1980, we had data for the number of fishers on Unguja and Pemba (5884 and 7058, respectively; Ngoile, 1982; Table 3.6). We thus calculated the 1980 catch per fisher of 0.67 $t \cdot fisher^{-1} \cdot year^{-1}$, and used this rate for the number of Pemba fishers to establish the Pemba catch for 1980. For 1981, we interpolated the number of fishers between frame surveys (1980 and 1985) and then repeated the steps used for 1980 to determine the 1981 catch data for Pemba.

However, these data did not include the catch by collectors except for the years 1980, 1985, 1989. We interpolated the number of collectors between these years to determine the number of collectors from 1980-1989 (Table 3.6). Jiddawi & Stanley (1999) estimated catch rates for collectors in Matemwe, Zanzibar to be 4.0 $kg \cdot collector^{-1} \cdot day^{-1}$. At Matemwe, fishers go to sea 16-20 days per month, while in other parts of Zanzibar fishers go to sea as often as 25 days per month (N. Jiddawi, Institute of Marine Sciences, pers comm.). Here, we assumed the catch rates from Matemwe to represent the average rate for collectors, which is likely conservative for earlier years because catch rates appear to have declined (N. Jiddawi, Institute of Marine Sciences, pers. comm.). Thus, we assumed a catch rate for collectors of 4.0 $kg \cdot collector^{-1} \cdot day^{-1}$ and an effort of 20 days per month (i.e., 0.96 $t \cdot collector^{-1} \cdot year^{-1}$). This rate and effort was multiplied by the time series of collectors (from 1980-1989) to obtain 'collector' catches from 1980-1989. Because 1989 was the last reliable data point for the number of collectors in Zanzibar, we used the ratio of 'collector' catch to boat-based catch in 1989 (23:100) to estimate a time series of collected fish from 1990-2005 based on assumed proportionality to reported fisheries catches.

For 1950-1980, we had only two data points for estimated catches: 1959 and 1975, which were presumed not to include collectors. We thus interpolated these boat-based catch data between 1960-1974 and 1976-1979. For 1950-1958, we extrapolated the catch backward based on the linearly increasing catches interpolated annually from 1959-1975 (an increase of 250 t annually). To estimate catches taken by collectors, we used the ratio of ‘collector’ catch to boat-based catch in 1980 (33:100) and carried this ratio back unaltered to 1950. We then aggregated the boat-based and ‘collector’ catch for a time series of Zanzibar marine fisheries catches from 1950-2005. Finally, we aggregated the estimated total catches for Zanzibar and the mainland to obtain an estimate of total catches for the United Republic of Tanzania from 1950-2005.

Results

For Mozambique and Tanzania combined, the overall reported catches potentially underestimated total catches by a factor of 3.5 over the 1950-2005 time period. For each country taken separately, reported catches were 6.2 and 1.7 times lower than reconstructed catches for Mozambique and Tanzania, respectively.

Mozambique

Catch data as reported by FAO on behalf of Mozambique suggested a steady increase in catches from 7,800 t in 1950 to a peak of 37,130 t in 1981, before declining to around 25,000 t per year in the late 1990s-early 2000s. In contrast, the estimated total marine fisheries catches as reconstructed here suggested a rapid increase in catches starting in the late 1960s and continuing through the civil war, reaching a peak of 222,080 t in 1986 before beginning a decline that seems to continue to the present day (Figure 3.3a). Thus, using the reconstruction approach as outlined here, Mozambique’s annual catches were likely between 47,000 and 177,000 t higher than the reported data suggested. Since 2000, the FAO has reported annual catches between 24,000 t and 32,000 t, while the present study suggested annual catches between 150,000 t and 173,000 t for the same time period.

The reconstructed time series data also illustrates the magnitude of small-scale catches. In terms of tonnage, the small-scale sector caught almost six times the amount of the industrial sector (Figure 3.3b). Excluding freshwater catches and ignoring imports and exports of industrial catch, and assuming that the entire small-scale catch was consumed within Mozambique, the average per capita marine seafood consumption over the 55-year period was 9.6 $kg \cdot person^{-1} \cdot year^{-1}$ for Mozambique. From 2000-2004, marine seafood consumption was estimated between 4.8 and 6.7 $kg \cdot person^{-1} \cdot year^{-1}$.

<u>Tanzania</u>

Catches as reported by FAO for Tanzania suggested an increase in fisheries catches from around 14,000 t through the 1950s to a peak of nearly 62,000 t on 1996 followed by a slow decline. In contrast, reconstructed catches show that fisheries catches increased from 25,000 t in the 1950s to around 97,000 t in the last decade (Figure 3.4a). Overall, for the 1950-2005 period, the reconstructed catch was 1.7 times larger than that reported by FAO.

The present study indicated that, for the Tanzanian mainland and Zanzibar, total marine catches over the last few decades ranged between 10,000-25,000 t and 36,000-77,000 t, respectively. Thus, mainland catches were about three times those of Zanzibar (Figure 3.4b). On the mainland, catch per fisher has been around 3.5 $t \cdot fisher^{-1} \cdot year^{-1}$ in recent years and total catches have declined, while catch rates have been much lower in Zanzibar, ranging between 0.5 and 1.5 $t \cdot fisher^{-1} \cdot year^{-1}$, while total catches have increased due to increased fishing pressure. Catch per fisher peaked in the early 1980s. On the mainland, catch per fisher in the mid-1990s was roughly 5 $t \cdot fisher^{-1} \cdot year^{-1}$ while in recent years it has been around 3.5 $t \cdot fisher^{-1} \cdot year^{-1}$.

Discussion

The Western Indian Ocean represents 8% of the world's oceans but, according to FAO data, generates only 4% of reported global landings (van der Elst et al,. 2005). As we have shown here by examples of Mozambique and Tanzania, such an assessment is more an indicator of poor and substantially incomplete reported data than underutilized fisheries productivity. According to our reconstructions, Mozambique and Tanzania's marine fisheries catches from 1950-2005 were 6.2 times and 1.7 times greater, respectively, than those reported by FAO based on country reports. These findings support broader research in the Western Indian Ocean that suggested that FAO data reflect less than half of the real catch in the region (van der Elst *et al.* 2005). Our findings also reinforce what Pauly and Zeller (2003) emphasized: there is a need to complement FAO data and incorporate estimates of previously ignored catches, even if these are based on approximations and assumptions.

Critics of this method will point first to the fact that uncertainty is unaccounted for. There is indeed significant uncertainty in catch reconstructions and some recent studies have incorporated this potential error using a Monte Carlo sampling technique (e.g. Tesfamichael and Pitcher, 2007). But there is far less uncertainty in the reconstructed catch data than there is in the FAO data (which also do not report uncertainty but still have been widely and uncritically used; e.g. Pontecorvo *et al.* 2009). Reconstructed data account for fisheries by all known sectors, including illegal catches, bycatch, catches by marginalized people (such as women and children), whereas the FAO data are only as good as its member countries demand or allow it to be (and have been shown to be biased for various reasons; see Pauly and Zeller, 2003). Thus, one is reminded that the insistence on precision can undermine a historical perspective and can lead to 'shifting baselines' (Pauly, 1995). As the economist John Maynard Keynes is attributed with having said: "It is better to be vaguely right than precisely wrong."

In both countries, marine fisheries catches recorded by the national fisheries divisions were not extrapolated countrywide. Furthermore, the catch by collectors (fishers on foot and divers) was often omitted from official fisheries data. The reconstruction for Mozambique, as undertaken here, now accounts for catches by all fishers and collectors, as well as discards by the shrimp fishery. For Tanzania, reconstructed catches now incorporate Zanzibar, as well as catches by collectors on both the mainland and Zanzibar. They also conservatively compensate for general underreporting on the Tanzania mainland. Thus, the reconstructed data better reflects total catches taken from marine ecosystems. Although there is a level of uncertainty associated with our estimates, we remained conservative in our assumptions throughout. The reconstructed data illustrate more likely historical trends and patterns for Mozambique and Tanzania over the last 50 plus years. Importantly, the catch estimates presented here are closer to the truth than the alternative of continuing to rely on reported catches, and therefore to assume that no data means no catch.

For national governments, the earning potential from tax revenues on commercial and export fisheries is often enticing. But the lack of data on total fisheries catches puts management authorities in serious risk of over-licensing. In negotiations of fisheries access agreements, reference tonnage is partly used to determine initial cost of the agreement. In the absence of better data, FAO data and other unreliable existing statistics that underestimate fisheries catches are often taken as benchmarks, which results in low tonnage values.

The present study is specific to Mozambique and Tanzania; however the situation presented is relevant for all the Western Indian Ocean countries, and Mozambique and Tanzania are likely representative. In sub-Saharan West Africa for example, foreign fishing nations' payments for access agreements greatly under-represent the true value of the resource being extracted by foreign vessels from local Exclusive Economic Zones (EEZs). In Guinea-Bissau, the revenue the country received by 'selling' the fishing rights to the EU is only 7.5% of the value of the fish had it been processed in Guinea-Bissau (Kaczynski and Fluharty, 2002). More holistic estimates of total catches being taken by countries will assist in ensuring more appropriate compensation for foreign fleet access agreements. Declining trends in fisheries catches over time, such as those documented here for Mozambique, also reveal potential overfishing of local resources. Given the common ontogenetic linkages between inshore (shallow) and offshore (deeper) shelf waters for many fish and invertebrate resources (e.g. Zeller and Pauly, 2001), the likely heavy or excessive fishing pressure by the small-scale fisheries in shallow, nearshore waters will likely be exacerbated by inappropriate or excessive catches granted by access agreements. This may substantially impact local food security.

In recent years, the Mozambique's Fisheries Research Institute has made great improvements in data collection, which is reflected in recent government reports. The new system has resulted in higher estimates of catch--800% greater than estimates derived using previous approaches (e.g., Afonso, 2006). These recent improvements to data monitoring will likely be adopted by FAO after several years of reporting have taken place (D. Gove, IIP, pers. comm.). But unless Mozambique, and hence FAO, retroactively use these data to hind cast back to 1950 to adjust the substantial historic underreporting, the future data will continue to misrepresent the historic baseline, with potentially dire consequences for ecosystem-based interpretation of the effects of fishing.

Small-scale fisheries catches, according to the reconstruction presented here, were substantial and, on average, accounted for 75% of total marine catches. Inshore resources are important to coastal people, many of whom live a marginal existence. The reconstructed small scale fisheries catch estimates suggest that fish is a more important part of food security than would otherwise be perceived. Our reconstruction showed that previous per capita fish estimates based on reported data (e.g., 3 kg for Mozambique but 8 kg for sub-Saharan Africa as a whole[1]) substantially under-estimated true consumption. Using the reconstructed data, average countrywide per capita marine fish consumption over the 55-year period was 9.6 kg·person^{-1}·year^{-1}. In Mozambique and Zanzibar, collectors play an important role in food security as the invertebrates they collect are often eaten at home while the fish caught by men at sea are sold (Semesi & Ngoile, 1993; de Boer & Longamane, 1996; de Boer et al*.,* 2000; Guard *et al.* 2000; Silva, 2006). On the Tanzanian mainland, collecting appears to occur at a reduced rate, compared to Mozambique and Zanzibar, possibly due to the availability of alternative sources of animal protein.

There are several reasons for the concern over the status of fisheries in Mozambique and Tanzania. The present catch reconstruction confirmed reports of declining catch rates on the Tanzanian mainland (Silva 2006). Historically, fishers in Tanzania were considered better off than farmers (Wenban-Smith 1965), but this has changed as more people have entered the fishery (Shao et al., 2003). The decline in catch rates is coupled with other indications of overexploitation, e.g., reduced mean size and decreased abundances (Kristiansen et al., 1995; de Boer et al. 2001) and the widespread use of unsustainable fishing practices (Lopes and Gervasio, 1999; Verheij et al., 2004). Population pressure also exists. Overall, the number of small-scale fishers in both countries appears to have quadrupled over the last four decades. Combined, fishing practices and population pressure strongly suggest that 'Malthusian overfishing' (Pauly, 1997) is occurring in Mozambique and Tanzania. Though there are attempts at fisheries management in both countries, and the level of enforcement has increased significantly in Mozambique (Afonso, 2006), enforcement of existing legislation should be a high priority along with parallel efforts to develop, implement, and support additional community-

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[1] World Resources Institute (WRI). Costal and Marine Ecosystems-Mozambique. http://earthtrends.wri.org/pdf_library/country_profiles/wat_cou_508.pdf [Accessed December 18, 2007].

based management actions, such as community-based no-take fishing zones (MPAs). However, focus on fisheries and related measures alone will not be sufficient, as overall poverty needs to be addressed through vigorous and innovative moves to enhance and support alternative livelihood options.

Equally important, increasing global markets for seafood are also a point for scrutiny. In 2002, there were 12 licensed industrial fishing vessels fishing in Tanzania's EEZ (Jiddawi & Öhman, 2002). By 2004, this number had grown to 24 (Mngulwi, 2006). Currently, there is a government provision to lift the export ban on marine finfish in Tanzania that had been in place since the colonial era, and allow ten different groups of fish to be exported (Mgawe, 2005). Anderson and Ngatunga (2005) point out that an export fishery would raise local prices and reduce the supply to domestic markets. It may also exacerbate hunger and poverty (Mgawe, 2000), and likely result in further non-sustainable increases in targeted fishing effort.

The present study illustrated that the marine fishing sector is a more important asset to national food security for Mozambique and Tanzania, and the magnitude of resource extraction much greater than was previously recognized. In both countries, little data do not mean small catches. Mozambique and Tanzania should be very cautious in allowing international markets to stimulate additional fishing effort given the domestic reliance on fish for fundamental food security purposes, especially in regards to access agreements.

Tables

Table 3.1 Number of fishers by province and the proportion of fishers represented in Mozambique's national fisheries statistics data.

Coastal province	2002 census of fishers[a]	Percent represented[b]	Number of fishers represented	Number of fishers not represented
Cabo Delgado	26,609	0	0	26,609
Nampula	39,585	70	27,710	11,876
Zambezia	14,151	100	14,151	0
Sofala	11,838	100	11,838	0
Inhambane	17,784	70	12,449	5,335
Gaza	1,497	0	0	1,497
Maputo	6,783	100	6,783	0
TOTAL	118,247	62	72,930	45,317

[a]IDPPE (2004) [b]KPMG (2006)

Table 3.2 Fisher, collector and human population data for Mozambique, and ratio of fishers & collectors to total population with sources and estimates.

Year	Reported fishers	Reported collectors	Source	Collector estimates[a]	Fishers & collectors	Population ($x 10^6$)	Ratio (fishers & collectors/ 1000 people)
1965	16,131	no data	Herrick et al. (1969)	13,198	29,329	7,414	3.96
1979	38,883	no data	Konigson et al. (1985)	32,086	70,969	11,329	6.26
1981	39,609	no data	Debeauvais et al. (1990)	32,407	72,016	11,885	6.06
1982	42,300	no data	Konigson et al. (1985)	34,609	76,909	12,097	6.35
1988	43,876	no data	Debeauvais et al. (1990)	35,899	79,775	13,369	5.97
1995	49,045	47,378	IDPPE (1998)	-	96,423	14,854	6.49
2002	69,359	48,888	IDPPE (2004)	-	118,247	18,676	6.33

[a]Based on a 45% proportion of collectors to total fishers, as derived from reported data for 1995 & 2002

Table 3.3 Industrial sector reported catches and sources for Mozambique, 1955-2003.

Year	Reported catch (t)	Source
1955-1960	3,300-3,900 [a]	Krantz et al. (1986)
1961-1975	3,285-15,655[b]	DNP (1976)
1981	24,650	Konigson et al. (1985)
1982	20,000	SIDA (1982)
1985	49,100	Gerboval et al. (1994)
1986	**51,610**	Gerboval et al. (1994)
1987	48,050	Gerboval et al. (1994)
1990	33,436	Gerboval et al. (1994)
1994	23,229	Charlier (1994)
2003	22,037	Tembe (2004)

[a]1955 catch was 3,300 t; 1960 catch was 3,900 t
[b]1961 catch was 3,285 t; 1974 catch was 15,655 t

Table 3.4 Decadal industrial shrimp catch and estimated discards for Mozambique, 1950-2000.

Year	Reported shrimp catch (t)[a]	Estimated discards (t)[b]
1950	0	0
1960	400	1,120
1970	800	2,240
1980	11,700	32,760
1990	10,539	29,509
2000	11,195	31,346

[a]FAO FishStat
[b]Based on 25,000 t of discards for the early 1980s, a discard:shrimp ratio of 2.8:1 was estimated.

Table 3.5 Number of fishers and collectors on the Tanzanian mainland, 1970-2005.

Year	No. of fishers	No. of collectors
1970	6,719[a]	202
1971	8,200[b]	246
1972	8,531[b]	256
1973	8,188[b]	246
1974	8,331[c]	250
1975	8,500[b]	255
1976	11,157[d]	335
1977	10,033[d]	301
1978	9,800[b]	294
1979	8,100[b]	243
1980	7,600[b]	228
1981	13,200[b]	396
1982	13,500[b]	405
1983	9,500[b]	285
1984	13,783[e]	413
1985	11,392[f]	342
1986	12,619	379
1987	12,739	382
1988	13,855	416
1989	13,887	417
1990	16,178	485
1991	16,361	491
1992	15,027	451
1993	15,027	451
1994	15,027	451
1995	13,822	415
1996	13,822	415
1997	13,822	415
1998	20,625	619
1999	20,625	619
2000	20,625	619
2001	19,071	576[g]
2002	19,071	631
2003	19,071	686
2004	19,071	741
2005	29,754	796[h]

[a]Fisheries Division (1970) [b]Bagachwa et al. (1994) [c]Fisheries Division (1975) [d]Mikisi (1984) [e]Bagachwa et al. (1994) [f]1985-2005 F. Sobo, Fisheries Division, pers. comm. [g]Fisheries Division(2002) [h]Fisheries Division (2005)

Table 3.6 Number of fishers and collectors for the islands of Ungaja and Pemba (comprising Zanzibar, Tanzania) for 1980-1989.

Year	No. of fishers (Unguja)	No. of fishers (Pemba)	Collectors (Zanzibar total)
1980	5884[a]	7058[a]	4555[a]
1981	5954	7194	3937
1982	6024	7330	3319
1983	6094	7467	2700
1984	6164	7603	2082
1985	6234[b]	7739[b]	1464[b]
1986	-	-	1679
1987	-	-	1894
1988	-	-	2108
1989	-	-	2323[c]

[a] Ngoile (1982) [b] Carrara (1987) [c] Mongi (1991)

Figures

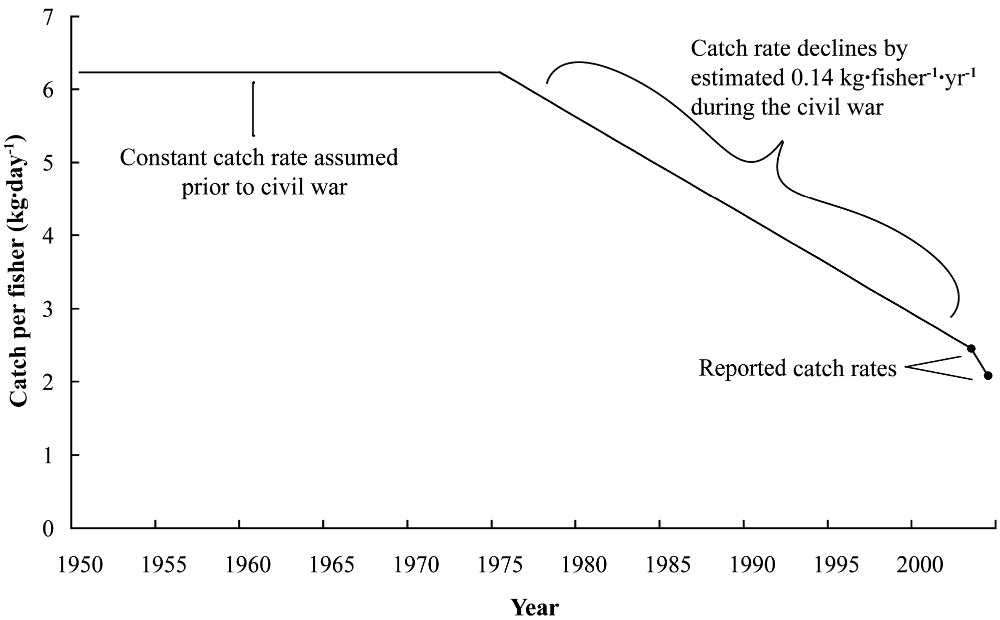

Figure 3.1 Small-scale catch rates (catch per fisher) estimated and reported (•) for Mozambique, 1950-2004; catch rate was assumed to decline with the start of the civil war in 1976.

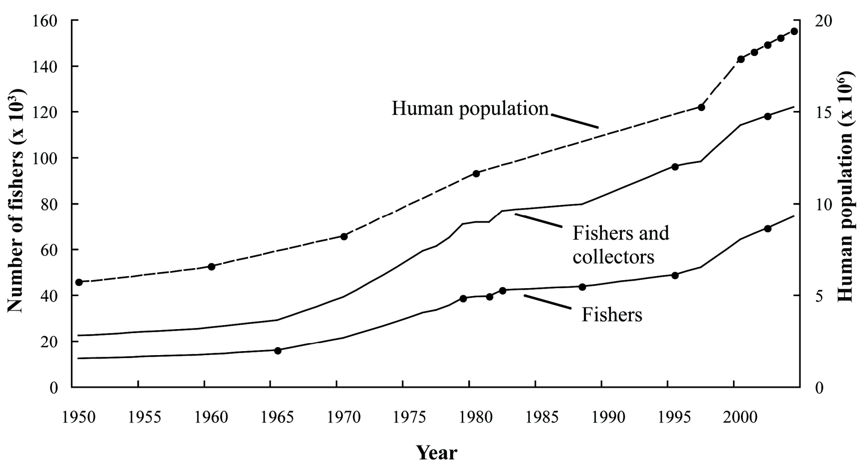

Figure 3.2 Number of fishers, number of fishers and collectors, and human population for Mozambique, 1950-2004. Reported data indicated by anchor points (•).

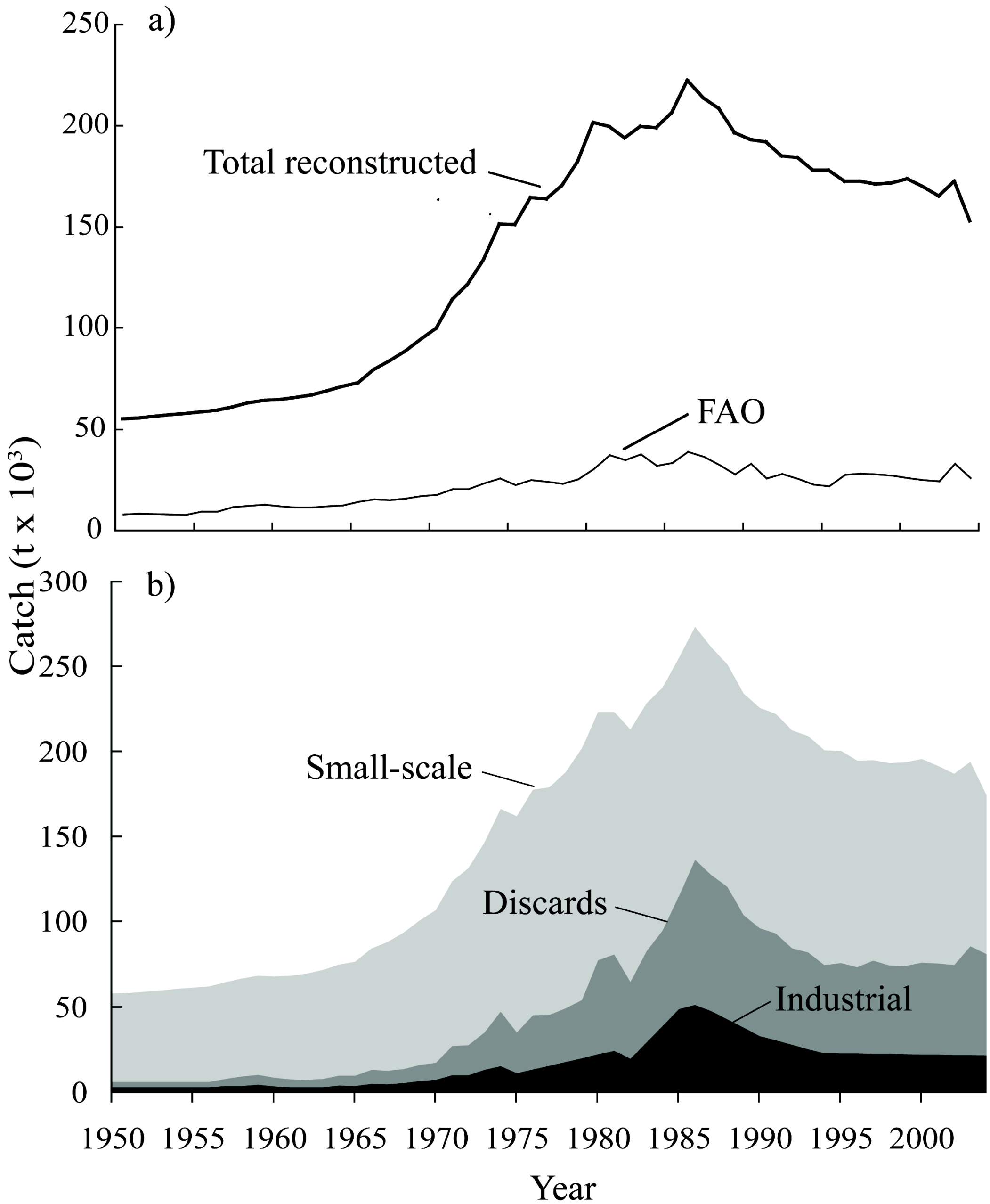

Figure 3.3 Mozambique's marine fisheries catches for 1950-2005, showing (a) total reconstructed catch (small-scale, industrial, plus discards) compared with FAO reported catch; and (b) catch reconstructions by sector.

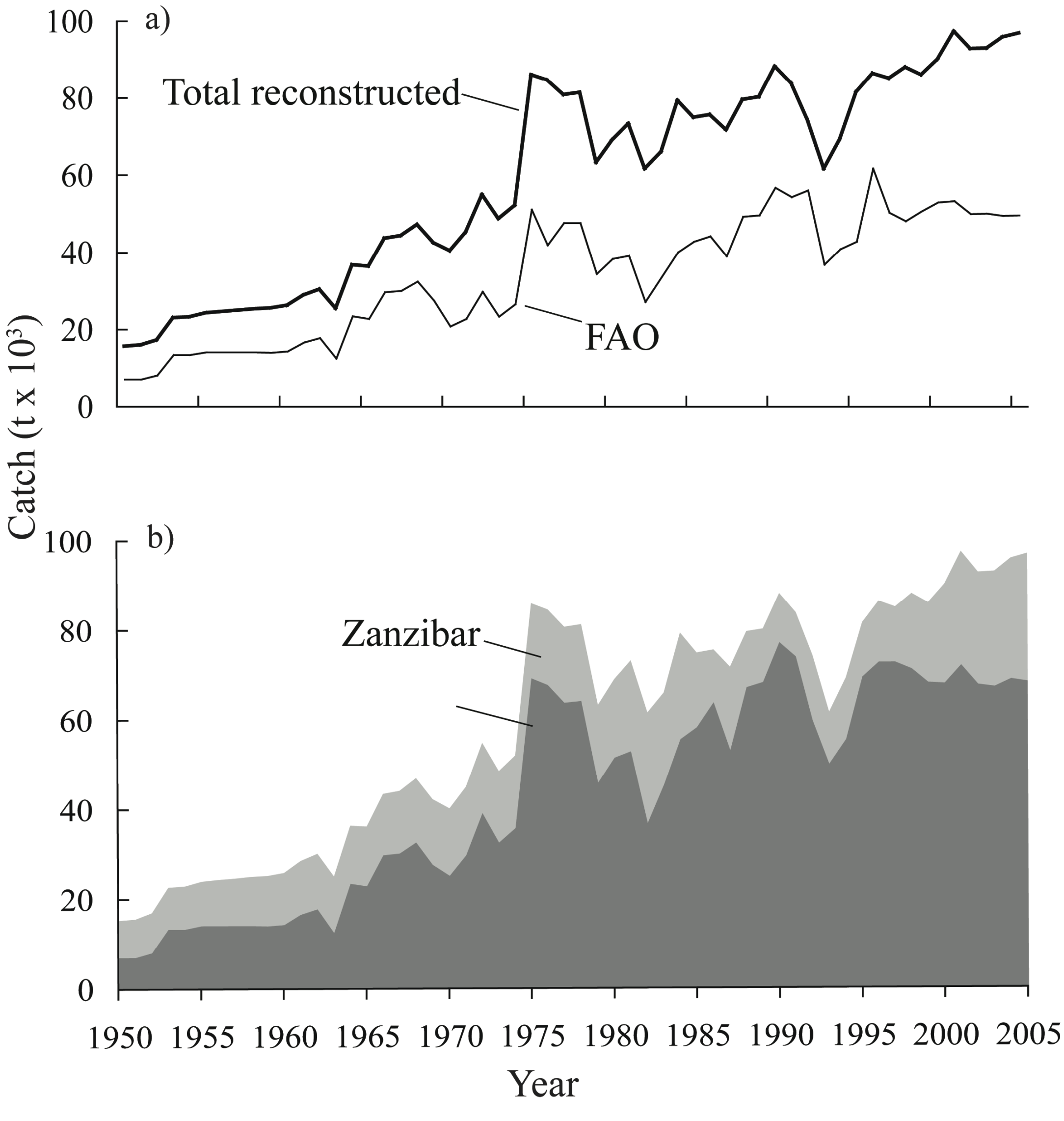

Figure 3.4 Tanzania's marine fisheries catches for 1950-2005, showing (a) total reconstructed catches (Tanzanian mainland plus Zanzibar) compared to FAO reported catch; and (b) reconstructed catches separated by Zanzibar and mainland.

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4 IN HOT SOUP: SHARKS CAPTURED IN ECUADOR'S WATERS[1]

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Introduction

Sharks have survived the dangers of the world's seas for more than 400 million years. Today, over 250 species of sharks exist, ranging in size from tiny pygmy sharks (*Euprotomicrus bispinatus*) to 12 m plankton-feeding whale sharks (*Rhincodon typus*) (Compagno et al., 2005). However, over the last couple of decades, the wasteful practice of shark finning (the removal of dorsal, pelvic, and pectoral fins) for shark fin soup has become a major threat to shark survival.

The consumption of shark fin soup is a Chinese tradition that dates back to second century B.C. In the past, consumption of fins was confined to the privileged classes. But rapid economic growth in China has had impacts on shark populations. A relatively small class of people demanding shark fins has been replaced by hundreds of millions of mouths willing to commonly pay $400/kg for fins. Ecuador exports shark fins to Taiwan, Singapore, China and Hong Kong. Roughly half of all shark fins traded globally are imported to Hong Kong. Between 1991 and 2000, Hong Kong shark fin imports alone grew 6% per year (Clarke, 2004). It is estimated that shark finning alone now claims between 26 million and 76 million sharks annually (Clarke et al., 2006).

Due to naturally slow population growth rates, many sharks are particularly vulnerable to overfishing, prompting the American Fisheries Society to recommend that sharks become high management priorities for fishing nations (Musick et al., 2000). Since the late 1980s, populations of almost all recorded shark species caught in the Northwest Atlantic decreased by more than 50%, with some species (e.g. hammerheads and thresher sharks) showing even greater declines (Baum et al., 2003). The IUCN Red List, a catalogue of species that are at high risk of extinction worldwide, lists 39 species of elasmobranches (i.e., sharks and rays).

The management of shark fisheries is usually difficult, due to a lack of data on shark captures, which results in underestimations of fishing pressure. The biomass of sharks caught globally is estimated to be three to four times larger than the shark catch estimates presented by the United Nations Food and Agriculture Organization (FAO) on behalf of its member countries (Clarke et al., 2006). In Ecuador, we suspected underreporting of shark captures was also a problem.

On the equator

More than 40 shark species are found in Ecuadorian waters, most of which (~90%) are listed on the IUCN Red List. Many of these species are frequently caught, some for meat and some for traditional use, such as angel shark eggs to treat asthma (Martinez et al., 1999). Most sharks, however, are caught and used only for their fins, which are sold primarily to Hong Kong traders but might also be exported to Taiwan, Singapore, and China. The shark fin trade has existed in Ecuador since at least the early 1960s (INP, 1964).

Sharks are often caught incidentally in various fishing gears, including, pelagic and bottom longlines, drift and set gillnets, handlines, and shrimp trawls (Watts and Wu, 2005). According to Ecuadorian law, fishers are not allowed to target sharks specifically, though the high price to be gained from shark fins subverts this regulation. ‘Incidental catch’ can make up as much as 70% of total landings (Aguilar, 2006). Sharks are finned and the carcasses are often discarded overboard as higher value fish species are used to stock the ship’s hold (Bostock and Herdson, 1985).

In the 1980s, there was concern in Ecuador about the high quantities of dead sharks being thrown back to sea without using the meat (~70 %) (Wood et al., 1988). The government-led attempt in the mid-1980s to increase internal sales of shark failed due to high prices and poor quality (Helder, 1994). There seems to be an aversion to shark meat in Ecuador, particularly on the coast-- perhaps because shark meat spoils rapidly and the quality of meat is often poor (Franciso-Fabian, 2001). Shark meat is sometimes used to make fishmeal and sometimes mislabeled and sold as ‘marlin fillets’, ‘sea bass’, or ‘flounder’ (Revelo and Guzman, 1997).

Large quantities of ‘incidental’ sharks led the Ecuadorian government to limit the export of shark fins in 1989. In 1993, another law was passed to prohibit the extraction of fins without using the meat (i.e. all sharks had to be landed with fins intact) (Franciso-Fabian, 2001). This law was prompted by growing concern that exported shark fins were actually originating from sharks caught within the protected Galapagos Marine Reserve (GMR), 1000 km from the Ecuadorian mainland.

<u>In the islands</u>

Historical accounts of early voyages to the Eastern Pacific point to the profusion of sharks there (Roberts, 2007). On his crowning visit to the Galapagos in 1835, Charles Darwin was impressed by the abundance of marine life and wrote in the Beagle records, “The Bay swarmed with animals; Fish, Shark & Turtles were popping their heads up in all parts.”

In the 1930s, at least one whale shark in the Galapagos Islands was, in the name of science, subjected to “repeated harpooning and a number of shots with a heavy rifle” (Gudger, 1933). Not long afterward, in the 1950s, shark finning in Galapagos became a commercial enterprise (INP, 1964). In the late 1980s, tens of thousands of sharks were caught for the Asian market (Camhi, 1995).

In 1998, industrial fishing (and shark finning) was prohibited in the GMR, which today encompasses a 40-mile radius around the archipelago. In 2000, the Inter-Institutional Management Authority of the GMR prohibited shark fishing, landing and trading of any type in the Galapagos Archipelago (the Ministry of the Environment officially enacted this legal resolution as an Ecuadorian Law in 2003). The Galapagos Islands and Marine Reserve are now a World Heritage Site and internationally recognized for their rich marine biodiversity. Galapagos waters are home to 30 species of sharks that come to the nutrient rich waters to visit symbiotic cleaning stations, where cleaner fish pick parasites from the sharks' bodies (Zarate, 2002). The GMR also provides a unique opportunity to reliably scuba dive with sharks. In 2006, more than 145,000 tourists visited Galapagos—representing a total value of $418 million, an estimated $63 million of which remains in the local economy (Watkins and Cruz, 2007).

Though capturing sharks is prohibited, illegal shark finning by local Galapagos fishers has been on the rise since the collapse of the sea cucumber fishery in the late 1990s (Watts and Wu, 2005). Mainland Ecuadorian and foreign (e.g. Colombian, Costa Rican, Japanese, Taiwanese, and Korean) industrial fishing vessels also illegally fin sharks within the Galapagos Marine Reserve. Over the last two decades, Ecuadorian authorities have apprehended a small fraction of local, national, and international fishing vessels illegally shark finning within the Reserve's boundaries. In 2001, the author witnessed the incineration of its 1044 shark fins and the at-sea disposal of 78 carcasses after the Galapagos National Park detained the Costa-Rican long-lining vessel, *Canella II*, for fishing illegally in the GMR. Given roughly 5 fins per shark, the crew of *Canella II* likely killed at least 200 sharks but retained only 78, which supports accounts of high rates of discarding in shark fisheries.

Fin flop: export legal or illegal?

Partly over concern for the Galapagos, the President of Ecuador signed a decree in 2004 for the complete ban on the export of shark fins, even from the mainland (Watts and Wu 2005). But shark finning is very lucrative; fishers receive a minimum of $20/kg (Franciso-Fabian, 2001). The only comparable activity in terms of profitability is drug trafficking. Thus, the export of mainland shark fins continued after the ban (the photos featured here were taken in May 2005) and, during this time, many shark fins were smuggled to Peru or simply labeled as ‘plastic sheeting’ or unspecified marine products. (Watts and Wu, 2005). In July 2007, against the advice from conservation groups, the Ecuadorian President overturned the ban on shark fin exports.

Despite this long history of shark fishing and the problems of illegal shark finning, the FAO did not begin reporting shark data on behalf of Ecuador until the 2005 update of data (which retroactively included statistics from 1991 to 2005). However, knowing that shark finning has existed at least since the early 1960s, this study reconstructs historical shark catches for the Ecuadorian mainland using sporadic data on shark landings. We examined the period 1979-2004, from when the FAO database for trade in fisheries began until 2004, when shark fin exports were officially banned.

Methods

For the purpose of this study, we considered shark captures by Ecuadorian mainland fishers in the two categories used by government and grey literature reports: small-scale and industrial. For the small-scale sector, shark catches were available for 1982 and 1987-2004, though the

1988 data point was discarded because it was anomalous (more than three times higher than the average annual catch). However, of Ecuador's 138 small-scale fishing ports, these data were representative of only 8 monitored ports: Esmeraldas, Manta, San Mateo, Santa Rosa, Anconcito, Engabao, Playas, Puerto Bolivar (Solís and Mendívez, 1999). According to a 1999 survey of fishers, this represents only 21,005 of the nation's 56,068 fishers. Assuming fishers nationwide have comparable average per capita catch rates, this implies that reported catch reflects only 37.5% of Ecuador's total shark catch.

National reported shark landings were thus increased by 2.7 times to give countrywide estimates and account for the number of ports and 62.5% of fishers that went unmonitored. For the years 1979-1981, when small-scale shark landings were unavailable, I assumed the sharks to be 5% of total small-scale marine fisheries landings (the average ratio of sharks to total catch for the years 1982 and 1987). For years between 1982 and 1987, I interpolated the ratio of sharks to total catch (ranging from 4-6%) and multiplied this by the small-scale catch reconstructions to obtain annual shark landing estimates.

Estimates of sharks landed by industrial fishing boats were available for 1979-1982 and 1990-1995. Industrial landings between 1982 and 1990 were interpolated. For the years 1996-2004, I assumed an industrial catch equal to the average annual industrial catch from 1990-1995 (608 t). I then aggregated the small-scale shark catch estimates and the industrial shark catch estimates to obtain total estimates for mainland shark landings.

FAO recently made shark captures available for Ecuador for the period 1991-2005 (www.fishstat.org). Ecuador's shark fin export data were obtained from several sources from 1979 to 2004, including the FAO commodities and trade fisheries database. Data were not available for the year 1996, which I interpolated. Dried shark fins conservatively represent 1-2%

of the live weight of sharks (Bostock and Herdson, 1985). Thus, I used an average of 1.5% to obtain estimates of live shark weight from dried shark fin weights (Table 5.1).

Results

I compared reconstructed catches with import data and FAO data (Figure 4.1). From the period of FAO reporting, 1991-2004, Ecuador's estimated shark landings are 3.6 times greater than FAO reports. Reconstructed shark landings for the Ecuadorian mainland averaged 6868 t per year from 1979-2004, with small-scale fisheries accounting for 93% of total landings. On average, shark fin exports from Ecuador were 109 tonnes per year over the 1979 to 2004 time period, or an equivalent of 6950 t in live weight per year. From 1998-2004, Ecuadorian shark fin exports exceed mainland catches by 44%, or an average of 3850 tonnes per year.

The FAO commodities and trade database only reports shark fin exports for the years 1981-1994, though national data sources (Table 4.1) clearly show that shark finning has occurred for at least ten additional years.

Discussion

This research shows that shark landings by Ecuadorian mainland fishers are three to four times greater than those reported by FAO (1991-2004). These findings agree with broader research indicating that global shark catches globally exceed the values presented by FAO by a factor of three or four (Clarke et al., 2006). Our results further support the notion that the use of FAO figures to characterize trends in shark fin trade may lead to false conclusions (Clarke, 2004).

Curiously, the fisheries data reported to the FAO by Ecuador did not include any shark catches until the 2005 update of data. Though reports indicate that 28 species of shark are commonly caught in Ecuador's waters, only six categories of sharks are reported by FAO on behalf of Ecuador: thresher sharks; shortfin makos; miscellaneous sharks; requiem sharks; hammerhead sharks; and houndsharks and smoothhounds. The absence of shark fin export data in the FAO database subsequent to 1994 is also problematic.

Great discrepancies not only exist between what FAO reports (and hence Ecuador) and what Ecuador catches on the mainland, but between what Ecuadorian mainland fishers capture and the amount of shark fins Ecuador exports. In the late 1990s, after the collapse of the sea cucumber fishery, many newly immigrated Galapagos fishers turned to fishing for sharks. There are anecdotes to suggest an estimated 80% of Ecuador's shark fin exports originated from Galapagos (WildAid, 2007). Our results suggest that, since 1998, an average of 44% of Ecuadorian shark exports are unaccounted for, and it is possible that sharks from the Galapagos account for this gap.

We recognize the amount of uncertainty in these reconstructions, but believe they better represent reality. Furthermore, these estimates of shark landings are likely conservative minimums given reports of high rates of shark discards. Sharks caught as bycatch while fishing for pelagic species, particularly before the 1990s, were likely discarded at sea and this bycatch is large and unaccounted for. According to reports from the Inter-America Tropical Tuna Commission (IATCC), Japanese long-liners also finned sharks through the 1990s (Merlen, 1995). Both of these sources of finning are not accounted for here.

Aside from reconstructing catches, anecdotes can be an important source of understanding for resource management (Pauly, 1995). Fishers report that that catches of shark per fisher have declined (Watts and Wu, 2005). Catch compositions of sharks might have also changed. In 1985, makos, tiger, bulls and Galapagos sharks were the most commonly caught sharks (Bostock and Herdson 1985). Today, in Manta, which some sources described as the epicenter of Ecuador's "shark mafia", blue sharks (*Prionace glauca*) and pelagic thresher sharks (*Alopias pelagicus*) make up nearly 90% of all shark landings; the former is listed as 'near threatened' and the latter as 'vulnerable' and facing a high risk of extinction in the medium-term future on the IUCN Red List (Aguilar et al., 2007).

Worldwide, an estimated 1.7 million tonnes of sharks are killed annually for their fins alone (Clarke et al., 2006). As top predators, sharks exert important controls on food webs and ecosystem function (Worm et al., 2002). The disappearance of sharks could have major impacts on marine ecology. The removal of sharks in the northwest Atlantic caused a trophic cascade and an increase in their food source, cownose rays, which led to a subsequent decline in commercially valuable scallops (Myers et al., 2007). A trophic model of Galapagos fisheries indicates that the removal of sharks would cause an increase in toothed whales, sea lions, and other reef predators, which would cause decreases in commercially valuable grouper (Okey et al., 2004). However, whether sharks are keystone predators is debatable, particularly in areas where tunas and billfishes are central to ecosystem function, such as the Central Pacific (Kitchell et al., 2002). But the goals of conserving biodiversity, the waste associated with finning, tourism, and precautionary principle (particularly due to slow-growing shark populations) are also sound reasons to preserve sharks.

Given the worldwide distribution of sharks and their susceptibility to overfishing, a call for international collaboration in shark management was made two decades ago (Manire and Gruber, 1990). In 1989, the Convention on International Trade in Endangered Species (CITES), which provides an international legal framework for preventing trade in endangered species, imposed an international ban on ivory. Comparing shark finning to killing elephants only for their tusks, several conservation groups are calling for a similar global ban for shark fins.

Though a global ban on shark finning has not yet been adopted, some nations have banned shark finning outright, including the U.S., Canada, Brazil, and, for a short while, Ecuador. The Bahamas banned shark finning for the simple reason that revenues generated by live sharks exceed the revenues generated by dead ones (Watts, 2001). In 2004, the International Commission for the Conservation of Atlantic Tuna (ICCAT) adopted an international ban on shark finning. The Inter-American Tropical Tuna Commission (IATTC) followed in 2005. In June 2007, CITES adopted a proposal to ban international trade in sawfishes, shark relatives considered to be critically endangered around the world.

In 2004, when Ecuador banned the export of shark fins, it had some of the most progressive shark legislation in the world, though its effect on the water was questionable. Today, a commercial export market for shark fins is again legal and in full effect. Researchers claim "shark stocks can be harvested sustainably and, if carefully managed, can provide very stable fisheries" (Walker, 1998). The question in Ecuador is not whether a shark fishery can be sustainable but whether it can be carefully managed.

The reconstructed shark captures presented here, which should be taken as minimum estimates, show that Ecuador's shark fisheries are more exploited than previously believed. These findings support urgent implementation of the measures Ecuadorian law mandates: eliminating targeted shark captures, finning, and transshipments, as well as adoption of measures to minimize incidental capture. Furthermore, the discrepancies in data show that monitoring of sharks is sporadic at best. Thus, a serious shark landings monitoring system and effective chain of custody standards are needed.

Better labeling is also needed for all fisheries products, including sharks (Jacquet and Pauly, 2008). In Ecuador, shark meat and fins are often mislabeled. In Hong Kong, customs data would be dramatically improved by establishing a Hong Kong-based customs inspection program for shark fins and other shark products. Furthermore, trade quantities often cannot be compared due to differences in commodities codes. Efforts should be made to more strictly teach and enforce these codes (Clarke, 2004).

Other shark conservation efforts in Ecuador include the Eastern Tropical Pacific (ETP) Marine Corridor Initiative. In 2004, the United Nations Foundation and Global Conservation Fund granted $3.315 million to strengthen five marine reserves in the eastern Pacific and to promote regional cooperation on marine conservation issues in the eastern Pacific. This has allowed initial implementation of the ETP corridor that will provide much-needed and long overdue protection for migratory species, such as sharks, sea turtles, whales, and seabirds. This large multiple-use area spans 521 million acres (211 million hectares) of ocean and constitutes the largest marine area explicitly managed for conservation and sustainable use under a voluntary cooperation agreement in the Western hemisphere. The tuna industry and some other fisheries have opposed the corridor, but the countries involved are all supportive. Overcoming this resistance and achieving active support of the industrial fishing sector is crucial to ensure that migratory species protected within national marine protected areas (MPAs) are not decimated in open waters. The recent placement of Galapagos on UNESCO's list of endangered World Heritage Sites further highlights the need for improved marine management even in relatively well-financed MPAs.

These top-down approaches are also complemented by bottom-up projects. The group WildAid is working to eliminate demand for shark fins soup and also initiated many country campaigns in

Ecuador. They are also helping in efforts to find substitute products for shark fin. The main culinary attraction of shark fins is their gelatinous texture. In proportion to its size, there is more gelatin in a shark's fin than any other living thing (Caldwell and Ellison, 1978). The texture of shark fin is important in making the soup, but shark fins are essentially tasteless. The flavor of shark fins soup relies entirely on the broth, usually made from chicken (Watts, 2001). Efforts to make shark fin analogs out of pork and melon rinds are underway. However, there is nothing that can substitute for sharks in the sea.

Tables

Table 4.1: Reconstructed data and sources used to estimate total shark landings, FAO data, and fin exports (t)

Year	Small-scale	Industrial	Mainland total	FAO[1]	Fin exports	Estimated live weight based on fin exports
1979	4290	378[7]	4668	--	128[8]	8533
1980	4046	77[7]	4123	--	121[8]	8067
1981	4758	169[7]	4927	--	142[8]	9467
1982	4741[2]	688[7]	5429	--	142[8]	9467
1983	3994	620	4614	--	89[8]	5933
1984	4889	553	5443	--	95[9]	6333
1985	4958	486	5445	--	76[9]	5067
1986	4494	419	4913	--	63[9]	4200
1987	9219[3]	352	9571	--	75[9]	5000
1988	9827[3]	285	10112	--	83[9]	5533
1989	10435[4]	218	10653	--	91[9]	6067
1990	4347[4]	151[4]	4498	--	92[9]	6133
1991	8696[4]	230[4]	8926	2600	85[1]	5667
1992	6957[4]	168[4]	7125	2423	82[1]	5467
1993	12173[3]	614[4]	12788	4131	84[1]	5600
1994	11304[4]	936[4]	12240	4004	101[1]	6733
1995	8696[4]	1548[4]	10244	2803	105[1]	7000
1996	9621[3]	608	10229	1805	--	6167
1997	9989[4]	608	10597	1874	80[10]	5333
1998	4247[5]	608	4954	980	77[10]	5133
1999	1665[4]	608	2272	625	124[10]	8267
2000	2608[6]	608	3216	807	154[10]	10267
2001	7438[6]	608	8046	2790	145[10]	9667
2002	5653[6]	608	6261	2120	158[10]	10533
2003	3721[6]	608	4329	1400	127[10]	8467
2004	2338[6]	608	2946	1254	99[10]	6600

SOURCES: 1) FAO (2007) 2) Herdson et al. (1985) 3) INP (1999) 4) Arriaga & Martinez (2002) 5) Revelo (1999) 6) INP (2005) 7) Bostock & Herson (1985) 8) Willman (1984) 9) Scott & Torres (1991) 10) Watts & Wu (1995)

Figures

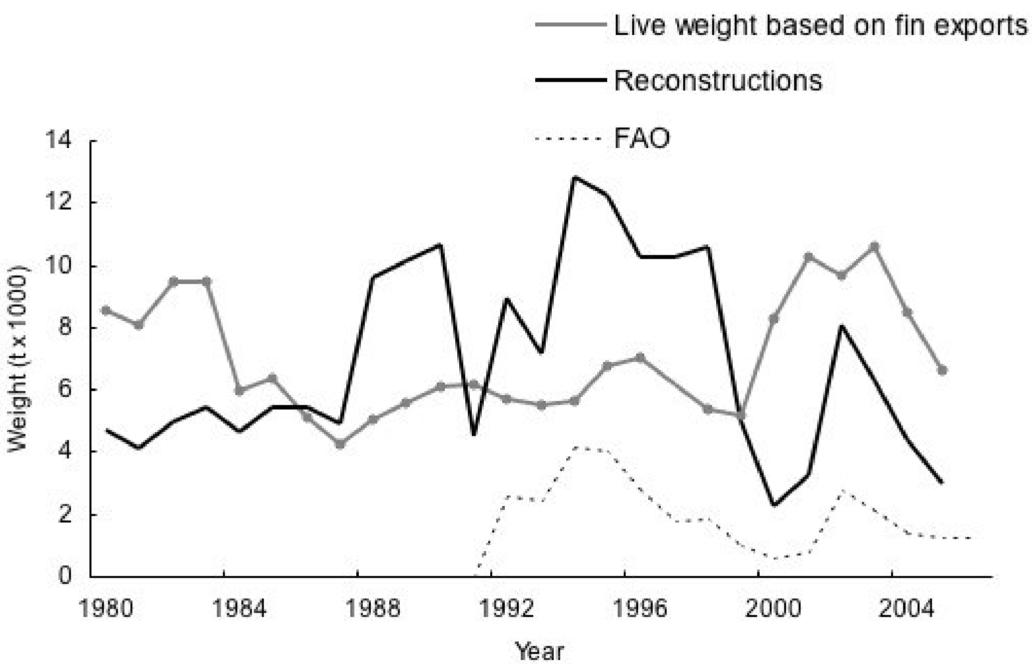

Figure 4.1 Sharks caught in Ecuador, 1979-2004

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5 COUNTING FISH: A TYPOLOGY FOR FISHERIES CATCH DATA

Introduction

Some fisheries catch data serve only as eulogies for once thriving enterprises (e.g. the North Atlantic cod fisheries). Conversely, some data-poor fisheries may be well managed (Johannes, 1998). The usefulness of catch data can be debated, but the general assumption is that scientific evidence based on data is a prerequisite for policies to protect resources, including fisheries resources, and to manage the people using them. In his description of sustainable fisheries, Charles (2001) writes, “It is a truism that good decisions require good information.”

Global fisheries reports, data, and interpretation are part of the mandate of the Food and Agriculture Organization of the United Nations (FAO), whose constitution requires the collection, analysis, interpretation, and dissemination of information related to nutrition, food, and agriculture (Ward, 2004). The FAO (1997) definition of ‘Fisheries Management’ includes “the integrated process of information gathering”. The United Nations Convention on the Law of the Sea (UNCLOS) in 1982 provided an international framework for highly migratory fish stocks and is even more explicit about the data collecting principles countries should follow.

Since 1950, FAO has compiled, from every country, reported fisheries landings and related data broken down into weight by taxa as well as spatially, by 18 large statistical areas. This database, known as FishStat (see http://www.fishstat.org), provides the only comprehensive global time series for national fisheries landings.

FAO catch data have served as the primary source for many global and regional studies evaluating and interpreting global fisheries trends (Garcia and de Leiva Morena, 2003), demonstrating ‘fishing down the marine food web’ (Pauly, 1998), estimating the fuel usage by the global fishing fleet (Tyedmers et al., 2005), inferring the potential collapse of fisheries worldwide (Worm et al., 2006), or assessing potential management options (Costello et al., 2008). Policy-makers, and organizations that set out to inform them (e.g. the World Resources Institute), often use FAO catch data to determine national earnings from fish exports, production trends, and per capita fish consumption.

FAO catch data are also used in conservation policies. An example is the Marine Trophic Index, partly based on global fisheries data and quantifying changes in marine food webs, which is one of eight measures of biodiversity to be used by countries party to the Convention on Biological Diversity (Pauly and Watson, 2005).

At the same time, recent studies have called into question how closely FAO fisheries data correspond to reality (Clarke et al., 2006; Watson and Pauly, 2001; Zeller et al., 2007). In general, the deficiencies associated with FAO catch data are the responsibility of FAO's member countries, where human resources and the political agenda affect data quality. Also, because FAO requires countries to report fisheries 'landings' rather than 'catches', many fish that are caught but not landed (e.g. discarded fish) are excluded from the datasets.

Here we present a simple typology for fisheries data with examples in each category. We hope this helps to illustrate and raise awareness about some issues of data quality so as to address and overcome them.

A Typology of fisheries data

The general classification framework for fisheries data presented here conceptually combines the possibilities of the 'knowing' and 'reporting' of fisheries catches. We recognize that both 'knowledge' and 'reporting' of a country's catch can occur in degrees, so it is best to consider each of these fields as a continuum. At the national and international level, we recognize countries can never report *all* of their catch. Given these caveats, fisheries catch data are best considered in four broad categories (Table 5.1), each of which applies at every link in the supply chain of data collection--from the original fisher to the collection agencies (e.g. local, national, regional, and global).

<u>Catch known and reported</u>

This is the ideal classification toward which fishers and collectors of fisheries data should strive. In this scenario, reported catch reflects as accurately as possible the actual catch being taken. At the national and international level, we suspect this is an empty data set; each time we investigate at those levels, assumed reporting accuracy evanesces. For example, the U.S.A. is often thought to have good catch statistics. However, upon close inspection, the statistics of the National Marine Fisheries Service do not include discarded bycatch (Harrington et al., 2005), recreational fish catches (Coleman et al., 2004), illegal catch (J. Sutinen, pers. comm.), nor fish caught within the three-mile coastal limit of state waters (e.g., Arctic Alaska; Booth and Zeller, 2008), which means that the reported national catches are lower than actual catch.

The best examples of knowing catch and reporting it are fisheries with high levels of observer coverage. The groundfish trawl fishery in British Columbia, Canada, for instance, has had 100% observer coverage since 1996 (Branch et al., 2006). Often, actual catch for such fisheries is reported spatially in great detail at the regional level (i.e. for assessments of specific stocks and management), but not publicly available because the spatial data are deemed commercially sensitive. It is also uncertain whether non-target catch and non-retained catch ends up being reported as fisheries ‘catches’ at the national, hence international level.

Catch known and underreported

This is likely the most common category for fisheries statistics. In this case, actual catch is greater than reported catch. The case of underreporting known catches (or not reporting them altogether) can be an intentional form of cheating and often takes place due to illegal activity at the enterprise (or fisher) level. In fisheries, data recording and hence reporting, are stymied by disincentives for fishers to report catch—i.e. the opportunity costs associated with taking time to complete forms, fear of punishment, political support, and material gain (Herrera and Kapur, 2007), though this has not always been the case (Rosenberg et al., 2005). The consequence of present-day underreporting catches is to subvert stock assessments and management, which leads to overoptimistic catch quotas, and undermine the sustainability of fisheries.

From shrimp and finfish trawl fisheries in the Eritrean EEZ (Tesfamichael and Pitcher, 2007) to sturgeon poachers in Oregon (Cohen, 1997), underreporting by fishers who know their catch is very common worldwide (Pitcher et al., 2002). Globally, Illegal, Unregulated and Unreported (IUU) catches were estimated as at least 11 million tonnes in 2007 (roughly 15% of total catch) valued between US$10 and $23 billion (Agnew *et al*. 2008).

The non-reporting of discards is particularly problematic. In some fisheries, good estimates of discards are available and could be expanded gear-wide or even country-wide, such as the study that estimated that nearly one-quarter of all fish caught by U.S. fisheries are discarded (Harrington et al., 2005). In other cases, it is necessary to rely on expert knowledge to complement literature for estimates of discards. This was the case for total catch estimation in Mozambique, which had to rely on grey literature and personal communication for an estimate of shrimp fisheries discards, which accounted for nearly two times the landed amount of targeted shrimp (Jacquet and Zeller, 2007a).

Intentional underreporting of catches also transpires due to the activity known as 'high grading', whereby fishers replace an initial catch of fish in the ship's hold with more valuable ones caught later and throw away the initial catch. High grading occurs because the replacement fish are fresher, or larger, or are a more valuable species. High grading obviously subverts catch statistics, as the discarded fraction of the catch is not reported.

Misreporting, when fishers know what they catch but report it as some other species, is also common (Jacquet and Pauly, 2008). When English fishers exceed their cod quota, they simply mislabel their cod as 'ling' (Clover, 2006). Around 40% of randomly tested shark fillets labeled as 'lemon sharks' in New Zealand were discovered to be hammerhead and bronze whaler sharks, which are illegal to target (Smith and Benson, 2001).

Knowing the catch and not reporting it does not always occur at the fisher level nor is it necessarily associated with clandestine behavior. The island of Zanzibar, Tanzania, for instance, reports its fisheries catch through a fisheries institution independent from the mainland Tanzanian fisheries institution. The catch is known (between 10,000-25,000 tonnes annually over the last few decades), but Zanzibar's catch is not incorporated into the official Tanzania statistics and hence is not reported to FAO on behalf of Tanzania. This oversight is significant, as Zanzibar fishers account for one-quarter of the country's catch (Jacquet and Zeller, 2007b).

Catch unknown and overreported

In this peculiar case, reported catch exceeds actual catch. This type of intentional misreporting usually stems from a strong centralized government with a state directive for a planned growth in fisheries. Watson and Pauly (2001) described an instance of this statistical malpractice when their predictive fisheries models could not explain reported catch trends of several countries, including China. China's high reported catches (and the regular, annual increases in reported catches) were in accordance with the central government's fisheries growth policies but not with what their large Exclusive Economic Zone was capable of biologically producing. Hence, China overreported fishery catches each year between the mid-1980s and 1998. As a consequence, FAO now presents global fisheries with China separate from the rest of the world.

Catch unknown and underreported

Similar to the case of knowing the catch, but not reporting it, this scenario also results in actual catches being larger than those reported. Often, not reporting is not intentional but instead an oversight due to lack of resources, cultural biases, or perceived management and hence reporting mandate. This scenario is the one most commonly applicable to the small-scale sector, including subsistence fishing (Chuenpagdee et al., 2006; Pauly, 2006) and recreational fishing (Zeller et al., 2008).

In general, data collection for the subsistence or small-scale fishing sector seems to suffer the 'streetlight parable': the search for lost keys focuses under the streetlight where one can see best but not necessarily where the keys can be found. Although collecting data from industrial fisheries and a few small-scale ports or markets may be easier, it may be unrepresentative of total catches.

In Ecuador, for example, national fisheries data is only gathered from 8 small-scale fishing ports, representing only 38% of the nation's fishers (Jacquet et al., 2008). Similarly, in Mozambique, only 115 of the 658 small-scale ports are monitored and reported. Thus, reported catches for the Mozambican small-scale sector reflect the landings of only 62% of canoe fishers

(Jacquet and Zeller, 2007a). In both cases (and likely others), fisheries catches are not extrapolated to the country as a whole and we suspect this oversight occurs in many countries around the world.

Discussion

It is our hope that this typology of fisheries catch reporting can be used when considering issues of data quality and possible gaps in information. There are several indicators that suggest to which category data belong (Table 5.1). For instance, if a dataset describes a fishery with high levels of observer coverage or high resolution to the species level, it is likely the data reflect a fishery where the catch is known and reported. On the other hand, if only export commodities (e.g. shrimp, tuna) are reported in a national dataset or per capita fish estimates based on reported data are much lower than those collected from independent sources or those reported in other countries regionally (e.g. in Mozambique), there is probably a good portion of the nation's catch that is unknown and underreported.

Several options exist for improving the problem of reporting and understanding historical fisheries catches. First, scientists and fisheries managers must accept that an estimation of catch (even a crude one) is preferable to the alternative (and less true) option of reporting zero fish caught. Essentially, a careful non-zero estimate, although not necessarily with high statistical precision, has clearly a higher statistical accuracy than a precise, but inaccurate reported catch of zero in catch statistics (no data being interpreted as zero catch). The need for improvement in this realm is particularly evident in the non-industrial, non-commercial fishing sector, where increased efforts should be made to establish comprehensive, even if from non-annual sampling and estimation, schemes (Zeller et al., 2007). At the national level, frame surveys, which count the number of fishers, per fisher catch rates, and are designed to complement port sampling, should be used to obtain countrywide estimates of fisheries catches. International and regional organizations (e.g. FAO, SPC) could facilitate, train, and coordinate efforts to re-estimate total catch using sampling, expansion, and interpolation methods.

Researchers must also recognize the need to synthesize historical documents and incorporate anecdotes into their work. Many existing documents tend to reiterate the commonly held assumption, based on biased databases, that many fisheries catches are small. What often needs to be done is a re-estimation of fisheries catches from the bottom up, even if that means using anecdotes, which can be as “factual as a temperature record” (Pauly, 1995) and must be considered to counter the shifting baselines syndrome. Studies affirm that the incorporation of historical anecdotes and reconstruction of catches can provide better baselines and compelling results (e.g. Jackson et al. 2001).

For commercial fleets, industry funded onboard monitoring systems should be developed and promoted. Other measures and incentives have to be implemented to increase the reporting rate and correctness in commercial fisheries, including adding fisheries observers to more fleets. Similarly, the international community should initiate efforts (via FAO) to get fishing fleets as well as countries to begin collecting and reporting more reliable data on fisheries discards. To further improve data, the international community must agree to and establish a better system of monitoring on the high seas (Agnew et al., 2008).

When portions of annual catches are not included in stock assessments, the result may be incorrect estimates of sustainable catches. The issue of fisheries data reporting is not trivial and the concern is not only for the resource. Chronic underreporting of the small-scale fishing sector can, for instance, lead to inequitable policy decisions that favor industrial fisheries (that often compete for the same resources), to the underestimation of the contribution of small-scale fishing to national GDP (Zeller et al., 2006), and to jeopardizing food security (Jacquet and Zeller, 2007a). Furthermore, corrections to inflated Chinese catch data suggested that world fish catches were not increasing but, in fact, declining (Watson and Pauly, 2001).

Similarly, improvements in data collection and/or reporting over the last decades may distort data trends. The FAO catch data are not static and can change each year as FAO tries to improve reporting, or receives modified member country data. But one must be careful at how to interpret improvements. In Mozambique, new systems of reporting implemented in 2003 indicated catches in the small-scale fishing sector were more than double those previously reported (Jacquet and Zeller, 2007a). But this does not mean that fishers are twice as well off or that there was an increase in small-scale effort. This simply showed a change in data collection methods. In fact, the balance of evidence suggests that Mozambique fisheries are over-exploited and catch rates have declined (Jacquet and Zeller, 2007a).

Conclusion

Astronomers use high-powered telescopes to peer across the universe at light that has traveled through space for billions of years. Such 'superb seeing' enables astronomers to look directly at the past. Fisheries scientists and managers do not have this astronomical good fortune. Instead, fisheries scientists perceive the past through their own personal experience, the anecdotes of others (written or oral), or, most often, through quantitative national or international catch data sets. Unfortunately, as we have illustrated, these historic data sets have various problems of incompleteness.

Many marine ecosystems were already impacted before 1950, when the FAO initiated its global fisheries catch data compilation. As suggested by Roman and Palumbi (2003), studies involving genetics may give us a good ecological perspective of historical abundance in the oceans. Until we have a better historical picture of ocean ecosystems with the help of genetic data and other data (e.g. Roberts, 2007), the public and its representatives will need to continue to try to make decisions based on societal values that, hopefully, are informed by science rooted in data.

Data are often unreliable, which is what led Hurwicz (1972) to develop his theory of 'incentive compatibility' to show the lack of incentive for people to share their information with the government truthfully. Although it is theoretically possible to get people to reveal their private information (Myerson, 1979), perfect information (i.e. certainty) is frequently missing from statistics, including fisheries data sets. But we should not allow uncertainty to cloud good decision-making, and fisheries managers must focus on the trends of the available data rather than focusing on the unknown (Rosenberg, 2007). When it comes to managing fish, as well as compiling fisheries catch data, it is better to be vaguely right than precisely wrong.

Tables

Table 5.1 Typology of reporting systems for fisheries data.

Catch is…	Reported vs. Actual catch	Characteristics	Indicators	Examples	Sources
Known and Reported	Reported = actual (perfect accuracy)	strong fisheries management structures and adequate resources for monitoring; often developed world	Observer coverage common; high resolution to species level in dataset	Alaska salmon, Canadian West-coast groundfish fishery and sablefish fishery	Branch et al. (2006)
Known and underreported	Reported catch < Actual catch (intentional underreporting)	fisheries often operating illegally—quota busting, defying EEZ boundaries or laws; sectors perceived to be of minor influence and/or without management or reporting mandates	Export data exceed catch data for certain groups/species	discards, shark finning, high grading, renaming and mislabeling, recreational fisheries	Coleman et al. (2004), Jacquet and Zeller (2007b), Jacquet et al. (2008)
Unknown and overreported	Reported catch > Actual catch (intentional overreporting)	centralized government with a policy of economic growth and lacking independent statistical reporting agencies	Increase in fisheries catches suspiciously consistent; biological models do not support supposed amount of fisheries resources being captured	China	Watson and Pauly (2001)
Unknown and underreported	Reported catch < Actual catch (unintentional underreporting)	poor resources for data collection, often developing countries; or sectors not mandated for reporting, often developed world	Only export commodities (e.g., shrimp, tuna) are reported; per capita fish estimates based on reported data are much lower than those collected from independent sources or those reported in other countries regionally	small-scale, subsistence, recreational fisheries	Jacquet and Zeller (2007a); Zeller et al. (2008)

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6 THE RISE OF CONSUMER AWARENESS CAMPAIGNS IN AN ERA OF COLLAPSING FISHERIES[1]

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Introduction

Atlantic halibut, now described as 'America's favorite whitefish,' was considered unpalatable in the early 1800s. By the 1830s, tastes had changed and a market for halibut developed, which led to a vigorous fishery in New England and Nova Scotia (Cushing, 1988). In less than 20 years, inshore halibut stocks of the Western Atlantic collapsed and have not recovered since (Pauly and Maclean, 2003).

Likewise, until the 1930s, Atlantic bluefin tuna were discarded as trash fish in the waters around Denmark (Pauly, 1998). In 2001, a 200-kilogram Atlantic bluefin tuna sold for just under US$175,000 at a Tokyo auction (AP, 2001). It is mainly to feed this market that the tuna fishery has depleted the Atlantic bluefin's spawning biomass to 20% of 1970 levels (Magnusson et al., 2001).

Fish fillets and fish sticks were originally made mostly from cod. After cod was depleted nearly everywhere it occurs, these fish products were replaced by haddock, then redfish, and then, lately, by Pacific pollock (Kurlansky, 1997). The market for seafood may be dynamic, but its consequences are uncomfortably static and predictable. The rising global market demand for seafood has led to an increase in industrial fishing coupled with fisheries mismanagement. The result has been overfishing, the collapse of innumerable fish populations (e.g. Myers and Worm, 2003) and the destruction of ocean habitat (e.g. Watling and Norse, 1998).

Fisheries have fully exploited more than half of the world's fish stocks (FAO, 2004) and drastically altered ecosystems are left in their wake (Pauly et al., 1998). As human consumption of fish has doubled in the last 30 years (Delgado et al., 2003), the world is now eating down the marine food web. Invertebrates and low-trophic level fish are replacing piscivorous species such as cod and swordfish. Rock and Jonah crab, at one time discarded as bycatch, are now marketed in spring rolls and crab congee. The change in public taste is essentially a reflection of the changes in marine ecosystems.

The expansion of bottom-trawl fishing during the 1980s devastated benthic communities and further altered ecosystems. After the removal of predators and competitors, jellyfish have flourished in the Bering, South China, and Black Seas (Pitcher and Pauly, 1998). The seafood market has adapted to these changes and the world harvest of jellyfish is now well over 250,000 tonnes annually, with consumption occurring primarily in Japan (Edwards et al. 2000).

Jellyfish, however, do not appeal to the palate of consumers in the West nor do they indicate healthy marine ecosystems. Thus pressure has built to complement the traditional methods of fisheries management (effort limitation, gear restriction, quotas) with non-traditional methods (e.g., the establishment of marine protected areas). This is the context in which, in North America and European Union, a number of awareness campaigns directed at seafood consumers have developed. This article examines the various limitations and successes of seafood awareness campaigns.

Background of seafood related social marketing

Kotler and Zaltman (1971) define social marketing as the application of marketing to the resolution of social problems. In the 1970s, the field of marketing underwent a major change and its use in changing social behavior was emphasized, though the results were not overwhelmingly successful. The most obvious proponents of social marketing for environmental change were the government (e.g. "Keep America Beautiful") and NGOs (e.g. "Save the Whales"). With the collapse of fish stocks and increase in concern for the oceans, NGOs have launched a variety of seafood related social marketing campaigns, ranging from eco-labeling to the explicit boycott of certain products.

From a policy perspective, the eco-label aims to educate consumers about the environmental effects of the products' production/consumption so as to catalyze a change in purchasing behavior and ultimately reduce negative environmental impacts. From a business perspective, companies are induced to use environmentally preferred production, distinguished by an eco-label, with the expectations of gaining a greater market share and higher profits.

The most famous and controversial seafood label, born in the 1990s with the first eco-labels, is perhaps the 'dolphin safe' logo on tuna cans. The best-established seafood label and most widely discussed (e.g. Constance and Bonanno, 1999; Phillips et al., 2003; Sumaila et al., 2005; Kaiser and Edward-Jones, 2006) is that of the Marine Stewardship Council (MSC). The MSC was created in 1997 by WWF and Unilever, after the latter, one of the world's largest seafood retailers, expressed its goal to source all fish from sustainable sources by 2005. The MSC designed a set of environmental criteria for sustainable and well-managed fisheries along with a label for fish products that receive MSC approval.

Aside from eco-labels, many NGOs and aquariums have launched campaigns to influence consumer behavior. Consumers can consult seafood wallet cards at the grocery or restaurant to determine which fish are ecologically best and worst to eat. The Smithsonian Institution published a cookbook of sustainable seafood dishes. The Incofish Project, funded by the European Commission, produced the 'FisherMin,' a ruler against which shoppers can measure their fish to ensure they are not buying juveniles (for rationale, see Froese, 2004). The fundamental goals of these campaigns are to encourage the public to eschew seafood caught unsustainably and, in so doing, help revive fish stocks on the brink of collapse.

The limitations of seafood awareness campaigns

The market

The main problems faced by seafood social marketing are the characteristics of the market itself, in terms of both consumers and producers. Asia consumes more than two-thirds of the world's seafood (FAO, 1999). Yet, to date, very few Asian consumers discriminate between products in the context of environmental issues and therefore are not targeted by groups like the MSC (Phillips et al., 2003). Furthermore, future expansion in demand for fish and fishery products is expected to arise not only in Asia, but in Latin America and Africa, where consumers are also likely not to be responsive to eco-labeling of fish (Gardiner and Viswanathan, 2004). Gardiner and Viswanathan (2004) also worry that, in the future, high demand from markets not requiring eco-labels could marginalize approaches to eco-labeling, and make eco-labels suitable only for niche markets.

This is perhaps because, unless the program is mandatory, only fisheries that stand to benefit financially from adopting a product certification and label are likely to do so. Many developing countries are concerned that the promotion of eco-friendly products is happening in markets where food requirements have already been met and that small-scale fishers will be left to sell the unsustainable fish by default (Constance and Bonanno, 1999). If eco-labeling cannot serve the needs of the small-scale fishers, i.e. the vast majority of fishers worldwide, how can it be considered in the global improvement of fisheries management? This argument is furthered by skepticism over the support of labeling programs by industrial fishing companies directly associated with the decline of fish population, such as Unilever (Constance and Bonanno, 1999).

Furthermore, in North America, the effect of eco-labels varies significantly between individuals with different levels of education or environmental involvement (Teisl et al., 1999). In terms of seafood eco-labels, Wessells et al. (1999) found few statistically significant variables that affected consumption of eco-labeled seafood. However, their study did reveal that one of the only variables that influenced the choice of a certified product was if the purchaser belonged to an environmental organization. They also found that consumers who generally purchase frozen seafood are less likely to choose an eco-labeled product.

Lack of traceability

Social marketing may be further undermined by more insidious counter-marketing strategies by seafood traders. Because of the absence of traceability, many exporters and even domestic suppliers are able to sell their fish as eco-friendlier versions. For instance, seafood awareness campaigns as well as health and safety organizations have stressed the benefits of tilapia, a vegetarian farm-raised freshwater fish. As a result, the demand for tilapia has increased. In response, the Whitefish Association of Ecuador now sells South Pacific hake, a pelagic, ocean-going fish caught with longlines, filleted and labeled as tilapia (Martinez-Ortiz, 2005).

Sharks, considered undesirable in Ecuadorian city markets, are filleted, relabeled and sold instead as weakfishes or even tuna (Bostock and Herdson, 1985). Using DNA testing, Marko et al. (2004) found that three-quarters of the fish sold in the U.S. as ‘Red snapper’ belong to a species other than *Lutjanus campechanus,* ‘the’ Red snapper (in the U.S.). Re-labeling not only deceives consumers but also provides them with the false sense that fish supply is keeping up with demand.

Lack of traceability and re-labeling of fish also undermines environmental regulations. The National Environmental Trust (2004) published a report on Patagonian toothfish revealing that a considerable amount of illegal toothfish enters the U.S. intermingled with other seafood or under the nondescript title 'frozen fish fillet'. The same report cited the 2001 South African indictment of Hout Bay Fishing Industries, a company that attempted to smuggle two tonnes of toothfish beneath a thin layer of crayfish.

Shrimp suppliers operate similarly. There has been a widespread campaign in Europe to raise awareness of the negative effects of farm-raised shrimp. As a result, Thai shrimp, which account for nearly 30% of global production, are often exported as wild-caught rather than farm-raised. In addition, due to EU tariffs on Thai shrimp, small producers simply smuggle Thai shrimp to Malaysia for processing (Miller, 1999).

Just as the inability to trace fish impedes the aims of consumer awareness campaigns, so does the inability to trace the industrial boats illegally catching those same fish. More than 1200 large-scale fishing vessels fly flags of convenience and more than 1400 fishing vessels operate under unknown flags, a drastic increase from the early 1990s (Gianni and Simpson, 2005). These flags provide cover to globally roaming fishing fleets seeking to evade conservation and management policies.

Greenberg (2005) writes of the pirate fishing boat caught illegally fishing for Patagonian toothfish in the South Georgia Strait. The boat was dynamited, but the owners were never found and the $400,000 fine remains unpaid. Similar accounts of owner evasion are a common occurrence worldwide. These boats land their illegal catches in ports with relaxed import regulations (Greenberg, 2005).

Mislabeling and renaming

Financial incentives associated with eco-friendliness have the unforeseen effect of inspiring fishers and seafood companies to misrepresent their seafood product. Although the Food and Agriculture Organization (FAO) of the United Nations has no official label, Nile perch fillets from Lake Victoria are sold with a self-attributed eco-label claiming the fish were caught under the FAO's code of conduct for responsible fisheries (Pitcher, 2003). This type of misrepresentation is widespread. A study conducted by Kangun et al. (1991) found that more than 50% of environmental advertising is deceptive or misleading.

Financial incentives may also spur undesirable species to be renamed with more appetizing titles. Rock crab, once discarded as bycatch, is now marketed and sold as 'peekytoe crab'. The Patagonian toothfish, an endangered species, is marketed as Chilean sea bass (Knecht, 2006). Slimeheads were opportunely renamed Orange roughy as the market developed (Pauly et al., 2003). Flesh of low value fish is used to make imitation 'krab'. Dual names and name changes confuse consumers and complicate education efforts by seafood advocacy groups.

Few efforts to measure campaign effectiveness

In part due to the amount of manipulation in the seafood market, seafood wallet cards and other related tools have seemingly proved to be ineffective in fulfilling their aims. After distributing over one million seafood wallet cards, the Monterey Bay Aquarium conducted a self-study that revealed no overall change in the market and that fishing pressures have not decreased for targeted species (Seafood Watch Evaluation, 2004). This is an unfortunate contradiction to Sproul's (1998, p. 146) assertion that "an informed consumer is a reformed abuser."

Still, the Monterey Bay assessment documents a genuine concern for results. After more than eight years of effort, the MSC annual reports (MSC, 2004; 2005) declare the number, value, and location of certified products but altogether ignore the certifications' effectiveness (quantifiable or otherwise).

The MSC's first certification was of the Australian rock-lobster industry, a process that cost more than $260,000 (Rogers et al., 2003). Despite the detailed process and indicators of responsible management, there is contention that this certification was done in error and that the rock-lobster industry may not be ecologically sustainable (Sutton, 2003). Similarly, the New Zealand hoki fishery, also certified by the MSC, reported significant stock declines in 2004 (Greenberg, 2005). The MSC may create an incentive for industry to foster effective stock management but has so far failed to demonstrably arrest the decline of fish stocks.

<u>Single species focus</u>

Many of the problems associated with fisheries do not only involve a negative impact on the species themselves, but also on the species that are caught incidentally and discarded as waste (Kelleher, 2005), as well as the destruction of habitat for a taxonomic range of species (e.g. Watling and Norse, 1998). Another foreseeable problem is that encouraging the consumption of 'sustainably caught' fish puts excessive pressure on presently healthy fish stocks.

In an era where understanding that fishery management must be ecosystem based is growing (Pikitch et al. 2004), the rhetoric of seafood campaigns based on a species-specific approach may represent a step backward. As Pauly and Maclean (2003) point out, low-trophic level, farmed fish such as tilapia may be substitutable for high-trophic level, wild fish at dinnertime, but they cannot replace the function of wild fish in the ecosystems from which they were extracted.

Successes of seafood awareness campaigns

Unilever's goal to source all fish for their company from sustainable sources by 2005 was an admirable one, though it was unattained. By 2005, Unilever managed 46% of its European fish products from MSC certified fisheries, but the overwhelming bulk of this was Alaska pollock (Unilever, 2005).

Meanwhile, the MSC has established itself as an independent organization and is gaining momentum (Howes, 2005). It has now certified 40 fisheries (the equivalent of 3 million tonnes of seafood, just under 4% of global production) and labeled more than 300 seafood products. Indeed, the mammoth retailer Wal-Mart announced its ambition to source all of its wild caught fish from MSC certified fisheries within the next five years (Wal-Mart, 2006).

The absence of uniform standards, a former inadequacy of seafood labeling, was recently resolved with a set of standardized guidelines published by the FAO. The guidelines outline general (and voluntary) principles that should govern eco-labeling schemes and minimum requirements a fishery should meet to be awarded an eco-label (FAO, 2006). The development made in the realm of seafood labeling over such a short time span may indeed confirm notable progress toward sustainable fishing practices (as Robinson (2004) proposes labeling, standards and certification has done for sustainable development as a whole) though the question arises of whether the this progress occurs swiftly enough.

Successes are also evident in some other seafood awareness campaigns. Tilapia (or fish labeled as such) is one of the most promoted eco-friendly fish and has moved up from to 9th most consumed fish in America in 2003 to 6th in 2004 (Cox, 2005). However, it is possible the change in preference was price or health driven (due to tilapia's low mercury content).

Some localized campaigns, such as SeaWeb's 'Give Swordfish a Break' campaign, which encouraged restaurant owners to omit swordfish from their menus beginning in 1998, have seen a rebounding of the population. But the success might be attributable to the second goal of the campaign to close nursery areas in the U.S. to fishing, which was achieved in 2000. There is also speculation that consumer concern over mercury levels reduced demand for swordfish.

Also, some NGOs focusing on seafood problems are, in their efforts, discovering the loopholes that prevent the efficacy of their programs and are then lobbying governments for legislative change. For instance, the National Environmental Trust (2004) launched the 'Take a Pass on Chilean Sea Bass' campaign and, while conducting research, found that illegally caught Patagonian toothfish (their real name) would arrive at ports and, before the paperwork could be cleared by officials, the toothfish would make it to market. Therefore, consumers would not know whether their fish is legally or illegally caught. NET successfully lobbied the U.S. government to require that toothfish imports be pre-approved by the National Marine Fisheries Service before being landed (NOAA, 2006).

In addition, consumer awareness campaigns have distributed a large amount of information and, presumably, this is raising awareness and the profile of fish in society. The Monterey Bay Aquarium's study finds that seafood wallet cards do increase awareness (Seafood Watch Evaluation, 2004) and a new ethical concern for the oceans is undeniably important. Many fishing nations are democracies, run by elected governments. Thus, citizens should be capable of reversing the trend of overfishing and consumer awareness campaigns may play a role in their decision-making.

Rethinking seafood and fisheries management

Despite the recent publicity of consumer awareness campaigns and the danger of mercury levels in seafood, U.S. citizens consumed a pound more seafood per capita in 2004 than they did in 2002 (an increase from 7.1 kg to 7.5 kg; Cox, 2005). If the goal is to reduce pressure on wild stocks of fish, then perhaps consumer-oriented conservation strategies need to be reconsidered.

NGO donors may legitimately require measures and reports of campaign effectiveness. In their paper on fisheries eco-labeling, Gardiner and Viswanathan (2004) cite criteria against which to judge different certification schemes. However, they do not mention criteria against which to judge the effectiveness of those certifications on the health of fish stocks. The majority of studies on seafood awareness campaign efficacy are of the *ex ante* variety about indications of willingness to pay or to use a label. Yet, *ex post* studies of seafood awareness campaigns' impacts on the seafood market are virtually nonexistent (except for some aspects in Seafood Watch Evaluation, 2004). Without evidence of seafood awareness campaigns' efficacy, former recommendations to intensify eco-labeling and other market-based efforts to move the fishing industry toward sustainability should be reconsidered.

The proliferation of labels does not necessarily ensure that conservation goals will be met. Organic food labeling is widespread in grocery stores across North America and is considered the most successful eco-labeling program. The California Certified Organic Farmers' eco-label, the predecessor to the 2002 USDA organic food label, has existed since 1973. Yet, from 1991-1998, California increased pesticide use by 40% (Kegley et al., 2006).

Considering the limitations of social marketing of seafood and the limited funding available, NGOs should reflect on the impacts of their programs. In the case of consumer awareness campaigns, they may consider shifting their conservation focus to other avenues. In analogy to the ‘slow food’ movement (Petrini, 2003), Chuenpagdee and Pauly (2005) suggest that NGOs try initiating a ‘slow fish’ movement, that would emphasize the need to slow the rate of fishing, reduce fishing capacity, and support small-scale over industrial fishers. NGOs could encourage fisheries to join such campaigns on the premise that quality can be a more important and profitable attribute than quantity (Martinez-Garmendia and Anderson, 2005). Perhaps NGOs should even consider a ‘no fish’ campaign that encourages boycotting fish altogether and distribute bumper stickers reading, ‘Save the Oceans! Eat a Chicken.’

Today there exists a tendency for environmental policy initiatives to be set outside the government sector, likely because the multinational companies affected by regulation are prominent and influential. Buttel (1992) notes a trend in ‘NGOization,’ whereby NGOs have gained influence previously achievable only by governments; this phenomenon is partly explained by the loss of legitimacy by nation states and international institutions.

But the current faith in the magic of free-market mechanisms must be questioned; we will have to manage fisheries with our heads, not our stomachs. Consumers should not be misled that a system of management or conservation based on purchasing power alone will adequately address the present dilemma facing fisheries globally.

Fisheries are the last major world industry exploiting wild natural resources for food, yet we do not think of the industry in such terms. Consider the U.S. National *Fish* and *Wildlife* Service, a name that implies fish are perceived and managed as something other than wildlife. NGOs can help people realize that fish are wildlife, and not only food. NGOs can also launch environmental education campaigns to alter the view of seas open to fishing will small exceptions (i.e., marine protected areas) to the reverse view, that the seas should be closed to fishing, with small exceptions (Walters, 1998). Through these or other means, NGOs can encourage the public to rally behind the point of serious fisheries management.

Though fisheries regulations may need overhauling (Pitcher et al., 1998), they are needed, nonetheless. A citizen's strongest influence is ultimately his/her engagement in the democratic process and the election of governments committed to fisheries management through curtailing overcapacity, abolishing flags of convenience, strengthening regulations, and ensuring traceability.

When whales were on the brink of extinction, the primary avenue of protection was not a campaign in opposition to using whale oil or against eating whales. Whaling ceased after the emergence and wide public acceptance of a 'whale mythology', which de-commodified them (Pauly, 1994). The moratorium on whaling, ratified by the International Whaling Commission (IWC), was a direct result of the revulsion toward whaling felt through most of the Western world. It is only when a similar revulsion is felt by the public about the wholesale destruction of fish populations and marine ecosystems that we can hope to save them from our management and our appetite.

Chapter 6 references

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7 TRADE SECRETS: RENAMING AND MISLABELING OF SEAFOOD[1]

[1] A version of this chapter has been published. Jacquet, J. & D. Pauly (2008). Trade secrets: Renaming and mislabeling seafood. Marine Policy 32: 309-318.

Introduction

In the 1980s, wild-caught fisheries peaked (Watson and Pauly, 2001). This same decade, trade liberalized and the traceability of all products, including seafood, became a concern. The Uruguay Round of trade negotiations (1986-1994) further enhanced trade in seafood (Timothy Hansen, Director, U.S. Seafood Inspection Program, pers. comm.). In the years that followed, more fish stocks collapsed around the world (Worm et al., 2006), and the issue of traceability, particularly illegal, unregulated, and unrecorded (IUU) fisheries, was identified as a factor contributing to overfishing (FAO, 2007).

The highest priority, in terms of traceability, is combating the global IUU fisheries that are kept afloat by nations that provide flags of convenience and relaxed import and export regulations. Worldwide, thousands of fishing boats scour the seas and employ fishing practices that would be illegal in their home nations (Gianni and Simpson, 2005).

The renaming and mislabeling of seafood is also significant in terms of global seafood traceability concerns. There are several factors to consider when labeling seafood, such as: a) species' identity; b) country of origin; c) production method; d) potential eco-labels. Primarily because consumers, especially in the U.S., are generally unfamiliar with seafood products, each of these factors can potentially be mislabeled. In contrast, wholesalers are often very familiar with their products. Though fishers mislabel seafood, especially if they caught it illegally, the literature reviewed here suggest that mislabeling is most often done by distributors and the final seafood retailer (e.g. fishmongers and restaurants) for the sake of increased profits. A further complicating factor is that many labeling regulations only apply to wholesalers, not restaurants. The widespread mislabeling of seafood negatively affects consumers in terms of price, their ability to make eco-friendly purchases, and potentially their health. Mislabeling also contributes to the further erosion of fisheries, not only because consumers cannot make informed decisions on behalf of conservation, but also because mislabeling undermines import/export seafood regulations.

Globally, the United Nations Food and Agriculture Organization (FAO) Codex *Alimentarius* require the country of origin of all food products to be identified with the exception that "when a food undergoes processing in a second country which changes its nature, the country in which the processing is performed shall be considered to be the country of origin" (FAO, 1985). A recent study indicates that only one-quarter of cans of tuna were labeled with a country of origin, often Thailand, even when the tuna was not caught, but only canned there (Burger and Gochfeld, 2004). Similarly, U.S. supermarkets sell cans of 'Wild Alaska salmon' with a 'product of Thailand' label (authors' pers. obs.).

Many FAO member nations, opposed to any barriers to trade, resist labeling requirements and debate which fish species can share a common commercial name. For example, there is disagreement between Peru and the EU as to what constitutes a 'sardine' (FAO, 2007). For these reasons and other producer concerns over label costs, the FAO Codex may owe its continued viability more to its utility for tax purposes than consumer awareness or protection.

Given the lax FAO requirements, some member nations have adopted their own seafood labeling policies. In 2002, the European Union (EU) implemented regulations to identify the official commercial and scientific name, the origin, and the production method (farmed or caught from the wild) for all fishery and aquaculture products (Moretti *et al.,* 2003), though evidence calls into question how closely these standards are being followed (Evans, 2007). In the U.S., the government recognizes that seafood is often mislabeled, but the enforcement of federal labeling requirements does not reflect a great deal of concern.

As early as the 1930s, canned mackerel was being labeled and sold as 'salmon' (Kallet and Schlink, 1933). But it was not until 1991, after the expansion of seafood trade globally, that the U.S. Food and Drug Administration (FDA) established the Office of Seafood and a 60 percent increase in funding for seafood inspection (Foulke, 1993). After testing seafood for ten years (1988-1997), the National Seafood Inspection Laboratory issued a press release indicating that 37 percent of fish and 13 percent of other seafood (shellfish are more difficult to disguise) were labeled incorrectly (Tennyson et al., 1997).

The FDA now maintains a list of seafood names for industry to use in uniformly labeling its product. The agency provides an online 'regulatory encyclopedia' with the official names for fish and photos of their fillets for use by federal, state, and local officials as well as seafood purchasers (see http://vm.cfsan.fda.gov/~frf/rfe0.html). But legislation that would require adequate seafood labeling requirements has been continually weakened, as was the case with the Country of Origin Label (COOL) Legislation in the U.S., which revised the country-of-origin labeling requirements and made them voluntary rather than mandatory, in part owed to a nearly US$30 million lobbying campaign (Lovera et al., 2005). Furthermore, COOL legislation exempts fish markets, restaurants, and fishing vessels (Golan et al., 2004) as well as processed imports (Food & Water Watch, 2007) from registering in the program.

Those existing U.S. seafood labeling regulations are by and large the result of protectionism. However, after September 11, 2001, the U.S. food supply was analyzed and found to be a security liability; subsequently, the U.S. Bioterrorism Act of 2005 required all links in the food and feed supply chain to be traceable (Hernandez, 2006). But, in 2006, the FDA had only enough resources to check 1 percent of the 8.9 million food shipments imported (Barrionuevo, 2007). The Agency tested only 0.59 percent of seafood imports in 2006—two-thirds the amount of imported seafood tested in 2003 (Food & Water Watch, 2007).

Rather, the traceability of seafood in the U.S. becomes a political priority when the protection of seafood producers is at stake. In Maine, lobster fishers, who started an 'Imposter Lobster' campaign, are working to restrict the use of the 'Maine lobster' label by processors in New Hampshire and Nova Scotia (Anon., 2006). But, of all fish, it is catfish that wields the greatest clout in U.S. Congress.

In 2000, fish farmers in the southern U.S. felt that catfish from Vietnam (which was not permitted to call itself catfish, and is therefore known as 'basa') should be labeled and sold as 'Vietnamese'--the "Product of Vietnam" label on the box apparently not capturing the depth of its foreignness. At the time, Vietnamese catfish accounted for nearly 20 percent of the U.S. market for catfish (Laws, 2001). So southern U.S. Congressmen introduced a bill that required wholesalers and restaurants to correctly label fish—but not all fish, just Vietnamese catfish. A few restaurants questioned why labeling catfish from Vietnam was necessary while labeling their crawfish, imported from China, was not (Walsh, 2001).

To the chagrin of U.S. fish farmers, Vietnamese catfish were also marketed as "Delta fresh catfish" and "Cajun Delight catfish". In 2001, the U.S. Farm Bill was amended so that the term "catfish" could only be used for species of fish raised in the southern U.S., and not for their close cousins from Southeast Asia (Laws, 2001). The farming of catfish, sponsored by the U.S. Agency for International Development (USAID) as part of a post-war reparation project, and again after the 2004 tsunami (USAID, 2005), had been, apparently, too successful.

Fish phonies

Financial incentives are the strongest motivation to rename fish with more appetizing titles or mislabel seafood as a high-priced species. Many fish are given an entirely new name (often similar to that of an already popular fish) to boost sales (Table 7.1). Concerned with the public image of the hogsucker (*Hypentelium* spp.) and stumpknocker (*Lepomis punctatus*), the U.S. National Marine Fisheries Service (NMFS), from 1973-1981, spent US$8.5 million on which "underutilized" fish species should be renamed (Miller, 1981). Even without this expenditure, fish with ugly names would have likely been rechristened.

Cheap hake from South Africa and an Indonesian fish called 'Malabar blood snapper' are now both marketed as 'Scarlet snapper' (Walsh, 2001). In California, rockfish can be sold as Pacific red snapper (Foulke, 1993). Slimeheads were sensibly renamed 'Orange roughy' (Pauly et al., 2003). Aside from being marketed as 'Cajun delight', catfish from Vietnam has also been sold as 'Pacific dory', 'White roughy', and 'Grouper teammate' (Walsh, 2001; Nolgren and Tomalin, 2006). The U.K. grocer Marks & Spencer got permission from trade authorities to sell Witch as 'Torbay sole' (Marks & Spencer, 2007). In the early 1990s, tilapia importers tried to rename their commodity 'St. Peter's fish', since it can be found on the Sea of Galilee in Israel and the name would resonate in the Bible Belt; however, the U.S. FDA did not allow the evangelical makeover (Foulke, 1993). Renaming, though not of fish, can also occur for the sake of political advantages. In 2002, Austin Mitchell, a Labour MP in Britain, temporarily changed his name to Austin Haddock during Seafood Week, to encourage fish consumption and garner support from his fishing constituency (Anon., 2007).

The problem of renaming fish is eclipsed, however, by the magnitude of mislabeling fish as a different species (Table 7.2). Many different fish species masquerade as *Lutjanus campechanus,* 'the' Red snapper in the U.S., found in the southern Atlantic and Gulf of Mexico and a best-selling restaurant fish. In 1992, the FDA intercepted around 550 kg of fresh rockfish from Canada mislabeled as Red snapper (Foulke, 1993), but this indictment was minuscule compared to the amount of Red snapper fraud that has occurred over the last two decades. Several studies indicate that 70 to 80 percent 'Red snapper' sold in the U.S. is some other fish (Tennyson, 1993; Hsieh et al., 1995; Marko et al., 2004). In one recent case involving Chicago sushi restaurants, all 14 'Red snappers' sampled were actually some other fish species (Fuller, 2007). South of the equator, a similar problem occurs with the antipodean analog of Red snapper: around 40 percent of Red emperors (*Lutjanus sebae*) in Australia are incorrectly labeled (Anon., 2003).

The mislabeling of grouper is nearly as problematic. Grouper are now overfished in the Gulf of Mexico and now, particularly at restaurants, many inexpensive fish are sold in its place. A string of grouper scandals was uncovered in Florida, where as much as 70 percent of fish labeled 'grouper' was actually another species. The catfish, hake and tilapia that appeared during one of the samples not only fell outside any grouper genus, they fell outside the broader family of sea basses to which all grouper belong (Nohlgren and Tomalin, 2006).

Seafood species may also be labeled as the correct species, but hide the fact that they have been farmed. A report that analyzed salmon from several different states showed that, when wild salmon are abundant (during the summer and fall), they are correctly labeled. Outside of the season for wild salmon, more than half of the sampled 'wild' salmon were actually farmed (Anon., 2006). Similarly, three-quarters (6 of 8) of 'wild' salmon fillets sampled by the *New York Times* in its namesake city's Fulton Market were actually farm-raised (Burros, 2005). The mislabeling of farmed fish as ‘wild’ is not confined to the U.S.--a look at more than 100 samples from retailers in the United Kingdom found that 15 percent of ‘wild’ salmon, 11 percent of ‘wild’ sea bream, and 10 percent of ‘wild’ sea bass were actually farmed (Evans, 2007). It is rare, but occasionally this type of mislabeling occurs by accident. In one study, a farmed salmon escaped to the wild--in spite of salmon farm claims of zero escapement--and was then caught and sold as wild (Burros, 2005), its ghost posing deep ontological questions.

For seafood awareness programs to obtain their desired outcomes (including improving the ecological health of fisheries), it is essential that seafood consumers have accurate information and that eco-labels acquire and/or maintain their integrity. But to increase profits, reputation, and/or because of the inconsistent availability associated with eco-friendliness, fishers and seafood companies also mislabel seafood products as environmentally friendly. In 2003, the Puget Customer’s Co-op (PCC) Natural Markets in Seattle, Washington was caught mislabeling between 4 and 5 percent of its fish with the label “EcoFish”, a certification sticker that denotes the seafood has been harvested in an environmentally responsible manner (Denn, 2003). After this discovery, EcoFish suspended its program at all PCC markets (Nyhan and Frey, 2003). Two salmon purchased during the Consumer Reports study (Anon, 2007) were labeled as ‘organic’ (both turned out to be farmed), though no federal rule exists for using the term ‘organic’ on fish. The giant retailer Wal-Mart was accused in January 2007 of mislabeling foods with ‘organic’ labels at dozens of stores in five states—this from a company that pledged to source all fish from sustainable sources by 2010 (Wong, 2007).

Consequences of mislabeling

<u>Consumer and government economic losses</u>

For free market economics to function properly, consumers require perfect information (Smith, 1904). Not only is some of the information about seafood imperfect, it is often deceptive. The mislabeling of fisheries products most often occurs after they are purchased from the fishers, who are most often ‘price-takers’. The price for certain fish can be high, even in terms of ex-vessel prices, due to resource scarcity. Rather than pay high prices, distributors, retailers, and restaurants often buy fish of lesser value, illegally sell these fish as their higher value relatives, and accrue the windfall profits. The consumer, meanwhile, loses.

When rockfish was renamed Pacific red snapper, restaurants profited from the substitution, not consumers (Walsh, 2001). When white sturgeon caviar is marked as ‘beluga caviar’, consumers pay five times too much (Cohen, 1997). In 1989, the U.S. FDA detained a 20,400-kg shipment of Oreo dory (*Pseudocyttus maculatus*) imported from New Zealand and bound for Ohio markets as Orange roughy (*Hoplostethus atlanticus*). Ohioans might not have detected the difference in taste, but they would have surely been upset to pay three times more for the fish (Foulke, 1993). Diners at one Florida restaurant would have also been angry had they known they paid US$23.95 in 2006 for ‘champagne-braised black grouper’ that was actually tilapia. The value of frozen catfish, when sold as grouper, quadruples, as does the loss to consumers (Tomalin, 2006). In New York City, wild salmon can sell for as much as US$64 per kg while farmed salmon goes for US$11-26 per kg (Burros, 2005). But farmed salmon sold as wild salmon can exceed the price genuine wild salmon when it is sold outside the wild salmon season (Anon., 2007).

In addition to consumers, governments can lose financially due to mislabeling. In January 2007, Mr. Danny Nguyen and his two seafood companies were charged with a 42-count criminal indictment for mislabeling over a hundred tonnes of Vietnamese catfish as grouper and other fish so as to avoid U.S. anti-dumping duties that were put in place for catfish in 2003 (NOAA, 2007). Nguyen's company and nine others were charged with selling nearly five million kg of Vietnamese catfish falsely labeled as sole, grouper, conger pike, and flounder (Intrafish, 2007).

Resource losses

Renamed and mislabeled fish can have dire consequences for species that are under protection and/or are illegal to sell. In a document on the promotion of shark products for export, one finds that, "In the USA, shark meat sale has a better chance of growth under anonymity" (Helder, 1994). This is true in other parts of the world, too (see Table 7.2). In Ecuador, sharks are filleted, relabeled and sold in city markets as flounders or even tuna (Bostock and Herdson, 1985). Approximately 40 percent of the nearly 200 shark fillets tested in a New Zealand study were not lemon sharks, as the label indicated, but were instead hammerhead, bronze whaler, and school sharks, which are illegal to harvest (Smith and Benson, 2001).

Overfishing in the Caspian Sea, where most of the world's caviar originates, has driven many of the 25 species of sturgeon there close to extinction. Meanwhile, U.S. imports of caviar have doubled since 1991 (Anon., 1998). How to feed the U.S. appetite for caviar? In a 1996 case, 2000 adult sturgeon in the Columbia River, Oregon, were killed to illegally harvest 1500 kg of caviar, which was relabeled and sold as imported beluga and Russian oestra caviar [61]. In the late 1990s, examination of 95 different samples of caviar being sold in New York City found that 23 percent were mislabeled with respect to species (Birstein et al., 1998).

Lack of traceability and re-labeling of fish also undermines environmental regulations. Over a five-year period, Neptune Fisheries imported at least 85,500 kg of mislabeled undersized lobsters to the U.S. from Nicaragua, where the export of such small tails (i.e. juvenile lobsters) is illegal (NOAA, 2003).

Undermining of eco-campaigns

Renaming and mislabeling of seafood also prevents 'eco-aware' consumers from making effective purchasing decisions on behalf of conservation (Jacquet and Pauly, 2007). Many exporters and even domestic suppliers are able to sell their fish as eco-friendlier versions due to the lack of traceability. With the extensive mislabeling of farmed salmon as wild, how meaningful is a boycott of farmed salmon, such as the Living Oceans Society's 'Farmed and Dangerous' campaign, if farmed salmon pose in the market as wild?

Similarly, there has been a widespread campaign in Europe to raise awareness of the negative effects of farm-raised shrimp, the production of which can destroy mangrove habitat and reduce water quality (Naylor et al., 2000). As a result, Thai shrimp, which account for nearly 30 percent of global production, are often exported labeled as 'wild-caught' rather than 'farm-raised' (Miller, 1999). For its eco-friendly and mercury-free reputation along with its price, tilapia has moved up from the 9th to the 5th most consumed fish in the U.S. In Ecuador, the Whitefish Association of Ecuador now sells South Pacific hake filleted and labeled as tilapia (Martinez-Ortiz, 2005).

Renaming and mislabeling also generates confusion among those consumers who support boycotts and stronger regulations. The 'Take a Pass on Chilean Sea Bass' campaign had to navigate through the fact that Chilean sea bass is actually Patagonian toothfish (*Dissostichus eleginoides*) and that, in recent years, Antarctic toothfish (*Dissostichus mawsoni*) has been substituted for its sparse relative. Furthermore, illegal shipments of toothfish enter the country labeled as crayfish or under the generic label of 'frozen fish fillet' (NET, 2005; Knecht, 2006).

Mislabeling also gives consumers the sense that supply is keeping up with demand. When there was a moratorium on U.S. grouper fishing between 2004 and 2005, mislabeled fish served to sustain demand for an overfished stock. When English fishers exceed their cod quota, they label their cod as ling to pass it through customs (Clover, 2006), but the reverse is also true. Consumers are sold sablefish (*Anoplopoma fimbria*) as ‘black cod’, groupers as ‘rock cod’, and the poisonous Oilfish as ‘blue’ or ‘Atlantic cod’ (see Table 7.2). The collapse of the Northern cod stocks off Newfoundland, Canada, might have gotten a lot of media attention, but to the consumer, cod stocks seem just fine.

<u>Health concerns</u>

Properly labeling seafood is not only required for economic and ecological reasons but also for health reasons. In the U.S., it is estimated that seafood products cause 18 to 20 percent of the food borne illnesses contracted by 76 million Americans each year Food and Water Watch, 2007). Mislabeling contributes to illness in the U.S. and beyond. For instance, two Chicago consumers of recently fell ill after ingesting the tetrodotoxin found in pufferfish, which was mislabeled as ‘monkfish’ (Anon., 2007).

Oilfishes (common names include: oilfish, escolar, rudderfish, butterfish, ruddercod, and snake mackerel) are indigestible by about half of all people and its waxy reputation has made its sale illegal in Italy and Japan. For many years, oilfishes have caused outbreaks of diarrhea among consumers in Australia, where food and agricultural officers determined the problem to be one related to incorrect marketing (Shadbolt et al., 2002). Consumers in Hong Kong recently got a potent dose of incorrect marketing when a large shipment of oilfish (*Ruvettus pretiosus*) from Indonesia was labeled as ‘Atlantic cod’ and more than 600 consumers fell ill (Lam, 2007).

The correct labeling of species is also important in terms of contaminants. The risk of poisoning due to the consumption of neurotoxins (e.g. mercury) through predatory fish, particularly tuna, has been debated for the last forty years. In the U.S., consumers have been warned about canned tuna and told that albacore tuna, labeled often as 'white tuna', is highest in mercury, while cans of 'chunk light' or 'light tuna' are composed of tuna species with lower mercury content. But about 90 million cans of 'light tuna' sold in the U.S. each year contain yellowfin tuna, which has mercury levels equivalent to that of albacore (Commission on Life Sciences, 2000; Roe et al., 2005). But rather than properly labeling their products, producers have chosen to reduce risk by decreasing the amount of tuna in a can by roughly 15 percent to exactly 170 g (6 oz.) and thus stay below the 'allowable' limit for mercury (Burger and Gochfeld, 2004).

Mercury is also a concern for individuals still consuming whale meat. In Japan, about 40 percent of what is supposed to be baleen whale meat is mislabeled as dolphin or other toothed whale meat, which has an average mercury level of 370 parts per million (ppm)—925 times higher than the Japanese legal limit for mercury, which is, with 0.4 ppm, lower than the U.S. limit of 1.0 ppm (Endo et al., 2003; Tibbetts, 2003).

Aside from species labeling, labeling the country of origin and the production method is also important for human health. High pesticide residuals have been found in Chinese shellfish that pose a risk to human health (Guo et al., 2007). A study of more than 700 salmon samples from around the world confirmed the need for labeling. Hites *et al.* (2004) found farmed salmon contain higher concentrations of contaminants than wild salmon. Moreover, salmon farmed in European countries have significantly higher levels of contamination than those raised in North and South America.

Discussion

In 2006, assuming a conservative 15 percent of farmed salmon were mislabeled (some investigations have found as much as 75 percent), 212,250 tonnes of farmed salmon were sold worldwide as wild. The consumer losses for these mislabeled salmon alone were at least US$2 million in illicit gains for the distributors and/or retailers as reward for their deception. Meanwhile, farmed salmon production (and its associated negative ecological impacts) expanded. The consumer's ability to impact the market, by avoiding farmed salmon, for instance, was made less effective. Furthermore, consumers of the fraudulent salmon ingested more contaminants than they would have had their salmon really been wild-caught.

The importance of properly labeling food (centered mainly on quality and health concerns) has been debated for at least a century. In the early 1900s, the public, stirred by Upton Sinclair's investigation into the horrifying realities of meatpacking plants in *The Jungle* (Sinclair, 1906), clamored for food safety standards. In the case of seafood, the government regularly seized canned fish in the 1920s, which it described in one case as "filthy, putrid, and decomposed". The canneries refused to clean up their practice, claiming the government could not prove the putrid fish was actually harmful to consumers [10, 82] (Chase and Schlink, 1927; Kallet and Schlink, 1933). Early proponents of the U.S. consumer movement, who founded the group that now issues *Consumer Reports*, independently tested products and to lobbied the government for better grading and labeling of products. The work by the *Consumer Reports* team in the 1920s and 1930s prompted governments to outlaw blatantly false claims in advertising, to establish quality standards for consumer goods, and become actively involved in labeling them (Klein, 2000). But, then and now, labeling requirements are slow to take effect. In 1973, nearly 100 percent of over 2000 people interviewed in the U.S. were in favor of a nutrition label on food products (Lenehan et al., 1973). Yet, the U.S. Nutrition Labeling and Education Act did not pass until 1990 and was not implemented until 1994. In Canada, nutrition label requirements were not made mandatory until 2005.

In terms of seafood, the mislabeling issue and the fishing industry's resistance toward (and power to contest) labeling standards is more than a century old. In 1906, after *The Jungle* (Sinclair, 1906) triggered public outrage, there was overwhelming Congressional support for a new Food and Drug Act. The U.S. Secretary of Agriculture's first response to the new act was to weaken it: the Maine fish packers wanted to allow all small pelagic fish to be labeled as 'sardines', which the Secretary granted (Kallet and Schlink, 1933). Industry's ability to weaken labeling legislation that is backed by popular support continues today. In April 2005, Country of Origin Legislation (COOL) went into effect for seafood, but after legislators struck "the onerous mandatory system" and established instead "a rigorous voluntary program". Agribusiness (e.g., Wal-Mart Stores, Tyson Foods, the American Meat Institute) participated in the political process with a US$29.2 million lobbying campaign against COOL legislation (Lovera et al., 2005). This in spite of the fact that several studies have indicated one-third of all seafood sold in the U.S. is mislabeled (Anon., 1992; Tennyson et al., 1997).

The fishing industry's standard argument is often that proposed labeling legislation is too costly. But the costs associated with mislabeling are also high: consumer and resource losses, eco-label ineffectiveness, and health concerns. Today the market climate is one that encourages consumers to responsible for their health and the health of the environment. While it is true that consumers should have a better understanding of their seafood (appearance, flavor, and origin), awareness alone will not protect consumers from deceit in the seafood market.

There are straightforward approaches that have proven effective at testing seafood for validity to the species level, including biochemical techniques, DNA fingerprinting, and assays (Birstein et al., 1998; Smith and Benson, 2001; Moretti et al., 2003). A database is also under construction that catalogues the molecular genetics of different seafood species (Maldini et al., 2006). While these techniques are relatively inexpensive, they require complex technologies, human resources, and political will, and are thus likely unrealistic in the developing world, where the majority of seafood consumed in developed countries originates. Until such methods become economically and politically viable, labeling is likely to remain an important, though cumbersome, component of international trade.

A global mandate for species, country-of-origin, and production method labeling as well as verifiability of eco-labels is necessary for all seafood. At the international level, the FAO *Codex Alimentarius* should require actual geographic site of origin, not just the place of processing. The U.S., which imports more than 80 percent of its seafood, could move from protecting catfish producers in the southern U.S. from competitive imports to becoming a leader for seafood labeling in the global arena. Though recent years have affirmed the Marine Stewardship Council (MSC) as the leader of eco-labeling, any attempts in this vein by the International Standards Organization (ISO), which has its own evaluation and certification scheme to assess sustainable fisheries, should collaborate with the MSC so that consumers are not further inundated with information to the extent that efforts become counter-productive (Sproul, 1998).

Perhaps the best method is to ensure labeling standards is with a third-party validation from ‘cradle to plate’. To improve traceability and retain public confidence in labeling claims, the MSC recently implemented a Chain of Custody certification that guarantees fish buyers that their seafood can be traced back through the supply chain from the point of sale to the fishery of origin (MSC, 2007). The MSC chain of custody standards could be adopted nationally and/or globally.

Additionally, the penalties for mislabeling and illegally harvesting fish must be raised. The fines for mislabeling foods as organic are high--up to US$10,000 in some cases (Wong, 2007). But fines for illegally harvesting fish—never mind mislabeling them--are minimal. In the case of the two poachers who were indicted on grounds of illegally harvesting American sturgeon caviar (and selling it as imported Russian caviar), their fines totaled US$17,375—less than 1 percent of the estimated US$2 million the pair made on the sale (Cohen, 1997).

Marine conservation non-profits should also continue efforts to win legislation for seafood traceability, including labeling standards. The National Environmental Trust (NET, 2005) published a report on Patagonian toothfish revealing that a considerable amount of illegal toothfish enters the U.S. intermingled with other seafood or under the nondescript title 'frozen fish fillet'. They have worked to prevent of fish from entering the U.S. under such a vague description but, so far, have not had success.

In 1992, *Consumer Reports* (Anon., 1992) published an article titled, "The label said Snapper, the lab said baloney". Fifteen years later, the mislabeling of Red snapper is, if anything, more widespread (e.g. Marko et al., 2004). Red snapper began disappearing a half century ago, but one would never know by reading a menu. Using old menus from the 1850s onward, researchers are presently gaining insights to historical marine abundance (Holm, 2003; Hopkin, 2005). In the future, due to the rampant mislabeling of seafood today, this sort of study would be futile.

Of greater concern is that species are mislabeled because there is a shortage of the desired species or because the species itself was illegally caught (illegal, because there is a shortage). Species are renamed because an ever-growing demand for seafood creates new markets for fish that were once considered unmarketable (e.g. slimeheads, toothfish). Today's renaming and mislabeling is not only an indication of cheating, but is, fundamentally, an indication that global fisheries are in distress.

Tables

Table 7.1 Some Cases of Renaming Seafood to Improve Marketing[a]

Scientific name	Original name	Renamed	Remarks (Source)
Hoplostethus atlanticus	Slimehead	Orange roughy	Originally named 'slimehead' in 1957, it was renamed in 1979 as the seafood market changed (Pauly et al., 2003).
Dissostichus elegenoides	Patagonian toothfish	Chilean sea bass	Renamed in late 1970s by a fish merchant from California. In 1994, fish merchants appealed to the FDA to change the name officially, which the FDA refused on grounds that Patagonian toothfish falls outside of the sea bass family (Knecht, 2006).
Glyptocephalus cynoglossus	Witch	Torbay sole	Renamed by Marks & Spencer, the U.K. grocer, after an English bay where the fish is often found (Marks & Spencer, 2007).
Squalus acanthias	Spiny dogfish	Rock salmon, Hass	From 1973-1981, the National Marine Fisheries Service (NMFS) spent US$8.5 million investigating which "underutilized species" with a bad image should be renamed (Miller, 1981).
Ruvettus pretiosus	Oilfish	Blue cod	A Toronto consumer fell ill after eating oilfish that was labeled as 'Blue cod' steaks at a Chinese supermarket (Anon, 2007).
Sebastes spp.	Rockfish	Pacific red snapper, Rock cod	In California, Rockfish can be sold as Pacific red snapper but, outside of California, the U.S. FDA only allows *Sebastes* spp. to be sold as 'Rockfish' (Foulke, 1993).
Merluccius capensis and *M. paradoxus*	South African hake	Scarlet snapper	"Anything that is red is going to be sold as red snapper, no matter what it is," said one restaurant supplier (quoted by Walsh, 2001).
Lutjanus malabaricus	Malabar blood snapper	Scarlet snapper	
Anoplopoma fimbria	Sablefish	Black cod	(Anon, 2007)
Oncorhyncus keta	Chum salmon	Silver brite salmon	This mislabel is common in Chicago and probably elsewhere (Anon, 1992).
Ictalurus punctatus	Channel catfish	Southern trout, Ocean catfish	One of the names used to rid catfish of their original image (think Porgy and Bess in "Catfish Row") [Authors' personal observation].
Pangasius bocourti	'Basa'	Cajun delight catfish, Delta fresh catfish, White roughy, Pacific dory, Grouper teammate	(USAID, 2005)
Cancer irroratus	Rock crab	Peekytoe crab	Once discarded as trash crab, rock crabs underwent a marketing makeover in the mid-1990s and, renamed as 'Peekytoe crab', have now become the "culinary darlings" of many chefs (Redmayne, 2002).

a) The scientific names of fish and invertebrates were verified using FishBase (www.fishbase.org) and SeaLifebase (www.sealifebase.org), respectively.

Table 7.2 Some Better Documented Cases of Fraudulent Mislabeling of Seafood for Purposes of Deceiving Customers[a]

You are in:	You purchase:	Which is supposed to be:	But you get:	Also called:	Remarks/Source
	Common name	Scientific name	Scientific name	Common name	
U.S.	Red snapper	*Lutjanus campe*	*Sebastes* spp.	Rockfish	Studies indicate that 70 to 80 percent 'Red snapper' sold in the U.S. is some other fish (Tennyson, 1993; Hsieh, 1995; Marko et al., 2004).
			Oreochromis spp.	Tilapia	
			Coryphaena hippurus	Mahi Mahi	
			Ictalurus punctatus	Channel catfish	
U.S.	Grouper	*Epinephelus* spp., *Mycteroperca* spp.	*Ictalurus punctatus*	Channel catfish	Grouper from the Gulf of Mexico was once abundant. Now, as much as 70 percent of tested 'groupers' (mostly in Florida) have been mislabeled (Nohlgren and Tomalin, 2006).
			Merluccius spp.	Hake	
			Oreochromis spp.	Tilapia	
			Theragra chalcogramma	Alaska pollock	
U.S.	'Wild' salmon	*Oncorhynchus spp.*	*Salmo salar*	Farmed salmon	Many 'wild' salmon are actually farmed, particularly outside of the salmon season (Burros, 2005; Evans, 2007).
U.S.	Mahi Mahi	*Coryphaena hippurus*	???	Yellowtail	(Burros, 1992)
U.S.	Halibut	*Hippoglossus* spp.	???	Sea bass	(Burros, 1992)
U.S.	Orange roughy	*Hoplostethus atlanticus*	*Pseudocyttus maculatus*	Oreo dory	(US FDA, 2006)
			Zeus faber	John dory	(Burros, 1992; US FDA, 2006)
U.S.	Swordfish	*Xiphias gladius*	*Isurus oxyrinchus*	Mako shark	(Burros, 1992; US FDA, 2006)
U.S.	Cod	*Gadus morhua*	*Theragra chalcogramma*	Alaska pollock	(Burros, 1992)
U.S.	'Dover sole'	*Microstomus pacificus*	*Atheresthes stomias*	Arrowtooth flounder	The irony is that *Solea solea* occurs in Dover (US FDA, 2006).
U.S.	Red drum	*Sciaenops ocellatus*	*Pogonias cromis*	Black drum	(US FDA, 2006)
U.S.	Rock cod	Scorpaenidae	*Squalus acanthias*	Spiny dogfish	(Gorton's Fresh Seafood, 2007)
U.S.	Monkfish	*Lophius* spp.	*Tetrodon* spp.	Pufferfish	Two Chicago customers recently fell ill after ingesting tetrodotoxin found in their 'monkfish', which was actually pufferfish (Anon, 2007).
U.S.	Shrimp, crabs, scallops, lobsters	Crustaceans, Decapods	Protein fibers extracted from offal	Surimi	One New Yorker complained bitterly about surimi substitution—tired of receiving "additive laden, colored, and extruded cheap fish sausage" in lieu of the shellfish he ordered (quoted in Burros, 1987).
U.S.	Beluga caviar	Eggs of *Huso huso*	Eggs of *Cyclopterus lumpus*	Lumpfish roe	(Pauly, 2004)
			Eggs of *Polyodon spatula*	Paddlefish roe	(US FDA, 2006)
U.S.	Scallops	Pectinidae	Various	Skate wings	(US FDA, 2006)
U.S.	Patagonian	*Dissostichus*	*Dissostichus*	Antarctic	(Knecht, 2006)

	toothfish	*eleginoides*	*mawsoni*	toothfish	
U.S.	Lobster	*Homarus* spp., *Panilurus* spp., *Panulirus* spp.	*Nephrops norvegicus*	Langoustine or scampi	(Hernandez, 2006)
U.S.	White perch	*Morone americana*	*Perca flavescens*	Yellow perch	(US FDA, 2006)
U.S.	Zander	*Sander lucioperca*	*Perca flavescens*	Yellow perch	(US FDA, 2006)
U.S.	Sauger	*Sander canadensis*	*Sander vitreus*	Walleye	(US FDA, 2006)
U.S.	Pink salmon	*Oncorhynchus gorbuscha*	*Oncorhynchus keta*	Chum salmon	(US FDA, 2006)
Hong Kong	Atlantic cod	*Gadus morhua*	*Ruvettus pretiosus*	Oilfish	(Lam, 2007)
France	'Thon blanc'	Thunninae	*Lamna nasus*	Porbeagle	French common name: 'Requin taupe commun' (Anon., 2006).
			Alopias vulpinus	Thintail thresher shark	French common name: 'Renard de mer' (Anon., 2006).
Ecuador	Tilapia	*Oreochromis* spp.	*Merluccius gayi*	South Pacific hake	(Martinez-Ortiz, 2005)
	Weakfish	Scioenidae			
	Flounder	Pleuronectidae			
Ecuador	Tuna	Thunninae	Selachians	Shark	(Bostock and Herdson, 1985)
	Flounder	Pleuronectidae			
Colombia	'Pargo rojo'	*Lutjanus* spp.	*Oreochromis* spp.	Tilapia	(Jeffrey Wielgus, University of British Columbia Fisheries Centre, pers. Comm.)
Australia	Barramundi	*Lates calcarifer*	*Lates niloticus*	Nile perch	13 percent of barramundi tested in an Australian study were mislabeled (Anon., 2003).
			Polydactylus macrochir	King threadfin	
Australia	King George whiting	*Sillaginodes punctatus*	*Micromesistius australis*	Southern blue whiting	(Hughes, 2003)
			Merlangius merlangus	North sea whiting	
			Sillago spp.	Silver whiting	
			Merluccius spp.	Hake	
Australia	Red emperor	*Lutjanus sebae*	*Lethrinus choerorhynchus*	Spangled emperor	41 percent of Red emperors tested in an Australian study were mislabeled (Anon., 2003).
			Lethrinus miniatus	Redthroat emperor	
Australia	Dhufish	*Glaucosoma hebraicum*	*Glaucosoma buergeri*	Northern pearl perch	46 percent of Dhufish tested in an Australian study were mislabeled (Anon., 2003).
			Glaucosoma scapulare	Pearl perch	

a) The scientific names of fish and invertebrates were verified with FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org), respectively.

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8 FUNDING PRIORITIES: BIG BARRIERS TO SMALL-SCALE FISHERIES[1]

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Since the mid-1990s, there has been a concerted effort to encourage fisheries sustainability by targeting large-scale, high-catch fisheries and by raising consumer awareness. Because of the often slow pace of regulatory approaches, this voluntary, market-oriented effort has been structured so as to avoid government involvement. But have small-scale fisheries, our best option for sustainable use of fisheries resources, been lost in the market-based push toward sustainability?

In financial terms, the largest sustainable fisheries initiative has been the U.S.-based Seafood Choices campaign, largely funded by the Packard Foundation. From 1999-2004, Seafood Choices invested $37 million in more than 30 nonprofit organizations to promote market-based sustainable seafood initiatives, such as ecolabeling certification and seafood wallet cards, which signal to consumers sustainably caught fish (Bridgespan Group, 2005). In contrast, over the last decade, only 2 U.S.-based nonprofit organizations have invested <$1.5 million in research and policy reform related to global fisheries subsidies (M. Hirshfield, personal communication). Since the late 1990s, the World Wildlife Fund for Nature (WWF) has had one full-time staff working on fisheries subsidies and lobbying countries to reduce subsidies (~ cost: <$100,000/year). In 2005 the nonprofit organization Oceana began a campaign against fisheries subsidies with some staff working part-time on the issue of subsidies (~ cost: <$75,000). In 2006 Oceana ramped up their efforts against subsidies (~ cost: $125,000-150,000) and in 2007 spent ~$400,000 on subsidy-related efforts, including a paid advertising campaign, media, staff, and travel (M. Hirshfield, personal communication).

Although they are often described as very variable between countries, small-scale fisheries are characterized as fishers operating on in boats of 15 m or less or without boats (Chuenpagdee et al., 2006). They generally use less energy-intensive fishing gear and cannot operate far offshore. While industrial trawlers use destructive fishing gear that destroys the bottom habitat upon which exploited species depend (Chuenpagdee et al., 2003) and, jointly with other industrial fisheries, discard 8-20 million tonnes of unwanted dead fish each year (Zeller & Pauly, 2005), the small-scale fisheries discard little to no fish and (with the exception of few gears, including dynamite) do not destroy benthic communities. Unlike specialized industrial fisheries, small-scale fishers are capable of targeting different fish species depending on their availability (Munro, 1979). Furthermore, small-scale fisheries produce little to no fishmeal while the industrial sector reduces 20-30 millions of fish annually into fishmeal to feed pigs, chickens, and farmed fish (Alder & Pauly, 2006). Small-scale fisheries employ 25 times more people and use one-quarter the fuel to catch roughly the same amount of edible fish (roughly 30 million tonnes) as the large-scale, industrial fishing sector (Chuenpagdee et al., 2006; Pauly 2006; Figure 8.1).

Although small-scale fisheries are potentially, and in many cases actually, more sustainable than large-scale fisheries, they are disadvantaged due to their typical remoteness, lack of infrastructure, and marginal political power. Furthermore, small-scale fisheries are at a disadvantage when competing for fisheries resources and market access with heavily subsidized industrial fleets (Ponte et al., 2007). More recently, small-scale fisheries have begun to face an additional barrier to trade from well-intentioned sustainable fisheries initiatives, such as ecolabeling.

The best fisheries ecolabel is that of the London-based Marine Stewardship Council (MSC), whose 2006 budget was $4.6 million (MSC, 2006). Since 1999, the MSC has certified about 4% of the global market for fish from capture fisheries (as opposed to farmed fish). Of the 23 MSC-certified fisheries, 2 are located in the developing world and only 1, the Mexican Red rock lobster, is a small-scale fishery. The MSC bias against small-scale fisheries is neither intentional nor unacknowledged, and it stems from real technical difficulties in defining sustainability criteria for fisheries that are data-poor.

Thus, critics of ecolabeling point out that product promotion is occurring in markets in which food requirements have already been met and that small-scale fishers, by default, are left to sell the "unsustainable" fish (Constance & Bonanno, 1999). Ecolabeling may provide good incentives for the improvement of industrial, high-volume fisheries, but ecolabeling cannot contribute much to the global improvement of fisheries management if it cannot serve the needs of small-scale fishers (i.e., the majority of fishers worldwide).

A market-based approach to improving fisheries sustainability globally is the elimination of harmful fisheries subsidies (Sumaila & Pauly, 2007). Worldwide, fisheries subsidies are estimated at $30-34 billion annually, the overwhelming majority of which goes to industrial fisheries (Table 8.1). Politicians keep excess fishing capacity afloat using subsidies. Large-scale vessels are built by heavy industry with big subsidies, whereas small-scale boat construction generally favors local craftsmanship and receives little government financing. On the water, large-scale fisheries are further granted the competitive edge over small-scale fisheries, often under the false premise that the large-scale sector delivers more fish to markets. The result: subsidies further marginalize small-scale fishers and marine biodiversity suffers more than if the market was truly competitive.

Fuel subsidies, which total $6.3 billion annually, illustrate the situation (Sumaila et al., 2006). The industrial fishing fleet uses 89% of total fuel for catching fish, whereas the small-scale fleet uses only 11%. The average industrial fisher receives an estimated 187 times more fuel subsidies each year than the average small-scale fisher (Tyedmers et al., 2005; Pauly, 2006). Yet, small-scale fishers catch four times more fish per liter of fuel (Pauly, 2006). The elimination of fuel subsidies to industrial trawlers alone would render the 200-strong fleet of high-seas bottom trawlers unprofitable, sparing the reef habitat and bycatch these industrial boats generate in their pursuit of overfished deep sea species (Sumaila, 2007). The retirement of the high-seas bottom trawlers would relieve pressure on at least 3 poster species for the sustainable seafood movement: Orange roughy (*Hoplostethus atlanticus*), rockfish (*Sebastes* spp.), and Patagonian toothfish (*Dissostichus elegenoides*), all of which are listed in the avoid category on seafood wallet cards and are eschewed by eco-friendly chefs. Moreover, the dearth in supply could make creating market infrastructure for alternative species from the small-scale sector economically viable.

Market-based sustainable seafood initiatives and the elimination of harmful fisheries subsidies are not incompatible goals, but conservation funding for fisheries is scarce. Since 1999, a minimum of $6.2 million/year has funded market-based sustainable seafood initiatives, whereas projects to abolish harmful fisheries subsidies are likely to have received <$150,000 annually over this same period. Given the role of the state in subsidizing large-scale, destructive fisheries, funding toward political reforms would trump consumer-oriented efforts to change the marketplace. The limited money for fisheries conservation should go toward efforts that yield the highest sustainability returns on conservation investments.

Nonprofit marine conservation groups could use this money to launch large-scale public relations campaigns, fund advocacy to lobby subsidies for industrial fisheries (including funds for advocacy groups of small-scale fishers, recreational anglers, and fiscal conservatives opposed to industrial fishing subsidies), and research to expose the flows of subsidy money. Groups opposed to farm subsidies, for instance, have tracked government dollars to individual farms and disclose the farm's name, location, and amount received in a given year via an online database (http://farm.ewg.org/farm). A global database could reveal the extent of fisheries subsidies, (e.g. the $300 million in subsidies that went to European drift-netters to convert to less-damaging fishing gear) and describe what happened with the money (e.g. most Italian drift-net operators pocketed the money and continue to fish illegally; Oceana 2005).

Ecolabeling, consumer seafood guides, and even boycotts have not resulted in accelerated progress in fisheries policies (Bridgespan Group, 2005; Jacquet and Pauly, 2007), partially because these initiatives are not appropriate for data-deficient, small-scale fisheries. More than $37 million has been invested in sustainable seafood initiatives to date, from which more than 12 million small-scale fishers worldwide will never benefit. It is time to consider funding of this magnitude for a more equitable and fundamental market-based approach that will yield results on the water: the elimination of harmful fisheries subsidies.

Tables

Table 8.1 Subsidy type, amount, main beneficiaries, and effect on capacity[a]

Subsidy type	Amount ($ billion)	Main beneficiary[b]	Effect on capacity[c]
Fishing port construction and renovation programs	8.0	Large	Bad
Fuel	6.3	Large	Bad
Fisheries management programs and services	5.8	Large	Good
Fishery development projects and support services	2.5	Small	Bad
Boat construction, renewal and modernization programs	1.9	Large	Bad
Fisher assistance programs	1.7	Small	Ugly
Marketing support/processing/storage/infrastructure programs	1.6	Small/Large	Bad
Fishing access agreements	1.0	Large	Bad
Fishery research and development	0.9	Large	Good
Rural fishers community development program	0.9	Small	Ugly
Vessel buyback programs	0.9	Large	Ugly
Tax exemption programs	0.7	Large	Bad

[a]Adapted from Sumaila & Pauly 2007
[b]Large or small-scale fishing sector
[c]The categories (good, bad, ugly) refer to their effect on fleet growth and hence overfishing: good subsidies do not increase the size of the fleet, bad do, and ugly subsidies depend on the context (see Sumaila & Pauly 2007).

Figures

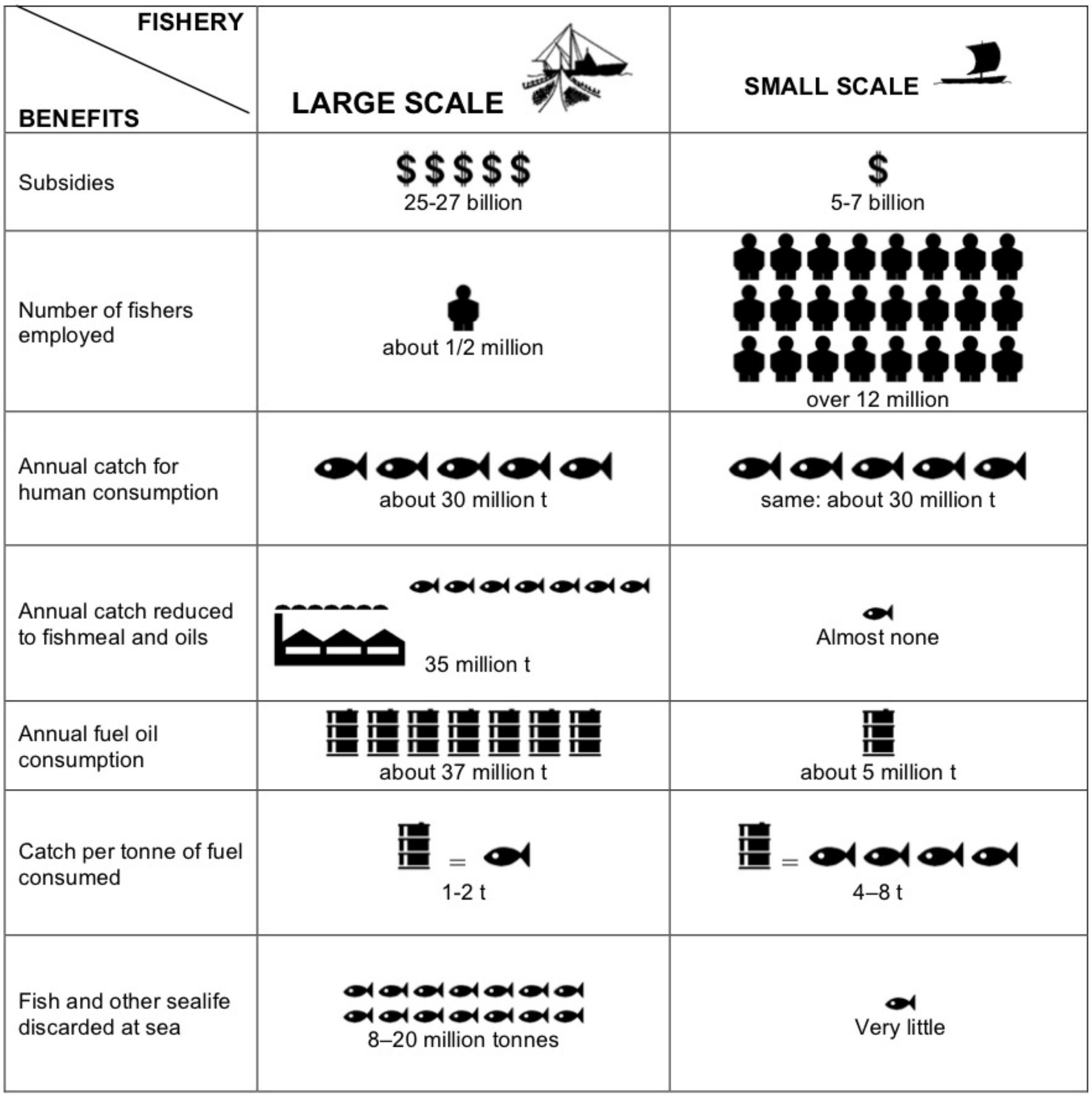

Figure 8.1 Schematic illustration of the duality of fisheries prevailing in most countries of the world, using numbers raised to global level. This duality of fisheries largely reflects the misplaced priorities of fisheries 'development', but also offers opportunity for reducing fishing mortality on depleted resources while maintaining most social benefits. The solution here is to phase out the large-scale fisheries. Adapted from graph in Pauly (2006).

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9 CONSERVING WILD FISH IN A SEA OF MARKET-BASED EFFORTS[2]

[2] A version of this chapter is in review. Jacquet, J., J. Hocevar, S. Lai, P. Majluf, N. Pelletier, T. Pitcher, E. Sala, R. Sumaila, and D. Pauly. Conserving wild fish in a sea of market-based efforts.

Introduction

Fish consumption is on the rise globally. The U.S.A. now consumes almost five times more fish than it did 100 years ago (~2.2 million t in 2004; ~500,000 t in 1910; NMFS, 2006), and Chinese consumers are now consuming almost five times more seafood per capita than they did in 1961 (25.4 kg/person in 2005; 4.8 kg/person in 1961; Halweil, 2006). Worldwide, per capita consumption of marine fishes has nearly doubled since the 1960s (9 kg in 1960s; 16 kg in 1997; WHO, 2006), while the human population also doubled over this same time period. Future projections show that seafood supply from capture fisheries is decreasing and that, overall, today's marine fisheries are unsustainable (Pauly *et al.*, 2002; Worm *et al.,* 2006).

To meet predicted demands for seafood by 2020, aquaculture production will be required to double. Alternatively, how and for what we fish (e.g., low trophic level species) will require considerable reform (Pitcher, 2008). Since the growing demand for seafood has been implicated in the marine fisheries crisis, it is perhaps appropriate that some effort be directed at reforming the human appetite (e.g., Grescoe, 2008). So far, this reform has largely manifested itself in a host of market efforts to encourage what is popularly referred to as 'sustainable seafood', whose meaning is generally a broad one covering ecologically responsible fishing that minimises the bycatch of non-target species, and brings acceptable levels of ecosystem and environmental impacts. This paper aims to provide an overview of these initiatives, review their common difficulties, and present several possible avenues for improving market-based approaches to conserve wild fish.

Overview of market-based sustainable seafood initiatives for capture marine fisheries

Marine capture fisheries peaked in the late 1980s (Watson & Pauly, 2001), though the problem was not realized until the early 1990s, when the first consumer-oriented initiative for sustainable seafood began. The first major seafood campaign was the boycott of canned tuna in the late 1980s, which led to the first seafood eco-label, the 'dolphin safe' label, in 1990.

In 1997, the first certification scheme created specifically for sustainable fisheries was established in the form of the Marine Stewardship Council (MSC) (Kaiser & Edward-Jones, 2006). The MSC designed a set of ecological criteria for sustainable and well-managed fisheries along with a label for fish products that receive MSC approval; two of the authors (TP and DP) actively participated in this process. Today, the MSC label is the best-established and most widely discussed fisheries certification (Constance & Bonanno, 1999; Phillips, 2003; Sumaila et al. 2005) and, as of the end of 2007, about 7% (~5.25 million tonnes) of the annual global landings of marine fisheries are currently MSC-certified (Agnew et al. 2006).

One year after the MSC's inception, the National Audubon Society and Carl Safina developed the first consumer seafood guide and, in 2000, the Monterey Bay Aquarium published a seafood wallet card. The first trade association, the Seafood Choices Alliance, founded in 2001, provided infrastructure for the initiatives that would follow (Table 9.1).

Globally, market-based sustainable seafood initiatives are on the rise (Figure 9.1; Table 9.1). The fundamental goals of these initiatives are to raise awareness and ultimately reduce overexploitation of sensitive species by reducing demand (by shifting purchasing decisions toward products from more sustainable fisheries). They can be considered in the following categories (as in Roheim & Sutinen, 2006):

i) Evaluation system, i.e., criteria to determine sustainability, and to generate items in (ii) to (v);

ii) Boycotts;

iii) Eco-labels;

iv) Consumer seafood guides (including cookbooks);

v) Distributor seafood guides (often used jointly with pressure on/engagement with retailers to not carry particular species or to improve practices);

vi) Trade associations.

Common difficulties

There are broad limitations of seafood awareness campaigns, including the global nature of the seafood market and lack of traceability of both the original fish and the various stages of processed products (Jacquet & Pauly, 2007). Here we highlight some specific trends and difficulties among programs and comment on how they are being addressed.

<u>What is 'sustainable'?</u>

Unfortunately, each different initiative has a different definition of sustainability and a different methodology to assess it. A recent assessment used 18 criteria to assess nine systems for evaluating fisheries sustainability and found that there were several areas that none of them addressed adequately: 1) socio-economic attributes, 2) food security, 3) capacity of the assessment to adapt to local issues and unique aspects of the fishery, and 4) peer review of assessment decision (Leadbitter & Ward, 2007).

Lacking in most sustainable seafood initiative is consideration of environmental implications of bringing both fisheries and aquaculture products to market (Pelletier & Tyedmers, 2008). These include use efficiencies and emissions intensities of compounds such as greenhouse gases, acid precipitants, ozone-depleting and eutrophying agents, and a wide variety of chemicals with ecotoxicological effects (Pelletier *et al.,* 2006). A growing body of life cycle and energy analyses of fisheries and aquaculture identify the key stages of seafood supply chains and facilitate comparisons of eco-efficiency between competing production technologies (e.g., Pelletier & Tyedmers, 2008). Such information could easily be incorporated in existing sustainable seafood initiatives.

In the case of the MSC, there have been controversies over aspects of the certification of Alaska pollock, New Zealand hoki and Western Australian rock lobster. Some feel there has been a lack of consideration of stock declines, key life history characteristics, food chain, by-catch, and habitat effects and/or a failure to identify all stakeholders (Ward, 2008). Moreover, another round of controversy could begin if the MSC certifies fisheries that target fish for reduction (i.e., fish caught for the fishmeal market) due to the wastefulness of converting wild fish into smaller (but more valuable) amounts of farmed fish.

Small-scale and developing world fisheries left out

Small-scale fisheries are probably the best hope for sustainable fisheries as they are typically low-tech and coast-bound, although there are exceptions to this. On a global scale, small-scale fisheries employ 25 times more people and use one-quarter the fuel to catch roughly the same amount of fish for human consumption as the large-scale, industrial fishing sector (Chuenpagdee *et al*., 2006). But in the marketplace, small-scale fisheries are at a disadvantage when competing for market access with large-scale industrial fleets, which are often heavily subsidized (Sumaila & Pauly, 2006). More recently, small-scale fisheries face an additional cost barrier to trade from well-intentioned sustainable fisheries initiatives, such as eco-labeling (Jacquet & Pauly, 2008a; Gulbrandsen, in press).

3.3 Traceability concerns

For seafood awareness programs to obtain their desired outcomes, it is essential that seafood consumers have accurate information and that eco-labels acquire and/or maintain their integrity. But, in the U.S.A. more than one-third of all fish appears to be mislabeled (Tennyson *et al.*, 1997) and many fish are also renamed. Mislabeling and renaming subverts all sustainable seafood initiatives, including those aimed at consumers (Jacquet & Pauly, 2008b). For example, the Canadian Living Ocean Society's 'Farmed and Dangerous' campaign encourages consumers not to eat farmed salmon due to its adverse ecological and human health effects, but several recent investigations indicate that retailers frequently mislabel farmed salmon as 'wild caught' (Burros, 2005; Consumer Reports, 2006; Evans, 2007).

Regional focus

Many seafood guides have a regional focus, despite the global nature of the seafood market. In the U.S.A., consumer seafood guides focus mainly on fish caught by national fisheries (Roheim & Sutinen, 2006), which is inappropriate given that more than 80% of seafood consumed in this country is imported.

Species-oriented programs do not reward individual fishers

Consumer boycotts and consumer guides have been criticized for being indiscriminate toward responsible and irresponsible fishing operators, imposing an economic cost on responsible operators (Kaiser & Edward-Jones, 2006; Roheim & Sutinen, 2006). It has been argued that eco-labeling, on the other hand, is capable of rewarding individual operators because it engages consumers in rewarding certain members or sub-sectors of the fishing community who conduct responsible fishing practices (Roheim & Sutinen, 2006). Unfortunately, rewarding individual operators may be at odds with creating simple messages. The MSC certification of the fishery for Patagonian toothfish in British-controlled waters off South Georgia, for instance, rewarded responsible fishing operators in that one region but sent a mixed message to consumers, who were advised by the U.S. -based National Environmental Trust to boycott the fish (Jacquet, 2007).

Confusion in and between initiatives

The many sustainable seafood initiatives generate too many seafood labels, too much information, and too much confusion. For instance, the 2007 'Seafood Watch' wallet card from Monterey Bay Aquarium lists tuna 12 ways (i.e., species, method of fishing, country) between the three columns of 'best choices', 'good alternatives', and 'avoid'. The World Wildlife Fund's seafood choice card in Spain lists bluefin tuna as a species to avoid, but as a 'best choice' if the tuna come from coastal fishing traps. Although these complexities reflect the reality of the global seafood market, they also confuse consumers (Jacquet, 2007, Stromsta, 2007a). This is intensified by government agencies recommending the consumption of seafood because of its nutritional values (e.g., omega-3 acids; Brunner et al. 2009), at the same time as other agencies recommend eating less of certain species (e.g., farmed salmon) due to their high concentrations of mercury and other toxic compounds.

Furthermore, different consumer guides provide different recommendations depending on their criteria for ranking seafood, so that there is not only confusion generated by each card but also between among? cards. Each sustainable seafood initiative must have some way of assessing sustainability, which invariably leads to inconsistencies. The confusion this generates is evident at www.seafoodguide.org, which was intended to enable querying seafood guides by web-enabled phones (R. Froese, IFM-GEOMAR, Kiel, Germany, pers. comm.), but has inadvertently exposed inconsistencies between the guides it covers. The website presents seafood guides for 19 countries and displays interesting results for countries with more than one guide (e.g., the website presents 3 for Germany and 9 for the U.S.). While different organizations might generate a unanimous recommendation (i.e., 'avoid') for some species (e.g., Atlantic cod, Atlantic bluefin tuna), the recommendations can be grossly inconsistent for other species. For example, six organizations (including the Blue Ocean Institute), for instance, rank Atlantic halibut as a fish to avoid while Environmental Defense recommends consuming it with caution and Friends of the Sea and Monterey Bay recommend it as a sustainable choice. Similarly inconsistent recommendations are generated for albacore, bigeye tuna, lingcod, Atlantic haddock and many other species.

Absence of price premium

From a policy perspective, an eco-label aims to educate consumers about the environmental effects of the products' production or consumption so as to catalyze a change in purchasing behavior and ultimately reduce negative environmental impacts. From a business perspective, companies are induced to use environmentally benign production methods, distinguished by an eco-label, with the expectations of gaining a greater market share and higher profits.

Price premiums for certified forest products are estimated between 5 to 10 percent (Gardiner & Viwanathan, 2004). Dolphin-safe tuna does receive a price premium measured at $400 per tonne (Vogel, 1995) and wild salmon can sometimes generate a price premium over farmed salmon, though the market is variable (Knapp, 2007). But, so far, there is no evidence that seafood certified as sustainable benefits from a price premium (Stromsta, 2007b). Instead, operators seem to be engaging in certification because it brings them access to new markets.

Lack of evidence of effectiveness

After distributing over one million seafood wallet cards, the Monterey Bay Aquarium conducted a study that revealed no overall change in the market and that fishing pressures had not decreased for targeted species (Quadra Planning Consultants Ltd., 2004). A review of 30 different non-profit organizations with market-based sustainable seafood campaigns from 1999-2004 found that consumer-oriented campaigns increased awareness and visibility for the sustainable seafood issue, but that there is “no clear evidence that this increased salience is leading to big changes in buying practices, nor accelerated fisheries policies” (Bridgespan Group, 2005). In other words, there is no evidence that consumer campaigns are effective at reducing demand or fishing pressure.

The dolphin-safe tuna label is often perceived as the most effective seafood-related label (due to its visibility and its price premium). The label combined with several national and international regulatory schemes (e.g., the U.S. Marine Mammal Protection Act, the U.S. embargo on non dolphin-safe tuna and the International Dolphin Conservation Act) has helped to reduce dolphin mortality because of a reduction in the number of boats setting on dolphins. This is why NOAA fisheries scientists suggested the definition of the label not be watered down to allow tuna caught with the chasing-and-encircling techniques to be certified as 'dolphin safe' there was international political pressure to do so in 2003.

However, several dolphin populations have not recovered as quickly as expected. For instance, time series data of population estimates for the northeastern pantropical spotted dolphin (*Stenella attenuata attenuata*) and eastern spinner dolphin populations (*Stenella longirostris*) in the eastern tropical Pacific from 1978 to 2000 show essentially no change in abundance over that time (Gerrodette & Forcada, 2005). There does appear to be a slight increase in the abundance of the two species in recent years (Gerrodette *et al.,* 2008) but spotted dolphins and spinner dolphins are estimated respectively at 19% and 29% of their abundance levels prior to 1959, the year when a yellowfin tuna purse seine fishery began in their region (Wade *et al.,* 2007). The tuna purse seine fishery continues to have negative effects on dolphin populations due to unreported bycatch, the separation of mothers and calves, and/or other factors (Gerrodette & Forcada, 2005; Cramer *et al.*, 2008). This data along with Ward (2007) show that dolphin populations are still in trouble, despite the label, 100% observer coverage and strict regulations, because 'dolphin-safe' methods of catching tuna did not lead to a sufficient reduction in overall fishing pressure and hence bycatch.

Furthermore, MSC certification is unlikely to arrest the decline of fish stocks (Ward, 2008; Gulbrandsen, in press). For example, 2008 data for the U.S.A. pollock fishery, which is MSC-certified and has been regarded as a poster fishery for sustainable seafood, are cause for concern. Acoustic surveys indicate the 2008 biomass is almost 50% below the biomass from the previous year, prompting NOAA officials to recommend to the North Pacific Fishery Management Council a sustainable catch of 815,000 metric tons for 2009, an 18.5 percent reduction from 2008 (NOAA, 2008). In some cases, such as in Western Australia, MSC certification might even be giving fishing interests leverage against establishing fishing sanctuaries on the grounds that sanctuaries are unnecessary if the affected fisheries are already certified (Sutton, 2003). Overall, eco-labels on behalf of dolphins and fisheries appear to be weak instruments for conservation (Ward, 2007).

Per capita U.S. demand for seafood has increased in recent years and is up from 6.9 kg per person in 2000 to 7.4 kg in 2007 (NOAA, 2008). Many of the species considered least sustainable by conservation groups (e.g., shrimp, tuna, and salmon) remain the most desirable. There may be psychological reasons for this. A recent and rather disconcerting study found that French customers who tasted two identical caviar samples preferred the one they thought came from a 'rare species' of sturgeon (Gault *et al.,* 2008). Rarity was valued more than intrinsic quality. Why would we expect most consumers of shark fin soup, bluefin tuna, or even cod to behave any differently?

More effective market-based efforts to conserve wild fish?

Given the limitations of consumer-based efforts to promote sustainable seafood, perhaps the large investment into household consumers sector was premature. Based on our collective experience and evidence, we present several additional avenues for market-based conservation measures that may strengthen or complement current initiatives,. We also argue that these proposed ideas should be tested in accordance with the scientific method and evidence-based conservation (Sutherland, 2004).

Labeling standards

Oftentimes, consumers cannot be sure that the seafood they purchase is the fish that the label or menu claims it to be (Jacquet & Pauly, 2008a). Without access to information on country of origin (where the fish is caught, not processed), fishing method, let alone the correct species, consumers cannot make effective decisions on behalf of sustainable seafood. Therefore, all market-based initiatives must consider putting additional effort into improving labeling standards, particularly in the U.S.A., where less than 2% of all imports and 0.6% of seafood imports are tested for contaminants in a laboratory. In contrast, in 2005, Japan physically inspected 12% of seafood products and 21% of processed seafood products (Food & Water Watch, 2007).

Of all the sustainable seafood initiatives, the MSC offers the best model of traceability in the form of chain of custody standards, which traces fish from the fishery of origin to the point of sale. There is evidence that traceability standards in fisheries (e.g., South Georgia toothfish) have improved as a result of MSC certification (Roheim and Sutinen, 2006). Without proper labeling, all consumer-oriented campaigns will continue to be undermined by cheating.

Directing efforts higher than households

In recognition of the limitations and pace of affecting household consumers, efforts to promote sustainable seafood should aim higher in the demand chain and focus on affecting large buyers (and indeed, many initiatives are shifting their efforts in this direction). Among food retailers, the ten largest companies account for nearly 50% of the U.S.A. seafood market (Bridgespan Group, 2005). In the U.K., nearly 90% of seafood is nowadays sold through supermarkets, which have gained immense buying power, particularly when compared to the past when fish was primarily sold through local fishmongers (Greenpeace, 2005). This focus on targeting large retailers, which consolidate seafood purchases, is likely to have a bigger and faster market impact than consumer guides. Furthermore, large retailers appear concerned about wild fish stocks on the grounds that sustainability is good business and have shown much interest, perhaps also for the sake of reputation gains.

Focusing on large retailers does seem to be the new goal of Seafood Choices (Bridgespan Group, 2005) and several other groups (Table 9.1). In May 2008, for instance, fourteen American and Canadian organizations formed the Conservation Alliance for Seafood Solutions and released their “Common Vision for Environmentally Sustainable Seafood.” While industry response to the Common Vision was mixed, companies voicing support for the initiative included retailers Ahold, Whole Foods Market, and Wal-Mart, as well as food service giant Compass Group.

Balancing positive and negative messaging in the marketplace

While it is true that environmental non-government organizations (ENGOs) can use retailers as allies to force change, another strategy that is underutilized, particularly in North America, is the use of negative messaging to affect retailer reputation. According to research related to cooperation, a good reputation is valuable currency and is gained by playing by the rules of a social community. It may be beneficial to act uncooperatively in a social dilemma, however, unless the news of defection is made available to those in the community (Semmann *et al.,* 2004). Thus whenever individual or institutional behavior is relevant to the public good, it should be made public (Pfeiffer & Nowak, 2006). Under this premise, one way to motivate large seafood retailers is to generate bad press that highlights unsustainable practices. This negative messaging uses the base of consumer awareness that has been raised by wallet cards and eco-labels to push companies already engaged in sustainability efforts to step up their efforts. Greenpeace is one group utilizing reputation in market-based seafood efforts.

First in Europe (in the U.K., followed by the Netherlands, Denmark, Germany, France, Spain, Austria, and Norway) and most recently in the U.S.A., Greenpeace has used a ranking system to assess supermarket chains in terms of the sustainability of their seafood (e.g., Greenpeace 2005; 2006). While this approach does provide information for consumers, the strategic focus is on the retailers, which are evaluated on the basis of the amount and number of unsustainable seafood products they sell, as well as the presence and quality of their procurement policies, labeling efforts, and training programs. The ranking has created competition at all levels, with some retailers taking steps to try to get to the top of the ranking and others seeking to get off the bottom. In the lead-up to the publication of Greenpeace's ranking of U.S. retailers, top-scoring Whole Foods Market agreed to stop selling red-listed orange roughy, Target committed to dropping red snapper, and Wegman's dropped bluefin tuna. Retailers adopting sustainable seafood procurement policies and dropping several red-listed items have marked all countries where Greenpeace has employed this approach. Within just two months of the release of the Swedish report, all but one major Swedish retailer had dropped all 14 products on Greenpeace Nordic's red list.

Greenpeace also uses public displays to affect reputation and catalyze change in seafood markets. In November 2008, Greenpeace erected 'crime scenes' at 8 Loblaw grocery stores in Toronto with the message "caught red-handed selling redlist fish." The following day, Loblaw officials were reportedly "disappointed" but said they would work to offer more MSC-certified fish (Fiorillo, 2008). The more conventional methods of positive messaging and alliance with retailers are complemented (and could be even more so) by using negative messaging and reputation to motivate large seafood retailers to act.

Connecting seafood to climate change

According to a United Nations report (Steinfeld et al., 2006), 18% of human-caused greenhouse gases stem from farm animals and the livestock industry. People for the Ethical Treatment of Animals (PETA) used the report as an opportunity to advertise in *The New York Times* how meat eating contributed to global warming and how a person switching to a plant-based diet does more for carbon footprint than switching from a sport utility vehicle to a sedan. Paul Watson succinctly described this phenomenon in a recent presentation at UBC's Fisheries Centre, "a meat eater on a bicycle is worse than a vegan in a Hummer".

The global concern for global warming also presents opportunities to connect seafood to climate change. In the same way that the UK has called attention to food miles, seafood miles could be used to inform and frame a discussion on sustainable seafood. Global fuel use by fisheries, just to catch and land fish (not process and ship it further) has been estimated as 1.2% of global oil consumption (Tyedmers *et al.,* 2005). No discussion about seafood sustainability should be complete without considering the relationships between its resource dependencies and emissions and the stability of the broader, biogeochemical cycles that cumulatively provide the implicate order for healthy marine ecosystems.

Fish sticks could be made of heavily-managed, MSC-certified Alaska pollock, but the fish might have traveled 4,300 miles before reaching the processing plant. Salmon farmed in Chile, filleted in China, processed and packaged in Canada, and eaten by a customer in San Diego could travel as far as 22,300 miles (Grescoe, 2008). In the growing Mediterranean bluefin tuna ranching industry, highly endangered fish are taken from the wild and towed back to large caves where they are fattened on herring and other wild-caught forage fish (Greenpeace, 2008). A full-grown bluefin tuna may include energy costs of finding, catching, and towing the tuna, as well as of catching, transporting, and freezing the feed fish. The inclusion of life-cycle thinking would, at a minimum, underscore the importance of promoting energy efficient fisheries and aquaculture production, as well as low-trophic level culture systems (Pelletier & Tyedmers, 2008) and industrial fisheries would likely be considered far less sustainable than small-scale fisheries.

Eliminating the wasteful fishmeal industry

In North America and Europe, there has been a call to eat lower on the food web (Pimentel & Pimentel, 2003; Pollan, 2008) and this has been echoed for marine food webs (Hall, 2007; Grescoe, 2008). However, humans currently must compete with factory-farmed animals for this meal of small pelagic fish. Currently, about 30 million tonnes of fish--36 percent of world fisheries catch—are ground up each year into fishmeal and oil, mostly to feed farmed fish, chicken, and pigs (Alder *et al.*, 2008). As Grescoe (2008) points out, "turning fish as delicious as sardines into fertilizers, mascara, or chicken feed may be one of our epoch's more subtle and grievous crimes against nature."

We argue that decreasing the amount of fish used for reduction should be a top priority of the sustainable seafood movement, particularly because pigs and chickens alone consume six times the amount of seafood as U.S.A. consumers and twice as much seafood as consumers in Japan. One premise of sustainable seafood should be that no fishery that catches fish for reduction into fishmeal and fish oil should be eco-certified. Instead, groups interested in promoting sustainable seafood should encourage direct human consumption of forage fish.

In Peru, for instance, the anchovy fishery, which began in the early 1950s, now amounts to as much as half of the world's fishmeal. Much of this fishmeal is used to feed farmed fish in China as well as livestock and farmed salmon. But as Peru exports fishmeal and other products derived from its catch of 5 to 10 million tonnes of anchovy each year, half of its population (15 million people) lives under conditions of critical poverty and 25% of infants are malnourished (NEI, 2006). This discrepancy led to a major campaign in 2006 involving scientists, chefs, and politicians to remake the image of the anchovy as fish fit for Kings and Queens too. The goal was to increase the real and perceived value of these fish, to develop local and export markets, to make investing in freezing and canning facilities attractive, so that Peru could afford to shift away from turning perfectly edible fish into fishmeal. During week to promote the humble anchovy, 18,000 Peruvians tasted the small fish at more than 30 restaurants in Lima, the nation's capital. Anchovies are much more valuable to the Peruvian economy as canned fillets rather than as fishmeal. One tonne of fillets is sold for five times the price of one tonne of meal and requires half the fish (3 tonnes for 1 tonne fillets versus 6 tonnes for 1 tonne meal). The government decided to dedicate 30% of its annual food security budget, or about US$80 million, for programs that will go to supplying anchovies. As a result, by late 2007, one year after the campaign began, demand for fresh anchovies has grown 46% and demand for canned anchovies is up 85%. It is hoped that higher prices for anchovies will limit their use in fishmeal industry, thereby causing an overall reduction in demand for anchovies.

Without fishmeal, protein alternatives for animal feed are needed. There is a new interest in mass-producing insects (Ratliff, 2008) as a sustainable protein source to replace fishmeal in fish and livestock feeds and experimental trials show that a fishmeal alternative, at least partially, might be possible. More important, agriculture and aquaculture need to revert back to less intensive systems, requiring only plant-based inputs.

Elimination of harmful fisheries subsidies

Arguably, a powerful market force driving overfishing is fisheries subsidies. Globally, fisheries subsidies are an estimated $30-34 billion annually, $20 billion of which contribute directly to encouraging excess fishing capacity (e.g., fuel subsidies, boat construction; Sumaila & Pauly, 2006; Sumaila *et al.,* 2008) and favor industrial fisheries over small-scale, more sustainable ones. Yet the U.S. conservation community's investment in eliminating harmful fisheries subsidies has been less than 4% of the investment into consumer-oriented market based campaigns over the last decade (Jacquet & Pauly, 2008b). The market-oriented goal of eliminating harmful fisheries subsidies must become a global conservation priority. Therefore efforts by the World Trade Organization to discipline fisheries subsidies is important and needs to be pursued with even more rigor than before (Sumaila & Pauly, 2007 Sumaila et al., 2007).

Setting seafood targets

Finally, to warrant continued investment each market-based conservation program should be designed so as to produce outcomes and testable results (Sutherland *et al.,* 2004). The number of consumers reached by a seafood choice campaign is not alone a measure of success, unless it is accompanied by a measureable improvement in wild fish populations. Simply creating demand for an eco-certified product is not enough unless there is a concurrent decrease in demand for other, overfished species.

Sustainable seafood initiatives must be integrated and coordinated with others and have a common goal. In the same way that coordinated efforts by the scientific community and governments have determined targets for greenhouse gas emissions, national and international targets are needed for seafood catch and consumption (and at what trophic level) to shift global fisheries to sustainable enterprises. Such an analysis must be regional, to take into account national differences in fishing capacity (industrial v. artisanal fleets) and complexity of the markets (local v. global). This analysis could yield an 'optimal sustainable consumption rate' of wild fish, and in turn determine the rate of increase of aquaculture production and other alternatives to seafood, to meet demand.

The sustainable seafood movement must also place more emphasis on data sharing and publishing results. The only way forward is to develop webs of interaction of initiatives and stakeholder groups that have been isolated in the past – because of lack of communication between stakeholder groups or because competing interests within and between groups.

Discussion

Seafood is one of the only wild foods (aside from mushrooms) that Westerners eat with any regularity. After more than a decade of market-based sustainable seafood initiatives, the demand for this last wild food source is higher than ever, which has resulted in further declining fish populations (Pauly *et al.,* 2002, Worm *et al.,* 2006) and a complementary rapid domestication of marine species (Duarte *et al*., 2007).

Individuals and groups working to curb overfishing in the 1980s and 1990s first attempted to work within regulatory frameworks, but became frustrated with the pace of regulatory approaches and the tactics of powerful interest groups. Many abandoned the political process in favor of the market. In 1992, Carl Safina unsuccessfully lobbied for a CITES listing of bluefin tuna, which would have banned the trade of tuna (Grescoe, 2008). Safina later assisted in designing the first seafood wallet card and then formed the Blue Ocean Institute, dedicated to creating a new ethic but also to developing seafood guides and working closely with consumers.

These efforts snowballed into the concerted international effort aimed at household consumers today.

We do not argue against the principle that consumers should make a point of choosing products that reflect their ideals, a premise that is especially prevalent in food choices (Pollan, 2007; Pollan, 2008; Clover, 2006: Grescoe, 2008). But in terms of monetary outlays and human energy, we argue that putting too much emphasis on end consumers is not an effective market-based strategy. There is simply too much cheating in the marketplace (e.g., mislabeling), too much misleading information, too many inconsistencies, and, so far, too few results.

Just as consumers experienced fatigue in the 1990s after corporate eco-advertising amounted to little action or outcome, so might this decade witness the same fatigue in terms of sustainable seafood campaigns. For instance, in 2002, Sainsbury's in the UK committed to sourcing all of its wild fish from sustainable sources by 2010. But after working closely with the MSC and shelving 12 MSC-labeled products, MSC-certified fish only amount to 1 percent of total fish sales (Roheim & Sutinen, 2006). In 2006, Wal-Mart pledged to source all of its capture fish from the MSC by 2010 (Gunther, 2006), a goal Wal-Mart is not likely to meet. The 'greenwashing' corporations were accused of in the 1990s could turn to a 'bluewashing' today.

However, it is important to note that these corporations are motivated to make these promises because they believe that their consumers want them to act. In this way, it is clear that consumers can help drive changes in the market. However, to avoid the 'bluewashing' phenomenon, sustainable seafood campaigns must be goal-oriented and communicate whether or not goals were met. National and international seafood consumption targets could help determine these goals. To achieve reduction in seafood demand more quickly, sustainable seafood initiatives might work higher in the demand chain, begin connecting seafood to climate change, campaign to divert small fish away from the fishmeal industry and into consumer markets and work to eliminate harmful fisheries subsidies.

The conservation movement's emphasis on consumers and market-based initiatives is perhaps a result of the Reagan-Thatcher-Bush years, during which government was perceived as the problem and markets as panaceas. Today, this perception is changing. Working with household consumers alone cannot save fish. Although government regulations are far from perfect, the successes of government efforts to improve fisheries have been more obvious and measureable (e.g., marine protected areas; Roberts et al. 2001). Even within a market-based approach, there is a need to ensure that information is correct and that conservation efforts are not obstructed by harmful subsidies. In other words, working with consumers and retailers also brings an imperative of working with governments.

Tables

Table 9.1: Timeline and Overview of Market-based Sustainable Seafood Initiatives

Year	Country	Sponsor	Category	Name	Remarks/HTML
Late 1980s	U.S.	Earth Island Institute	Boycott/Eco-label	Dolphin safe logo	Boycott of canned tuna resulted in the first seafood eco-label, the 'dolphin safe' logo. http://www.earthisland.org/dolphinSafeTuna/consumer/
1995	Global	United Nations Food and Agriculture Organization	Evaluation system	Code of Conduct for Responsible Fisheries	Voluntary agreement that sets out principles and international standards for fisheries management. http://www.fao.org/DOCREP/005/v9878e/v9878e00.htm
1997	Global	World Wildlife Fund & Unilever	Eco-label/evaluation system	Marine Stewardship Council	Became independent in 1999. To date, 22 certified fisheries; 4% of global market. http://www.msc.org
1997	U.S.	Monterey Bay Aquarium	Consumer seafood guide/Evaluation system	Seafood Watch Program	Began as a list of sustainable seafood for an aquarium exhibit and in 2000 became a wallet card. Other aquaria use the same information with a different interface. http://www.mbayaq.org/cr/seafoodwatch.asp
1998	U.S.	Audubon	Consumer seafood guide/Evaluation system	Seafood Lover's Guide	First consumer seafood guide, produced by Carl Safina who, at the time, was working for Audubon. Today it is also co-sponsored by the Wildlife Conservation Society. http://seafood.audubon.org/
1998-2000	U.S.	SeaWeb & Natural Resources Defense Council	Boycott	Give Swordfish a Break	700 chefs boycott swordfish until the international fishery commission cut quotas http://www.seaweb.org/programs/swordfish/
1999	Global		Evaluation system	Rapfish	RapFish considers 5 areas: ecological, economic, ethical, social, technological (Pitcher and Preikshot, 2001), and the FAO Code of Conduct (Pitcher, 1999). Microsoft Excel Software for Rapfish is available (Kavanagh and Pitcher, 2004). http://www.fao.org/DOCREP/005/X4175E/X4175E00.HTM
1999	U.S.		Eco-label/Evaluation system	EcoFish	New England-based company selling sustainably caught fish. In 2001, EcoFish was certified as sustainable by the MSC (the first seafood distributor to earn such certification). Also have a new seafood safe logo based on contaminant testing. http://www.ecofish.com/
1999	Australia		Evaluation system	Environment Protection and Biodiversity Conservation Act	Legislation that requires fisheries that fall into certain categories to undergo sustainability assessments that are then submitted to the Dept. of Environment and Heritage (has been done for nearly every export species). http://www.environment.gov.au/epbc/
1999	Australia		Consumer	Victoria National	Evaluates the status of important commercial fishery species from southern Australia

			seafood guide/ Evaluation system	Parks Assoc.	
2000	U.S.		Consumer seafood guide	Fish for Thought: An Eco-Cookbook	
2001	U.S.		Trade association	Seafood Choices Alliance	http://www.seafoodchoices.com/home.php
2001	U.S.	Environmental Defense	Consumer seafood guide	Oceans Alive	Program was formerly known as Seafood Selector Website and Pocket Guide and was renamed the Ocean Alive program in 2005. http://www.oceansalive.org/home.cfm
2001	U.S.	EarthEasy	Consumer seafood guide	Sustainable Seafood Guide	http://www.eartheasy.com/eat_sustainable_seafoods.htm
2001	U.S.	Seafood Choices Alliance	Distributor seafood guide	Sourcing Seafood	http://www.seafoodchoices.com/resources/sourcingseafood.php
2001	U.S.		Distributor seafood guide	Choice Catch	Sponsored by New England Aquarium and Ahold. Formerly known as EcoSounds, Choice Catch audits domestic and international sources of seafood for environmental impact and sustainability based on scientific information available to ensure sustainability and traceability of Ahold's seafood product (Ahold is the fifth largest U.S. grocery chain). http://www.neaq.org/choicecatch/
2001	Global		Eco-label/evaluation system	Marine Aquarium Council certification and eco-label	Marine Aquarium Council is a third-party certifier. http://www.aquariumcouncil.org/
2002	Global		Evaluation system	Traffic Lights	Unilever's internal fishery assessment system based on FAO guidelines. http://www.seafoodchoices.com/membership/champions_unilever.php
2002-2007	U.S.	National Environmental Trust (NET)	Boycott	Take a Pass on Chilean sea bass campaign	Program ended when NET merged with Pew Charitable Trusts.
2002	U.S.	Environmental Defense	Distributor seafood guide	Business Guide to Sustainable Seafood	101-page document available online http://www.environmentaldefense.org/documents/2532_BusinessGuideSustainableSeafood.pdf
2002	U.S.	Sustainable Fishery Advocates	Eco-label	FishWise	Began in California and is now implemented in 34 stores. As of 2005, also provides retailers/consumers with information regarding contaminants. http://www.sustainablefishery.org/
2002	U.S.	South Carolina Aquarium	Distributor seafood guide	Sustainable Seafood Initiative	Restaurant partners agree to remove Chilean sea bass, orange roughy, and shark from their menus. Collaboration between southern business and NGOs. http://www.scaquarium.org/SSI/default.html

2002	UK	Marine Conservation Society	Distributor seafood guide	Good Fish Guide	Has been used by some UK supermarkets looking at sustainability. http://www.fishonline.org/
2002-2005	Canada	Endangered Fish Alliance	Distributor seafood guide	Endangered Fish Alliance	Ask that members not serve swordfish, Chilean sea bass, orange roughy, and certain types of caviar. 161 pioneer members. In 2005 merged with Environmental Defense. http://www.endangeredfishalliance.org/
2003	U.S.	Blue Ocean Institute	Consumer seafood guide/ Evaluation system		Fully transparent. Based on the methodology developed by C. Safina in the Audubon Society's Seafood Lover's Almanac. Other aquariums use the same information with a different interface (e.g., Shedd aquarium re-labels it as "Right Bite").
2004	U.S.	Star Chefs	Consumer seafood guide	Sustainable Seafood Guide	http://www.starchefs.com/features/food_debates/html/sustainable_seafood.shtml
2004	Canada		Eco-label?	Organic Ocean	Group of independent B.C. fishermen who sell sustainable seafood. http://www.organicocean.com/
2004	N.Z.	New Zealand Forest and Bird	Consumer seafood guide/Evaluation system	Best Fish Guide	Have full evaluation online; first independent ecological ranking for N.Z. commercial fisheries. http://www.forestandbird.org.nz/bestfishguide/index.asp
2004	U.S.	The Smithsonian	Consumer seafood guide	One Fish, Two Fish, Crawfish, Bluefish	Sustainable Seafood cookbook.
2004	Australia	AZ Marine Conservation Society	Consumer seafood guide	Sustainable Seafood Guide	http://www.amcs.org.au/default2.asp?active_page_id=137
2004	South Africa	World Wildlife Fund	Consumer seafood guide	Seafood pocket guide	Text messaging available. http://www.panda.org.za/sassi/
2005	U.S.		Consumer seafood guide	Co-op American Safe Seafood Wallet List	Article that combined information from the FDA, FDA, Monterey Bay Aquarium, and Blue Ocean Institute; reprinted by other magazines
2005	EU		Trade association	Seafood Choices Alliance	European branch.
2005	UK	Greenpeace	Distributor seafood guide	Recipe for Disaster	Reviews sustainability of common fish in UK supermarkets by combining recommendations from Australian, New Zealand, USA and UK NGOs.
2005	Italy, Switzerland	Friend of the Sea	Eco-label/evaluation system		Uses FAO guidelines and third-party certification (includes aquaculture) and is used by Italy-based retailer Co-op and, in October 2007, the Swiss retailer MANOR; also allows text messaging.
2005	Canada	Vancouver Aquarium	Distributor seafood guide/Evaluation system/ Eco-	Ocean Wise	Vancouver-based restaurants.

			label		
2005	Spain	Greenpeace	Consumer seafood guide	Guia para el consumo responsable de pescado	Report and consumer guide
2006	U.S.	PCC Natural Markets	Consumer seafood guide	Seafood choices for a healthier ocean	Partnership with Monterey Bay Aquarium
2006	U.S.	Environmental Defense Wegman's and Bon Appetit	Distributor seafood guide	first corporate purchasing partnership	http://www.environmentaldefense.org/page.cfm?tagID=1464
2006	Canada	Various NGOs	Consumer seafood guide/ Evaluation system/more	SeaChoice	
2006	E.U.	IncoFish Project	Miscellaneous	FisherMin,	A ruler against which shoppers can measure their fish to ensure they are not buying juveniles (Froese, 2004). http://www.incofish.org/Results/tools/FishNorth.php
2007	E.U./North America	WWF, the North Sea Foundation (Dutch), Greenpeace, Seafood Choices Alliance	Evaluation system	A Common Tool for Assessing Seafood Sustainability	http://www.seafoodchoices.org/newsroom/CommonMethods.php
2007	E.U./North America		Distributor seafood guide	Sustainable Fisheries Partnership/Fish Source	
2007	E.U.		Trade Association	Responsible Fishing Alliance	Sustainable Food LabWill work with business-to-business seafood trade focusing on small-scale capture fishers and aquaculture.
2007	USA	Blue Ocean Institute	Consumer seafood guide	Fish Phone	
2007	Belgium	World Wildlife Fund (WWF)	Consumer seafood guide		
2007	Denmark	WWF	Consumer seafood guide		
2007	Finland	WWF	Consumer		

			seafood guide		
2007	France	WWF	Consumer seafood guide		
2007	Germany	WWF	Consumer seafood guide		
2007	Hong Kong	WWF	Consumer seafood guide		
2007	Indonesia	WWF	Consumer seafood guide		
2007	Netherlands	WWF	Consumer seafood guide		
2007	Norway	WWF	Consumer seafood guide		
2007	Poland	WWF	Consumer seafood guide		
2007	Spain	WWF	Consumer seafood guide		
2007	Sweden	WWF	Consumer seafood guide		
2007	Switzerland	WWF	Consumer seafood guide		
?	Netherlands	North Sea Foundation	Consumer seafood guide	North Sea Foundation *De Goede Visgids*	http://www.goedevis.nl/
2002	Germany	Greenpeace	Consumer seafood guide	*Magazin*	http://www.greenpeace.de/themen/meere/fischerei/
2008	Netherlands	Greenpeace	Consumer seafood guide	*Maak Schoon Schap*	http://www.maakschoonschap.nl/
2008	US	New England Aquarium	Consumer seafood guide	Celebrate Seafood	http://neaq.org/documents/CelebrateSeafoodGuide.pdf

Figures

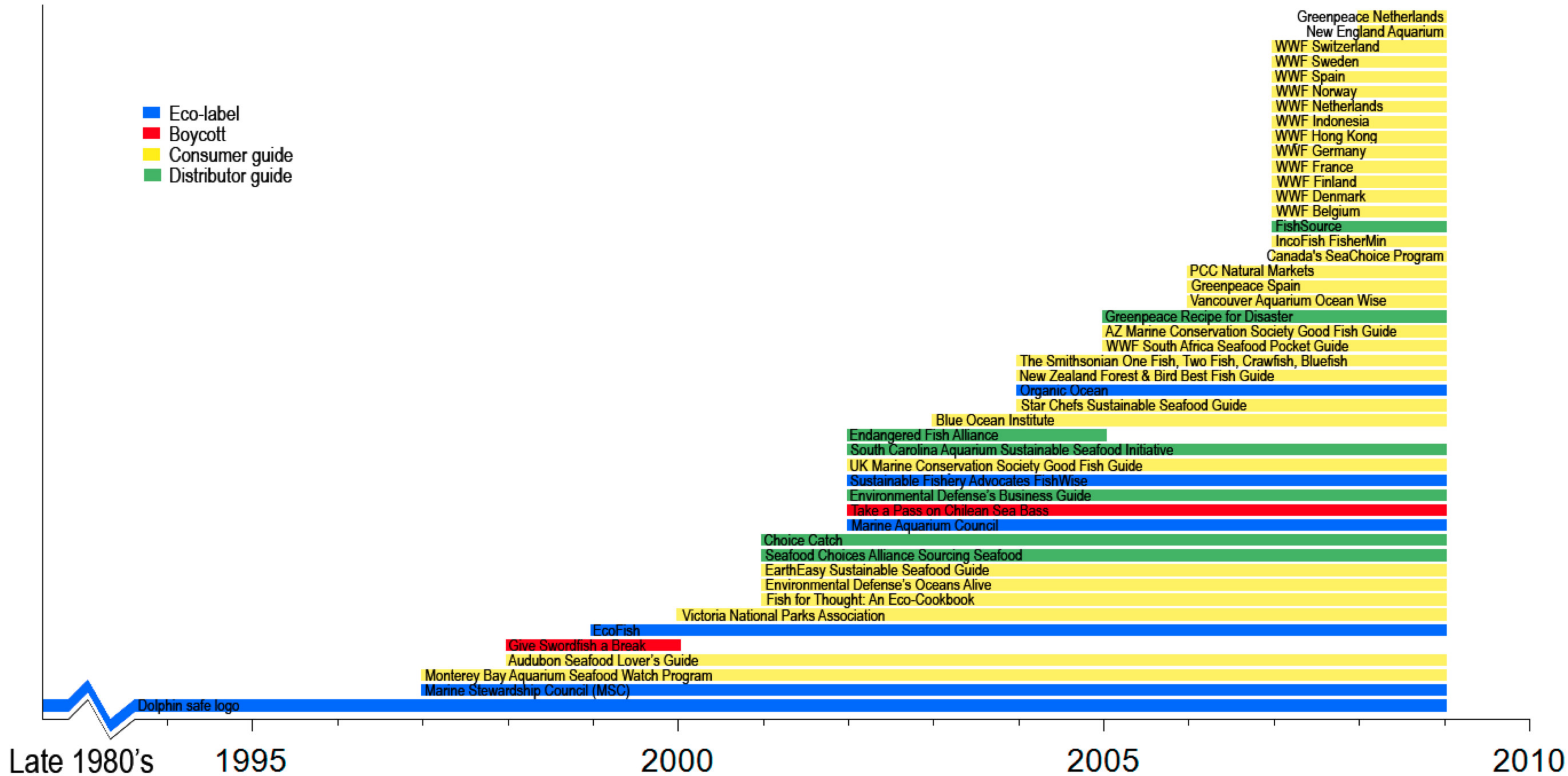

Figure 9.1 The rise in sustainable seafood initiatives, 1989-2009

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10 WHAT CAN CONSERVATIONISTS LEARN FROM INVESTOR BEHAVIOR?[1]

[1] A version of this chapter has been accepted for publication. Jacquet, J. (in press) What can conservationists learn from investor behavior? Conservation Biology.

How do we encourage personal savings and investment? Answers to this question, revealed through new analyses in experimental economics, provide insight into how to encourage collective savings and investment in our future through ecological conservation.

Lesson 1: Awareness alone is a weak instrument for change

The 2001 bankruptcy of major corporations such as Enron, WorldCom, and Global Crossing resulted in devastating losses for the companies' employees, many of whom held their retirement assets in employer stock. The media repeatedly highlighted these financial losses; *The New York Times* alone ran 1,364 stories over the 6-month period following Enron's bankruptcy, 112 of which ran on the front page. The amount of awareness raised about the riskiness of investing in employer stock far surpassed media attention given to ecological concerns.

Yet, even after the media barrage about an issue directly affecting them, employees overwhelming retained their employer stocks--the fraction of assets held in employer stock fell by no more than 2 percentage points. Workers in Texas (home to Enron), who were subject to even greater media exposure, responded to the loss with no overall reduction in employer stock investments (Choi et al., 2005).

If the collapse of major corporations resulting in loss of personal savings did not change household behavior, how can we expect consumers to change in response to information on environmental degradation? Information alone is insufficient. Conservation initiatives must include solutions, beyond raising awareness of an ecological concern.

Lesson 2: The default institutional setting determines the destiny

In the same way that relatively few people donate their organs unless organ donation is the default, relatively few employees save money via their firm's 401(k) plan unless saving money is the default. A U.S. study examining employee behavior found that when enrollment in a 401(k) plan was optional but not the default, 30% of employees participated. If, however, the default was reversed and the firm automatically enrolled its employees in the 401(k), 80% of employees kept the 401(k) plan (without losing their freedom to choose; employees could opt out with a 5-minute process) (Choi et al., 2004).

Moreover, the psychology of personal savings could influence how conservationists work to save our ecological heritage. Changing default settings for patterns of consumption (allowing the less desirable outcome but only upon request) can be preferable to regulations because it allows for greater consumer freedom. In the same way firms should make a savings program the default for their employees, conservation groups could lobby institutions (e.g. governments, utilities, universities, businesses, architecture firms) to make socially optimal choices the default for their citizens.

For instance, when households have the option to pay premiums for renewable energy sources or recycling programs, these green options should be the default. Thermostats in corporate buildings should be set lower but allow for employees to increase the temperature each morning. Architects should make appealing stairwells central to building design, rather than the current elevator default (elevators would be available but not central). Stores could continue to provide plastic bags for their customers but only upon request.

Lesson 3: Sometimes, setting extreme defaults is optimal.

Defaults should be set to maximize the average well-being, which is not the same as setting the default to the average preference of all citizens. Often, default rates of savings should be bolder than the average person would want (Choi et al., 2003) and this relates to our conservation goals. Conservation groups might aim to set extreme defaults to start and then ratchet them down as demanded by society rather than lobbying for constant incremental increases from a very weak base.

In the oceans, for example, our collective debt (e.g. overfishing, pollution, climate change) far outweighs our savings (e.g. marine protected areas). More than 99% of the world's oceans are open to fishing (Spalding et al., 2008). Perhaps conservation groups should initiate policies to reverse our conceptual default—the view of the oceans as being open to fishing with small exceptions—to see the oceans as closed to fishing with small exceptions (Walters et al., 1998).

The recent financial crises around the world point to the role that institutions play in both creating and assuaging economic hardship. Free markets may be compatible with long-term stability, both economically and ecologically, but only with an institutional component that encourages precautionary, risk-averse behavior. This behavior will not develop from education alone. Just as the Enron debacle did not lead to changes in investments in employer stocks, awareness of environmental problems alone is not likely to yield the desired ecological results. Conservation efforts must enlist existing institutions to reset default patterns of consumption, support regulatory efforts, and shift conceptual views of nature. Just as we need an institutional nudge to cultivate our personal savings account, we also need this to save the planet.

Chapter 10 References

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11 BEYOND FOOD: FISH IN THE 21ST CENTURY

Aside from mushrooms, seafood is the last wild food regularly eaten in Western society. Overfishing imperils this last globalized hunter-gatherer food system and those humans who still largely rely on fish for survival. Overfishing can be considered in two primary categories: a Malthusian form, a combination of overpopulation and destructive fishing practices (Pauly, 1997), and an industrial form, which is the coupling of over-efficient fishing techniques with lax and unsustainable policies.

Globalization further exacerbates overfishing and the tension between luxury and subsistence markets. The increasing demand for seafood has led to fishing in the furthest reaches of the ocean, while the demand for luxury seafood from the developed world competes with the food-security demand from the developing world for the same marine resources.

Sometimes, the competition between the developed and developing worlds is obvious. In African waters, for instance, shrimp trawlers from distant lands compete with local fishers for the same fishing grounds. Most often, however, the 'invisible hand' of the market shrouds the redirection of fish from those who need it to survive to those who do not. This redirection is facilitated by non-transparent access agreements (Kaczynski and Fluharty, 2002) and subtly and not so subtly unequal trade patterns.

Industrial development through the 1960s and 1970s led to a pattern in the small-scale sector where the desire for cash gradually shifted the principally subsistence fisheries to subsistence-plus-market fisheries. In the most extreme cases, the effects of the globalized market are more severe, as developing countries eager for foreign exchange sell off what they perceive to be 'surplus' fisheries production (often driven by reliance on incomplete statistics) and fishing rights to the developed world. This can result in an inversion of the Robin Hood parable: the stealing of fish from the poor to feed the rich.

It is possible that many developing world countries never had a 'surplus' of fish in the first place, but that the catches of their small-scale, subsistence fishers have simply gone unrecorded. In Mozambique, for instance, access agreements have allowed distant water fleets to access Mozambican waters—often under the premise that local, small-scale fishers produce little to no fish. Since the 1950s, Mozambique has reported primarily industrial catches and has vastly under-reported the nation's small-scale fishing sector due to lack of resources and civil war. However, based on reconstructed data for the small-scale sector, since 2000, the Mozambique fishing sector as a whole caught between 150,000 and 172,000 t per year. Overall, reconstructed marine fisheries catches from 1950-2005 for Mozambique were 6.2 times greater than data reported to and by the United Nations Food and Agriculture Organization (FAO) (Chapter 3).

Similarly, in Tanzania, Zanzibar's recorded fisheries statistics are missing from Tanzania's marine fisheries catches reported by FAO. Taking into account reconstructed small-scale fisheries catches, total mainland catches are also at least one-third larger than reported by official data, which means that Tanzanian marine fish catches are at least 95,000 t in recent years and that, for 1950-2005, catches were 1.7 times greater than those reported. The small-scale fishing sector's catches in both countries, which make up approximately 75% of total catch, are not small, even if they appear to be so in international statistics (Chapter 3).

In Ecuador, globalization's effects on the small-scale sector have led fishers to target previously undesired species (i.e. sharks). The Asian demand for shark fin soup has led to heavy shark fishing pressure in the Eastern Pacific and yet, perhaps due to the highly contentious nature of shark finning, shark catches in the region are also underreported. Until the 2005 update of fisheries data, the FAO did not report elasmobranches for Ecuador (after 2005, Ecuador backdated shark captures for 1991 to 2004). Yet, the reconstruction of Ecuador's mainland shark landings for 1979 to 2004 shows that shark landings were an estimated 7,000 tonnes per year, or nearly half a million sharks, and 3.6 times greater than those retrospectively reported by FAO for 1991 to 2004 (Chapter 4).

These cases of data misrepresentation are cited as case studies in a typology to classify fisheries catch data (Chapter 5). At each stage in the reporting chain, from fisher to national/international agencies, fisheries catch can be: known and reported; known and underreported; unknown and overreported; or unknown and underreported. Of these four categories, underreporting seems to be the likeliest outcome.

To obtain a better understanding of fisheries catches around the world, catches can be reconstructed based on biological models (e.g. Watson & Pauly, 2001) or by using historical gray literature to establish proxies, as I have done here (Chapters 3 and 4) and has been done elsewhere (Zeller *et al.*, 2006; 2007). In the meanwhile, countries must recognize that they are often operating with limited and insufficient data and that political will must be garnered to make precautionary fisheries management decisions in the face of data uncertainty (Chapter 5) and perhaps even prior to scientific consensus (Ludwig *et al.*, 1993).

In the specific case of Ecuador, the discrepancies in data require immediate implementation of the measures existing Ecuadorian law mandates: eliminating targeted shark captures, finning, and transshipments, as well as adoption of measures to minimize incidental capture. Most of all, a serious shark landings monitoring system and effective chain of custody standards are needed. This recommendation, in fact, is true for the seafood sector as a whole.

As the global trade and market for seafood has grown, the market has simultaneously masked and revealed unconventional signs of overfishing through the twin problems of renaming and mislabeling (Chapter 7). Resource scarcity, the potential for greater profits, and weak legislation have all encouraged incorrect labeling, the results of which include consumer losses, the further degradation of fisheries resources, and even adverse effects on human health.

To protect consumers, governments should support a global mandate to label species, country-of-origin, and catching or production method on all seafood with high penalties for infractions. To garner support for such legislative actions, consumers must become better acquainted and concerned with their seafood and its origin. This is especially important in the U.S., where 80 percent of the seafood is imported, more than one-third of all fish is mislabeled, and less than one percent of seafood is inspected (Chapter 7).

The problem of renaming and mislabeling also subverts consumer awareness campaigns, which have become very popular conservation investments in recent years and in part aim to decrease consumption of overfished species by encouraging demand for sustainably-caught ones (Chapter 6 and 9). But even the most sophisticated of consumers would have difficulty navigating the confusing messages and cheating that occur in Western seafood markets.

Just as Charles Darwin (1859) convinced us of the significance of small changes over large amounts of time (i.e. natural selection), so too have we learned the ecological consequences of early fishing epochs that Jackson et al. (2001) describe as the 'aboriginal' and 'colonial' periods. Using anecdotes as data (as per Pauly, 1995), historical ecologists show that early fisheries, despite being low-tech in nature, had significant impacts (e.g. Jackson *et al.*, 2001). The incorporation of anecdotes into scientific studies also allows us to comprehend the true magnitude and impact of small-scale fisheries in the developing world (e.g. Chapters 3 and 4), recreational fisheries (Zeller et al., 2008; McClenachan, 2009), and the aquarium trade.

It requires less convincing to comprehend the considerable impacts of the recent 'global' fishing industry. One trawler today can remove 60 tonnes of fish from the ocean in a single haul.

Indeed, industrial fisheries are capable of reducing fish biomass by 90% in just 15 years (Myers and Worm, 2003). Put simply, this modern industrial era hailed a type of fishing that led to big changes over small amounts of time.

This is why consumer efforts, which aim to reform consumer preferences in luxury markets, are largely futile. So far, the consumer campaigns that address “sustainable seafood” have not proved themselves capable of much more than catering to niche desires to ‘do the right thing’ (Chapter 6 and 9). These small changes at the household level would require widespread adoption and, therefore, a lot of time – time we do not have -- to yield positive effects. Furthermore, localized successes in reducing demand for certain species are easily masked by a globalized and increasing demand for seafood.

This certainly does not mean efforts should not be undertaken. Indeed, one could argue the benefits of marine protected areas are also eclipsed in an ocean where more than 99% of the ocean is open to fishing (Spalding *et al.,* 2008; *Wood et al*., 2008). However, it does provide an argument that the conservation community must be more strategic in its efforts and its funding strategy (Chapter 8).

Today’s conservation movement, like the fishing industry it seeks to revolutionize, must make big changes over small time. It can do this best by working higher in the demand chain, in what can be described as vertical (consumer to mega-consumer or government), rather than horizontal (consumer to consumer), agitation. In a market-based approach, efforts should be directed at eliminating harmful fisheries subsidies (Chapter 8), working with large seafood buyers, and eliminating the use of fishmeal in agricultural feed (Chapter 9).

Finally, the biggest change the conservation community could hope to achieve would be to create an ethical shift that seeks to create mythologies for fish and invertebrates, i.e., to decommodify them. We were able to achieve this with whales because they are mammals that nurse their young, communicate with one another, and apparently exhibit high levels of intelligence. However, fish are, for the most part, cold-blooded, expressionless creatures. But, in some ways, fish are not that different from birds and, as anyone who has ever been to England knows, there is no shortage of sentiment for avian species. Like the albatross, tunas cover remarkable migratory distances. Like an eagle, an octopus can also build an impressive home. And, like many macaws, the Moorish idol chooses a mate for life. Fish are not simply food. When discussing their future, we should engage as citizens concerned about Earth's fellow inhabitants as much as consumers worried only about our appetite.

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