

Diagnosing and solving the global crisis of fisheries: obstacles and rewards

by

Daniel PAULY (1)

ABSTRACT. - The multiple factors contributing to the crisis, which since the mid-1990s besets global fisheries, are presented along with key trends illustrating four manifestations of that crisis, i.e., (i) a declining world catch, (ii) increasing global fishing effort, (iii) declining catch per effort and profitability, and (iv) a three-way global expansion of fishing (geographic, bathymetric, taxonomic). The point is made that fisheries scientists and economists collectively know what is required to turn these trends around and to rebuild fish stocks, from which both humanity and marine life would greatly benefit. Socio-economic and political factors that prevent this turnaround in the majority of countries are briefly elaborated upon, along with what natural scientists can contribute to the debate on and the solutions to the global fisheries crisis.

RÉSUMÉ. - Diagnostics et solutions pour la crise globale des pêcheries : obstacles et décisions à prendre.

La crise qui, depuis le milieu des années 90 affecte les pêches mondiales, est due à de multiples facteurs. Ces derniers sont présentés à la lumière des tendances majeures illustrées par les quatre manifestations de cette crise, i.e., (i) le déclin des captures mondiales, (ii) l'augmentation de l'effort de pêche global, (iii) la diminution des captures par unité d'effort et la réduction des profits, et (iv) l'extension des pêches mondiales dans trois directions (géographique, bathymétrique et taxonomique). On constate que les scientifiques des pêches et les économistes savent bien ce qu'il faudrait faire pour résoudre ces problèmes et reconstruire les stocks de poissons à partir desquels la population humaine et la vie des organismes marins tireraient un grand bénéfice. Les facteurs sociaux-économiques et politiques qui empêchent cela dans la majorité des pays sont brièvement présentés, de même que la contribution des scientifiques à ce débat et les solutions à cette crise globale des pêches.

Key words. - Fisheries - World catch - Global fishing effort - Catch per effort - Global expansion of fisheries - Review.

It is obvious to the majority of observers, at least since the early to mid-1990s that marine fisheries, globally, are mired in a multifaceted crisis, which has only deepened in the ensuing two decades (Jackson *et al.*, 2001; Pauly *et al.*, 2002). This crisis has numerous causes, and, depending on one's discipline, it can be attributed to (1) the sheer size of the aggregate demand of too many people, particularly by those living in the rich markets of Europe, North America and East-Asia (Swartz *et al.*, 2010a); (2) government subsidies providing perverse incentive to continue fishing even when stocks are depleted (Mesnil, 2008; Sumaila *et al.*, 2010; Gascuel *et al.*, 2011); (3) lack of incentives for fishers to engage in resource conservation (Fujita and Bonzon, 2005); (4) lack of appropriate governance for what continues to be the largest 'common' on earth (Hardin, 1968; Ludwig *et al.*, 1993); (5) inequities between global, regional and national actors, also leading to perverse arrangements (Kaczynski and Fluharty, 2002; Le Manach *et al.*, 2012), or (6) a mixture of these elements, often with others added (Pauly, 2009a, 2009b; Sumaila, 2012). None of these elements is likely to be solely responsible for the crisis, but all will have to be considered if the crisis is to be overcome, and fisheries put on a sustainable course.

For this to even reach the realm of the possible, however, there has to be widespread agreement on the major manifestations of this crisis, with emphasis on features that have general (international) character. They include:

- (i) A declining world catch (in spite of, or rather due to:)
- (ii) An increasing global fishing effort;
- (iii) A declining catch per effort and profitability of fishing vessels (leading to:)
- (iv) A three-way expansion of fishing fleets, operating in more distant and deeper fishing grounds, and for new species.

These various points, which can be easily masked by extraneous processes, are as a whole unknown to the public and even to many fisheries scientists, who are generally not aware that fisheries are now part of a global system, and that the forces shaping them are not necessarily visible through the study, however detailed, of one fishery on one fishing ground in one country. This is the vantage afforded from working globally, which is what the *Sea Around Us* project does (Pauly, 2007), as does the United Nations Food and Agriculture Organization (FAO), which is responsible for aggregating reports on national fish catches from every member country since 1950 – although there are forces that

(1) Fisheries Centre, University of British Columbia, Main Mall 2202, Vancouver B.C., Canada, V6T 1Z4. [d.pauly@fisheries.ubc.ca]

can cloud this perspective, because, as mentioned above, it can easily be masked.

A declining world catch

According to FAO (2012), the total catch of marine fisheries has declined from 86.4 million tonnes in 1996 to 74.4 million tonnes in 2010, i.e. by 12 million tonnes. This is not highlighted in successive bi-annual editions of FAO State of the World Fisheries and Aquaculture report, and is, in fact, frequently masked by (i) FAO emphasis on the growth of aquaculture, especially mariculture (Campbell and Pauly, 2012), which is indeed a growing industry, but not ‘fisheries’, and (ii) China’s massive, and still ongoing,

over-reporting of its domestic marine catches (Watson and Pauly, 2001), which makes it necessarily, when reporting global catch trends, to deal separately with, or to omit China (FAO, 2012; Fig. 1A).

This decline is relatively small (i.e. 0.56 million t·year⁻¹, or 0.7% year⁻¹), which led FAO (2010) to suggest that the world catch was ‘stable’ (Pauly and Froese, 2012). As will be shown below, even if the FAO reported catch was roughly correct (which it is not), a stable (let alone a slowly declining) catch is not sustainable when it is obtained from ever-expanding fisheries and an ever-increasing fishing effort, i.e. the two processes that now characterize fisheries (see below).

The ‘catch reconstructions’ that are performed from the bottom-up by the *Sea Around Us* project and associ-

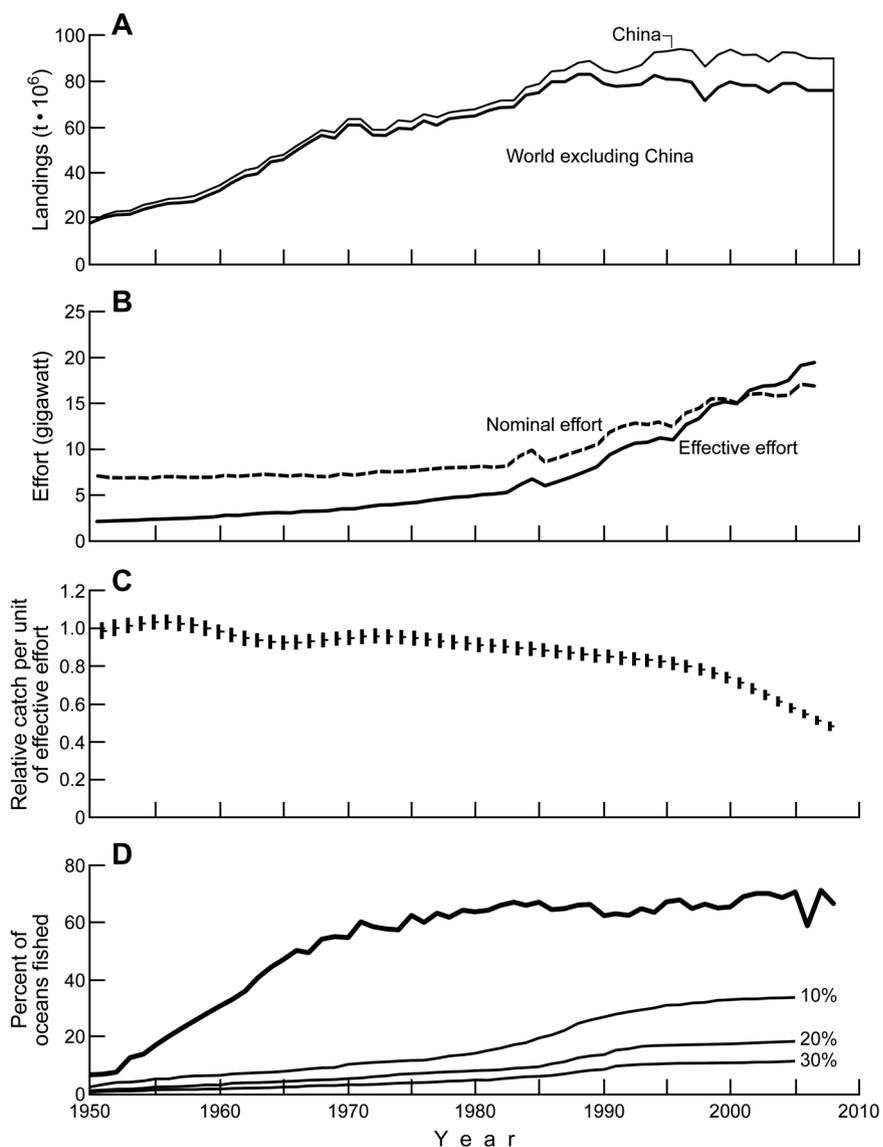


Figure 1. - Key indicators of the global marine fisheries crisis. **A:** Declining global catch (FAO, 2012; with and without China excluded, see text), despite of – or rather because of **B:** Rapidly increasing nominal and effective fishing effort (see text for definitions), especially in East Asia and Europe (Anticamara *et al.*, 2011), which lead to **C:** Accelerating decline of catch/effort (Watson *et al.*, 2012), but which has been partly masked by a relentless geographic expansion of fisheries; **D:** Illustrating the expansion of fisheries through the plateauing increase of fished area (Watson *et al.*, 2012) and the lower lines labeled 10, 20 and 30%, which refer to the cumulative areas where the fraction of primary production appropriated by fisheries reaches these % thresholds (Swartz *et al.*, 2010b). See text for elaborations.

ated scientists (see, e.g. Zeller *et al.*, 2007a, 2007b, 2011a, 2011b) show that the FAO member countries submit catch data that generally underestimate actual catch by 30-50% in developed countries and 100-300% in developing countries, notably by neglecting the catch of small-scale fisheries (see below) and discarded by catch (Zeller and Pauly, 2005). While a preliminary summation of the reconstructed catches suggest that world catches peaked in the 1980s at much higher values than reported by the FAO (as anticipated in figure 1 by Pauly *et al.*, 2002), these summed catches also suggest that the recent decline of global catches is much steeper than indicated by FAO data.

An increasing global fishing effort

Measuring the fishing effort that is applied globally is difficult, especially because common measures of fishing effort (e.g. number of vessels deployed, or hours fished, i.e. 'nominal' fishing effort) mask the technology-driven increases in its effectiveness (about 2.5 % per year, see Pauly and Palomares, 2010), e.g. through the transition for tuna catching, from pole-and-line to purse seining, and the civilian use of technologies developed for warfare (GPS, echosounders,...). However, the deployed capacity of industrial fleets, expressed as potential fishing power (e.g. in kW), which has strongly increased, suggests a strong increase of 'effective' fishing effort (Fig. 1B). Needless to say, this increase of effort, which occurred mainly in East Asia, notably in China, is largely driven by government subsidies. Note, however, that the increase of the fishing effort of artisanal fisheries (= *petits métiers*), while strong, especially in developing countries (Pauly, 2006), corresponds to only a small fraction of the cumulative power of industrial fleets. Also, government subsidies mostly go to industrial fisheries (Jacquet and Pauly, 2008).

A declining catch per effort and profitability

It is obvious that a declining (or even stagnant) world catch, when combined with a globally increasing effort will yield globally declining catch per [unit of] effort (CPUE), but demonstrating this rigorously while accounting for the spatio-temporal distribution of both catches and effort is not trivial (see Walters, 2003). Nevertheless, such analysis was performed by Watson *et al.* (2012), who demonstrated a global decline in the catch/effort of global marine fisheries, accelerating in recent years (Fig. 1C). These trends, jointly with the subsidization that drive them, have a devastating impact on the economics of fisheries (Arnason *et al.*, 2009; Gascuel *et al.*, 2011).

A three-way expansion of fishing fleets

Industrial, contrary to artisanal fisheries, are highly mobile and they just move to new grounds when an old fishing ground has been depleted, thus masking their effect. Indeed, this has been the *modus operandi* since steam trawlers began operating in British coastal waters in the 1880s (Roberts, 2007). These trawlers found themselves fishing deep into the North Sea a few years later, and a few decades later, their successors were fishing in the waters around Iceland (Bonfil *et al.*, 1998).

This trend only increased after World War II, and especially after 1975, when catches peaked in the North Atlantic (Berkes *et al.*, 2006). Since then, building on ventures initiated in colonial times, the fishing fleets of Spain, France and a number of other European countries are operating, jointly with fleets from East Asia, along the shores of West Africa and in the tropical Indian and Pacific Oceans, while other fleets are fishing the waters around the Antarctica (Kock, 1992; Pauly *et al.*, 2005), finally reaching the slope and shelf of the Antarctic continent itself (Ainley and Pauly, in press). Indeed the rate of geographic expansion of fisheries can and has been estimated at about 1 million km² per year from the 1950 to the end of the 1970s, increasing 3-4 fold in the 1980s (because UNCLOS closed, in the early 1980s, the Exclusive Economic Zones of countries to distant-water fleets, which thus had to operate in the much less productive high seas), and finally approaching zero in the 21st century (Fig. 1D), as nearly all potential fishing grounds became exploited (Swartz *et al.*, 2010b), at ever greater depths (Morato *et al.*, 2006).

The third dimension into which fisheries have expanded is the realm of new species, which were once considered inedible – a fact made obvious with names like slimehead (refashioned as 'Orange roughy') and Patagonian toothfish (now 'Chilean sea bass'; Jacquet and Pauly, 2008).

Can we turn this around?

Yes, we can!

The experiences of a few countries (e.g. the USA, Norway, Australia) suggest that science-based governance of fisheries can rebuild previously depleted stocks, adjust catch quota such that the biomass of exploited stocks is maintained at levels which reduce the risk of sudden collapses (Pikitch *et al.*, 2012), and that unsubsidized fleet capacity is kept low enough for the fisheries to be profitable, which is essentially a function of their catch/effort (Sumaila *et al.*, 2012). In fact, contrary to what many scientists say almost reflexively when posed practical questions, we do know enough to rebuild stocks decimated by industrial fishing. Moreover, European governments, and many others, have signed numer-

ous international binding agreements in which they commit themselves to rebuilding their exploited stocks (Veitch *et al.*, 2012).

While stock rebuilding and the elimination of IUU fishing is difficult are the case of highly migratory species which involve the High Sea, and various, largely ineffective Regional Fisheries Management Organizations (Cullis-Suzuki and Pauly, 2010), it straightforward in the case of neritic species, which contribute the bulk of the world catch and which are confined to the Exclusive Economic Zones (EEZs) of large and medium-sized maritime countries. This also applies to the waters of the maritime countries of the European Union, which are under the management authority of the European Commission (Froese and Quass, 2013).

Then why don't we?

As for the lack of progress on reducing emission of greenhouse gasses, the answer to questions about lack of progress on stock rebuilding and/or fishing effort reduction is that, unfortunately, some groups benefit from the *status quo* – or in other words, there is no 'we' in this. Indeed, the list is rather long of groups which have or see no reason to change the status quo in fisheries:

- The owners of distant-water fleets (and their scientific advisers and consultants) who manage to meet this ever increasing demand by deploying their vessels wherever they want, i.e. without having to consider sustainability (see, e.g. Norse *et al.*, 2012) or equity, the later because the economic situation of most developing countries is so dire that they cannot refuse the pittance they get in exchange (see, e.g. Kaczynski and Fluharty, 2002; Le Manach *et al.*, 2012) or because of pervasive corruption;

- A political class which defends the short-term interests of fleet owners rather than the long-term interests of the public (see Mesnil, 2008; Gascuel *et al.*, 2011 for the case of France), because it is easier than confronting the crisis that the former have created and will maintain as long as we let them.

- Consumers and NGOs in developed countries who have accepted 'sustainable seafood' as the solution (Jacquet *et al.*, 2010a), when in fact the definition of sustainable has been diluted to suit the *status quo* of industrial fisheries (Jacquet *et al.*, 2010b);

- The public at large, who does not seem to be aware of the damage that subsidized industrial fishing inflicts on marine ecosystems.

What can research do about all this?

Some of the features of the global fisheries crisis can be

seen and quantified only by working on a global basis, e.g. estimating the rate (of about 0.8° latitude per year) at which the center of gravity of fisheries impact has moved southward from 1950 to the present (Swartz *et al.*, 2010b). However, this global crisis is also the sum total of national crises, e.g. that in France, in which ever-increasing subsidies have led to decreasing catches and a propensity for French fishers to riot (as they disgracefully did in Brussels in the summer of 2008) to maintain what they think is their right to continue overexploiting (at a net loss to society) the resource they have depleted.

Thus, studies with local or national scope can be conducted to elucidate how the crisis manifests itself, and pressure points identified on how to reverse its local or national manifestations (Gascuel *et al.* (2011) provide an excellent example). Particular emphasis should be given, in this context, to artisanal fisheries, because, contrary to industrial fisheries, they are, or could be made sustainable. However, they are currently neglected (Pauly, 2006), and their contribution to the world catch is strongly underestimated in the FAO database (see, e.g. Harper and Zeller, 2011; Zeller *et al.*, 2007a, 2007b, 2011a, 2011b). Also, and this will be relevant to the readership of *Cybium*, there is a rather tight relationship between overfishing, the key feature of the crisis, and endangering marine biodiversity.

Subsidized overfishing, whether 'sustainable' or not (and yes, 'sustainable overfishing' exists) implies that exploited stocks are maintained, through excessive fishing pressure, at levels that generate less than MSY. This is, for example, the case for most European stocks (Froese and Proelß, 2010; Froese, 2011). Low biomass of target species implies low biomass of the species with which they are associated, i.e. of the biodiversity of our seas. Conversely, rebuilding the biomass of the stocks our fisheries target implies that the population of associated species and of dependent species, for example, seabirds feeding on forage fish (Cury *et al.*, 2012), will increase, a win-win solution (Pikitch *et al.*, 2012).

But scientists cannot expect that their contributions (whether documenting a case of overfishing, or an achievable path to rebuilding, or showing how such rebuilding would not only produce higher catches but also help maintain marine biodiversity) will themselves generate positive changes. Ministers of Fisheries do not read papers by fisheries scientists. Rather, they respond politically to problems (and solutions!) framed in political terms. This means that our science must reach policy-makers, either through an angry public (the current situation in the oceans justifies anger), because we manage to make the problem convincing (e.g. by working with science journalists, who will generally clarify and thus improve our message, rather than 'dumb it down', as many colleagues erroneously believe), or through environmental NGOs, which are increasingly science-based

and justifiably recognized as legitimate actors in fisheries debates.

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