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## A vision for marine fisheries in a global blue economy

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### A B S T R A C T

A brief history of marine fisheries is presented which emphasizes the expansion of industrial fleets in the 20th century, and their inherent lack of sustainability. In contrast, small scale fisheries, i.e. artisanal, subsistence and recreational fisheries could become part of a blue economy, given that care is taken to reduce incentives for building up fishing effort. However, they usually receive little attention from policy makers, as reflected by the almost complete absence from the catch data submitted by member countries to the FAO. While industrial fisheries tend to lack the features that would make them compatible with a blue economy, small-scale fisheries possess most of these features, and thus may represent the future of sustainable fisheries.

### 1. Introduction

There are various definitions of the ‘blue economy’, starting with that given in the seminal book of Pauli [21]; see also Boonstra et al. (this volume). However, we will use here that of UNEP (2013), i.e., that the blue economy should “improve human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”. Both Pauli [21] and UNEP (2013) emphasize features that would make the economy more resilient and more locally based, such that shocks, i.e., economic or environmental disturbances, would not be magnified into regional or even global crises, as is presently the case.

A blue economy would also have to be sustainable in the fundamental sense that all its component activities could be, in principle, be continued forever. Thus, for example, mining cannot be sustainable because it exploits non-renewal resources [6,10], while agriculture can be sustainable in principle - although most of it is not, in particular because soil losses are generally not compensated for [20]. This essay is devoted to investigating the possibility of marine fisheries becoming part of a worldwide blue economy and to identify constraints to the changes that would be required for this to occur.

Fishing is a very old activity. There is numerous documentation of fishing by early modern humans, for example, over 100,000 years ago along the coast of modern Eritrea [39] and in the Congo 90,000 years ago [42].

Marine fishing is also well documented from Antiquity [12,28] and in European medieval sources [8,23]. In fact, Christianity in Europe encouraged fishing through its prohibition to eating the meat of land animals during the Lent season and religious festivities

While European (i.e., Basque) fishing may have expanded to the Americas even before 1492, when America was “discovered” [19], it is

the emergence of industrial fishing, heavily relying on the use of fossil fuels, which gradually turned fisheries into the global, ever-expanding enterprise it has now become. Indeed, this essay is mainly devoted to presenting how we can overcome the damage that this continuous expansion has wrought.

The first coal-driven steam trawlers were deployed along the English coast in the 1880s (see [29]). While inefficient by modern standards, these behemoths were far superior to the rowed and sailed boats of the time, and they made short shrift of the accumulated coastal fish along the coasts of the British Isles. There are numerous photos of the time attesting to the huge number and size of the fish that were then caught, e.g., giant halibut.

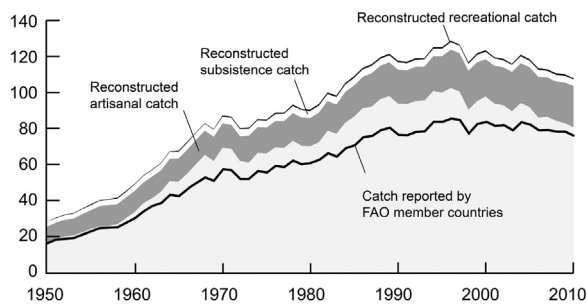
Within a decade, however, it became necessary, for these trawlers to maintain their catch rates, to expand their reach into the central North Sea and later into the broader North Atlantic, all the way to Iceland and beyond [22]. This evolution was similar in other industrialized countries, e.g., France, Germany and Russia, which saw their coastal resources depleted after a few years of trawling. The First World War (1914–1918) provided a respite to the North Atlantic fisheries resources, but four years later, when the fishing vessels and the young men returned from the war, the trend picked up again. Similar developments occurred on the East Coast of northern North America, especially in New England, and around newly industrialized Japan. Efforts to control the growth of industrial fishing fleets between the two world wars failed, but the Second World War succeeded in this, through fishing vessels and young men were again drafted into war.

In the two decades following WWII, the creation of the UN system provided fora for the rational discussion about the governance of fisheries, which by then were thoroughly internationalized. Some countries wanted to maintain the old concept of freedom of the seas. Other

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**Fig. 1.** The difference between the two series is due to reported catches consisting mainly of industrial landings, i.e., not including industrial discards (about 10 million t year<sup>-1</sup>), subsistence, recreational and illegal catches, and underestimating artisanal catches. Also note that about 1/4 of industrial catches are used to produce animal feed. Contrasting a time series of the sums of ‘official’ catches reported to FAO by its member countries and the sums of ‘reconstructed’ catches from these same countries (modified from [27]).

countries, especially in Latin America, began to claim large swaths of marine space, which some called “Patriotic Seas”, the conceptual ancestors of Exclusive Economic Zones (EEZ). Some countries took intermediate positions, especially the United States, which used the newly invented, convenient concept of maximum sustainable yield to simultaneously claim access to the “underexploited” stocks of tuna in the eastern Central Pacific and to deny Japan access to the “overexploited” salmon in Alaska waters [15].

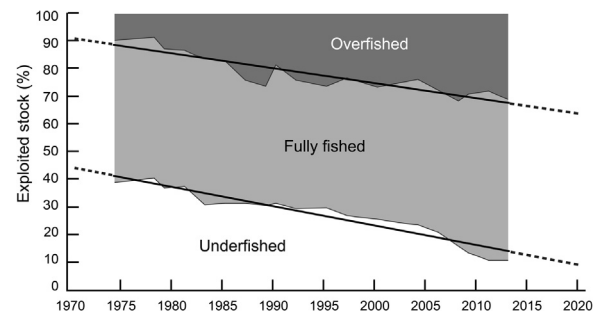
In Europe, a theory of fishing emerged which emphasized the rational exploitation of stocks based on optimal fishing mortality and mesh sizes given unpredictably variable recruitment [2]. In Africa and Asia, where numerous countries were still European colonies, efforts were undertaken to introduce trawling and other forms of industrialized fishing, but except for a few countries, notably Thailand, they failed to initiate a self-sustained development.

The subsequent period, from the mid-1960s, saw tremendous increases in catches and landings (Fig. 1), mainly due to the geographic expansion of fishing, but also saw massive collapses that were often attributed to environmental conditions, but in which excessive fishing had, in most cases, played a major role. Examples are the Peruvian anchoveta, whose first collapse occurred in 1972 (see contributions in [26]), the Norwegian herring [30] and Atlantic menhaden [17].

Some of these stocks were consciously allowed to rebuild – as in the case of the Norwegian herring – while others continued to be over-exploited, such as the Atlantic menhaden, of which only a small population within Chesapeake and its environs continue to be occur in exploitable amounts [16].

The main response of fisheries, when viewed as a global system, however, was to expand [3,36,37]. European countries began fishing all around Africa (e.g., Spain, also operating in the Pacific), and, at the end of the 1980s, China joined the fray [25]. This expansion without stock rebuilding in the waters of nearly all industrialized countries (the US and Norway are among the few exceptions) succeeded at first in increasing global landings. Since the mid-1990s, however, global fisheries catches have been declining because new stocks are being discovered and exploited at a rate that no longer compensates the losses due to the collapse of traditional stocks [27]. This trend, extrapolated to the mid-21st century is what is behind the projection by Worm et al. [41] that all fish stock in the world would collapse by 2048, which was wrong, in the main, only because it gave a precise date. The tendency toward increasing stock collapses is, indeed, documented in the last volume of the *State of the World's Fisheries and Aquaculture*, or SOFIA (FAO 2016; and see Fig. 2).

The UN Convention on the Law of the SEA (UNCLOS), signed in 1982 and ratified in 1994, did affect the expansion of the fishing fleets of industrialized countries in that it became necessary for them to obtain access rights to operate in the EEZ of another country. This brought a certain degree of control over where distant-water fleets could



**Fig. 2.** Trends in the status of global marine fisheries, as reproduced from figure 13, p. 39 in SOFIA (FAO 2016). The two (regression) lines, if extrapolated, suggest that ‘underfished’ stock will cease to exist in less than two decades, while it may take longer for all stock to be ‘overfished’. This trend shows no sign of being reversed.

operate. However, this is limited by the power imbalance between the rich countries that purchased access from often-impoverished African coastal countries or small island states in the Pacific. In addition, UNCLOS left 60% of the oceans beyond national, and in fact anyone’s jurisdiction, as Regional Fisheries Management Organizations (RFMOs) exert the most tenuous of controls on fisheries in the high sea [13,14].

Lately, as resources declined, industrial fisheries, especially distant-water and or deep-sea fisheries became ever more dependent on government subsidies, currently of about 35 billion USD per year [34] for a global ex-vessel value of about 140 billion USD, i.e., 25% of the ex-vessel value of the global marine fisheries catch. To this, one could add the subsidy-like contributions provided to fleet owner by illegal fishing [33] and by thousands of underpaid and mistreated crew working under inhumane condition (see e.g. [31]).

## 2. The roles of small-scale fisheries

Given this bleak portrait of international fisheries, how can we expect a blue economy to accommodate them? Actually, the above portrait omitted a major sector of fisheries, i.e., the small-scale sector, consisting of artisanal, subsistence and recreational fisheries, which strongly differ from the highly mobile industrial fisheries.

Artisanal fisheries consist of locally based operations that catch fish exclusively destined for human consumption (as opposed to industrial fisheries, 25% of whose catch is destined for reduction to fish meal and other animal feed [4,44]). Artisanal fisheries, which use less fuel than industrial fisheries per tonne of fish landed, are more selective than industrial fisheries (which often rely on fuel-guzzling trawlers [38]; because they often use traps and other passive gear whose deployment rely on a deep knowledge of fish behavior, and which allow fish to literally catch themselves. Artisanal fisheries moreover, can both provide animal protein and micronutrients to local markets in rural areas, where it is most needed and, when encouraged to do so, can also sell to international markets, where they can connect to outlets marketing high quality seafood products.

To a large extent, artisanal fisheries compete with industrial fleets, i.e., exploit the same coastal stock as foreign industrial trawlers and purse seiners, e.g., in West Africa, but also but also in Europe, particularly along the coast of the Mediterranean, in the Americas, and throughout Asia. However, decision-making in fisheries usually gives scant attention to artisanal fisheries to the extent that the majority of FAO member countries do not record their catch. In fact, fully accounting, by way of catch reconstructions [27] for artisanal fisheries, as well as for subsistence fisheries (see below), for discarding of fish [18], and for illegal and other illegal catches added 50% to the sum of the marine fisheries catch reported by member countries to the FAO (Fig. 1).

Subsistence fisheries, i.e., the catching of fish and aquatic vertebrates (often by women) for the consumption of one’s own family and

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