FISHERIES MANAGEMENT: SUSTAINABILITY VS. REALITY

Daniel Pauly
Fisheries Centre, University of British Columbia, Vancouver, Canada

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Summary

Fisheries have a long history, marked mainly by lack of sustainability. This has become worse since the Industrial Revolution, which added industrial fishing vessels to the smaller crafts and fixed gear that had so far been used to exploit coastal fish populations. The added fishing effort led globally to a massive increase of catches from offshore and/or distant areas previously not exploited. Also, this added effort led in many countries to the marginalization of small-scale fishers, and especially of aboriginal people.

However, present levels of effort are unsustainable, if only because of the ecological damage thus generated, and which research has so far largely ignored. Re-establishing as semblance of sustainability will require a massive reduction of fishing effort in most parts of the world. This may be achieved, at a minimum of social cost, by replacing, wherever possible, large and invariably subsidized industrial (and/or distant-water) fleets, by ecologically more benign small-scale operations.

1. Introduction: From Foraging to Industrial Fishing

The earliest evidence of fishing by *Homo sapiens* so far identified are sophisticated bone harpoons, recovered, along with middens and related evidence, by archeologists digging at a site estimated to be 90,000 years old, in present day Congo (ex-Zaire). The main species that was targeted is a now extinct, 2 m long freshwater catfish; most probably, the fishers in question moved on to other species. This pattern of fisheries exterminating the population upon which they originally relied, then moving on to other species, has been going on since.

The last major step in this was the development, during the Industrial Revolution, of vessels of unprecedented fishing power, such as stream trawlers. Added to the substantial fishing effort of the traditional, small-scale fleet that operated inshore and tended to target juveniles, these industrial vessels, targeting stocks of adult fishes further offshore, quickly reduced populations that had previously been perceived as immune to the effects of fishing.

2. Large-scale vs. Small-scale Fisheries

The developments of a dual sector, consisting of a few large vessels competing usually for different life stages of the same shared resources with a multitude of small coastal vessels, or fixed gear (or 'industrial' vs. 'artisanal'), as occurred in Europe at the end of the 19th century, was quickly duplicated in other parts of the world, either via local industrialization (USA, Canada, Japan, Korea, etc.), via import of vessels (India, Southeast Asia) or via distant-water fleets operating with or without the agreement of the coastal country, as often occurs along West Africa coastlines. Overall, fishing effort is now at least twice what would be required to harvest world catches, and this may be explained as a result of profit maximizing firms competing against each other while exploiting largely open-access resources.

Besides this problem of global overcapacity, the duality of the fisheries sector illustrated in Figure 1, and, almost everywhere in the world, pitting artisanal fishers against the operators of industrial fleets, is the greatest problem besetting fishing enterprises.

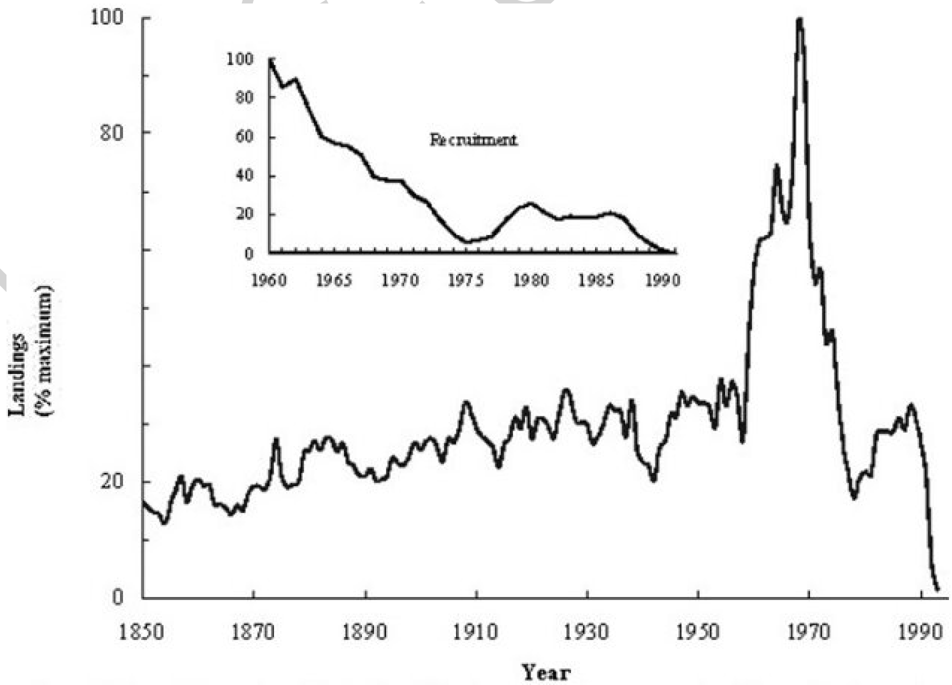

Figure 1. Schematic illustration of the duality of fisheries prevailing in most countries of the world, using numbers raised to global level (based on an original graph by David

Thompson, updated with FAO data. This duality of fisheries, which largely reflects the misplaced priorities of fisheries 'development', offers the opportunity for reducing fishing mortality on depleted resources while maintaining social benefits, by reducing mainly the large-scale fisheries.

Indeed, the two problems are closely interrelated. Thus, 'buy-back' programs aiming at reducing fleet overcapacity often have the perverse result of eliminating relatively harmless small-scale craft, while subsidizing the modernization of industrial fleets.

FISHERY / BENEFITS	LARGE SCALE	SMALL SCALE
Number of fishers employed	about ½ million	over 12 millions
Annual catch of marine fish for human consumption	about 29 million tonnes	about 24 million tonnes
Capital cost of each job on fishing vessels	$30,000 - $300,000	$250 - $2,500
Annual catch of marine fish for industrial reduction to meal and oil, etc.	about 22 million tonnes	Almost none
Annual fuel oil consumption	14 – 19 million tonnes	1 – 3 million tonnes
Fish caught per tonne of fuel consumed	2 – 5 tonnes	10 – 20 tonnes
Fishers employed for each $1 million invested in fishing vessels	5 - 30	500 – 4,000
Fish and invertebrates discarded at sea	16 – 40 million tonnes	None

Figure 2. Marine global fisheries catches (1950s to 1990s). Based on nominal catch series of the Food and Agriculture Organization of the United Nations. Note relative increase of pelagic (open water), relative to demersal (bottom) fishes, and of invertebrates, both symptomatic of fishing down marine food webs (see text).

Moreover, the duality of fisheries, and the within-sector competition it entails also makes it very difficult to address issues of sustainability, as each subsector believes all would be well if the other were not operating. Indeed, it took two World Wars, and the recovery of major fish stocks from fishers and fishing vessels drafted into the war effort, for the notion of sustainable fishing to become widely accepted, at least in theory, by the industry as a whole. Sustainable fishing, and its converse, overfishing, imply that fisheries have strong impact on the abundance and biological productivity of fish stocks, and that therefore, there should be, for each fishery/resource complex, a level of fishing effort such that its yield is optimized.

Fisheries research, in the three decades following the Second World War, turned this costly insight into quantitative fish population dynamics, and 'stock assessments', based mainly on the mathematical models of R.J. Beverton, S.J. Holt and J.A. Gulland in England, M. B. Schaefer in the USA, and W.E. Ricker in Canada. However, the demonstration, though these models, of the benefits of limiting fishing effort did not stop the relentless expansion of industrial fleets. Rather, during this same period, they expanded throughout the world, to Latin America, the shores of newly independent states of Asia and Africa, and into subpolar and polar seas. Global landings, in this period climbed from 20 million in 1950 to 70 million tonnes 1975 (Figure 2).

None of the these fisheries came even close to being sustainable, even by the standard of their time, and only a few stock collapses were strong enough to induce reflection. One of these is the collapse of the Peruvian anchoveta *Engraulis ringens*, visible even in the highly aggregated trend of Figure 2. However, as this collapse was associated with the El Niño event of 1972/73, it sent to managers and scientists the (misleading) message that fisheries are typically at the mercy of environmental fluctuations. Thus, the collapse, in the 1970s, of the demersal resources of the Gulf of Thailand was far more representative of fisheries in general in that it showed how a modern fleet could reduce, within a decade, a coastal multispecies stock to less than one tenth of its original biomass. Indeed, the Gulf of Thailand trawl fishery re-enacted the destruction of coastal stocks that occurred in the North Atlantic at the end of the 19^{th} Century.

In the 1980s and 1990s, the technological and geographic expansion of industrial fleets continued, but led to relatively small increases in global marine landings, now fluctuating between 90 and 100 million tonnes (Figure 2). This, however, went along with a massive increase of discarding unwanted by-catch, now estimated at nearly 30 million tonnes, and of widespread cheating, along with the accompanying degradation of catch statistics. The latter, also due to governments' staff and cost-cutting measures led, in many areas of the developed world, to largely unreliable catch statistics, not to speak of developing countries, where the multitudes of species caught, and of places where they are landed, accentuates the lack of resources devoted to monitoring the fisheries.

During this period, fisheries research went on, much of it along traditional lines, i.e., performing assessments for single-species fisheries, in view of estimating their Total Allowable Catch (TAC), while fighting off claims by conservationists asserting, with increasing public support, that industrial fisheries 'rape the sea'.

Yet the scientific evidence for large-scale ecosystem impacts of industrial fishing is extremely strong, and it hard to conceive how fisheries research will be able to continue as credible activity if it cannot restructure itself around that evidence. One reason why this should be possible is that multispecies models derived from standard, single-species models do in fact predict pervasive ecosystem impacts of exploiting single species.

3. Three Cases of Absent Sustainability

3.1. Hypothesis: Resources are Inevitably Overexploited

It has been suggested that:

"although there is considerable variation in detail, there is remarkable consistency in the history of resource exploitation: resources are inevitably overexploited, often to the point of collapse or extinction. We suggest that such consistency is due to the following common features:
(i) Wealth or the prospect of wealth generates political and social power that is used to promote unlimited exploitation of resources.
(ii) Scientific understanding and consensus is hampered by the lack of controls and replicates, so that each new problem involves learning about a new system.
(iii) The complexity of the underlying biological and physical systems precludes a reductionist approach to management. Optimum levels of exploitation must be determined by trial and error.
(iv) Large levels of natural variability mask the effects of overexploitation. Initial overexploitation is not detectable until it is severe and often irreversible."
(Ludwig et al. 1993).

This contention is illustrated here through three examples of ecosystem impacts by fisheries, indicating a lack of sustainability for their operations.

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Biographical Sketch

Daniel Pauly is a French citizen who grew up in the French-speaking part of Switzerland, but completed high school and university studies in the Federal Republic of Germany, where he acquired a 'Diplom' (= Msc) in 1974 and a Doctorate degree in Fisheries Biology in 1979 at the University of Kiel. In 1979, he joined the International Center for Living Aquatic Resources Management (ICLARM), in Manila, Philippines, 1979 as a Postdoctoral Fellow, and gradually took responsibilities as Associate, and Senior Scientist, then Program and Division Director. In 1985 he obtained the 'Habilitation', again at Kiel University. In 1994, he became a professor at the Fisheries Centre, University of British Columbia, Vancouver. His scientific output, covering fish biology, fisheries management and ecosystem modeling, comprise over 350 items, including books, scientific articles and software used throughout the world.