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Large Marine Ecosystems and the *Sea Around Us* project

by

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Introduction

Fisheries have traditionally been seen as local affairs, largely defined by the range of the vessel exploiting a given resource. The need for countries to manage all fisheries within their Exclusive Economic Zones (EEZ), a consequence of the United Nations Convention on the Law of the Sea (UNCLOS), led to attempts to derive indicators for marine fisheries and ecosystems at the national level (see e.g., Prescott-Allen 2001). Also, it was realized that, given the large scale migration of some exploited stocks, and of distant-water fleets, an even better integration of fisheries could be achieved at the level of Large Marine Ecosystems (LMEs, Sherman *et al.* 2003).

However, no national or international jurisdiction reports, at the LME level, catches and other quantities from which fisheries sustainability indicators could be derived. Indeed, if the fisheries of LMEs are to be assessed, and if comparisons of the fisheries in, and of their impact on LMEs, are to be performed, then the fisheries within LMEs must be assembled for these explicit purposes, mainly by assembling data sets from national and other sources.

The *Sea Around Us* project was created in 1999 with the aim of assessing the impact of fisheries on marine ecosystems and of developing policies which can mitigate this impact (Pauly 2007). Thus, we set ourselves, from the very beginning, the task of assembling data on all the fisheries that impacted on 'places', i.e., areas of the sea, since whatever one's definition of an 'ecosystem' is, it must include reference to a place.

When dealing with the fisheries of places such as LMEs, the physical and other features that are relevant to the fisheries must also be expressed at the LME scale. The *Sea Around Us* website (www.seaaroundus.org) provides such statistics, which can be used in LME-specific accounts, as will be presented in Sherman and Hempel (in press). These are:

1) The percentage of global coral reef area in a given LME (rather than the area itself, which is highly variable between sources), based on a global map produced by the World Conservation Monitoring Centre (www.unep-wcmc.org);
2) The percentage of seamounts in a given LME (rather than their number, for the same reason), based on a global map of Kitchingman and Lai (2004);
3) The percentage of the area of a given LME that is part of a Marine Protected Area (MPA), based on an MPA database documented in Wood *et al.* (in press).

Other fisheries-relevant information, not presented here, but available through the 'Biodiversity' option on our website, are fish species by LME (from www.fishbase.org), and marine mammals and other marine organisms, to be consolidated in SeaLifeBase (www.sealifebase.org). Additionally, the 'Ecosystem' option allows access to maps of primary production, major estuaries (Alder 2003), and other features of LMEs.

However, the major exhibit of the website, and the major product of the *Sea Around Us* project are time series of fisheries catches by LME, obtained by aggregating catches previously mapped in 180,000 spatial cells of ½ degree lat.-long. (Watson *et al.* 2004).

As these aggregates of spatial cells can then be combined with other data, for example, the

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price of the fish therein, or their trophic level, one can straightforwardly derive other time series, e.g., of indicators of the value, or the state of fisheries in any of the 64 LMEs presently recognized in the world ocean. As this capability is globally unique to the *Sea Around Us* project, we were recently asked to collaborate on a report on the LMEs of the world (Sherman and Hempel in press). Our role was to help characterize the fisheries of each LME, by producing for each of them a set of 5 graphs presenting catch trends and time series of indicators of the status of fisheries, and commenting on them. (The only exceptions were 6 Arctic LMEs, for which catch data time series had been previously unavailable, and where we limited ourselves to presenting new time catch series, recently derived in the context of another initiative by the *Sea Around Us* project.)

We believe in the power of good graphs

An emphasis on compelling graphs

We believe in the power of good graphs. Thus, while we wrote a chapter for a UNEP report (from which this account was adapted) which presented the methods, data and assumptions behind each of the indicators we used to describe the fisheries of LMEs, we put our emphasis on the five graph types used to document the fisheries of LMEs. We reproduce two of these types of graphs here, for all LMEs combined, as they provide a nice summary of world fisheries. Further details can be found on our website (www.seaaroundus.org), and in the above-cited book, which should become available at the end of 2007.

Figure 1 shows the landings, by species for all LMEs in the world. Since this graph is normalized to show the 11 most abundant species (with the remainder pooled into 'mixed group'), and not many species are globally important, this graph exhibits more 'mixed group' landings (as 12th category) than typically occur in any specific LME. Also, it will be noted that LMEs account for the overwhelming part of the world catch. Indeed, the only major group not caught primarily in LMEs is represented by large pelagic fishes, predominantly tunas.

Figure 2 illustrates the dual nature of newly derived Stock-Catch-Status Plots, for all LMEs in the world combined. It illustrates that, overall, 70 % of global stocks within LMEs are deemed overexploited or collapsed (Figure 2, top), while only 30% of the stocks remain fully exploited. However, the latter provide 50% of the globally reported landings biomass, while overexploited and collapsed stocks provide the remainder (Figure 2, bottom). This confirms the common observation (e.g. Worm *et al.* 2006) that fisheries tend to affect biodiversity even more strongly that they affect biomass.

Discussion

The five types of graphs used to characterize each LME (only two types were presented here for all LMEs combined) allow comprehensive overviews of the general status of fisheries of LMEs. Catch and catch values indicate status and trends of the fisheries, through changes in catch levels and composition. These relate strongly to the status of

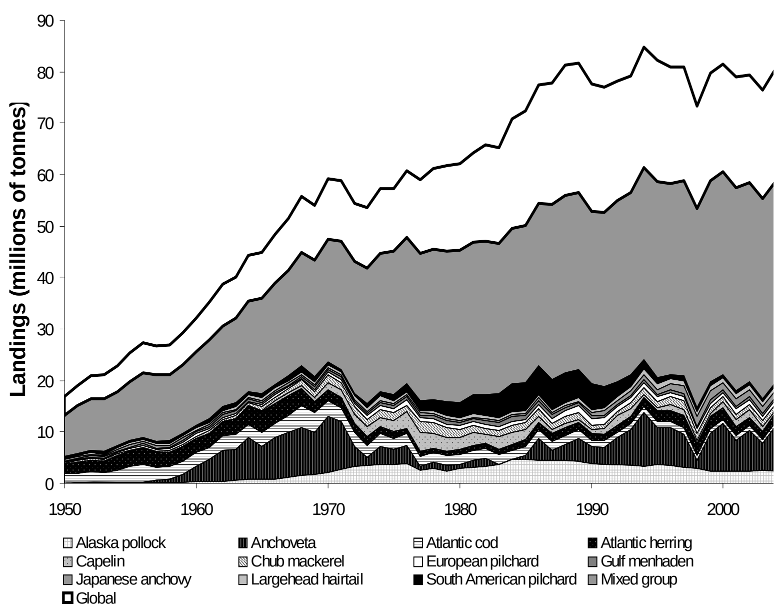

Figure 1. Landings by species in all LMEs (shaded time series), and in the world ocean (top black line). Our website (www.seaaroundus.org) also presents landings by 'Commercial groups', 'Functional Groups, as used in Ecopath models (see www.ecopath.org), 'Country fishing', and 'Gear', based on Watson et al. *(2006).*

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stocks in the LME, as indicated by the Stock-Catch-Status Plots developed here. These graphs, however, require accurate and complete catch data. Such catches are not available for all LMEs. The methods we use for re-expressing FAO's global reported landings dataset on a spatial basis, here through LMEs, cannot compensate for these limitations. Rather, it makes them visible, and emphasizes the need for catch reconstruction at the national level (*sensu* Zeller *et al.* 2007), from which LME catch time series can then be derived. Hence the present emphasis by the *Sea Around Us* project on catch reconstructions, i.e., on accounting for IUU catches.

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... fisheries tend to affect biodiversity even more strongly that they affect biomass

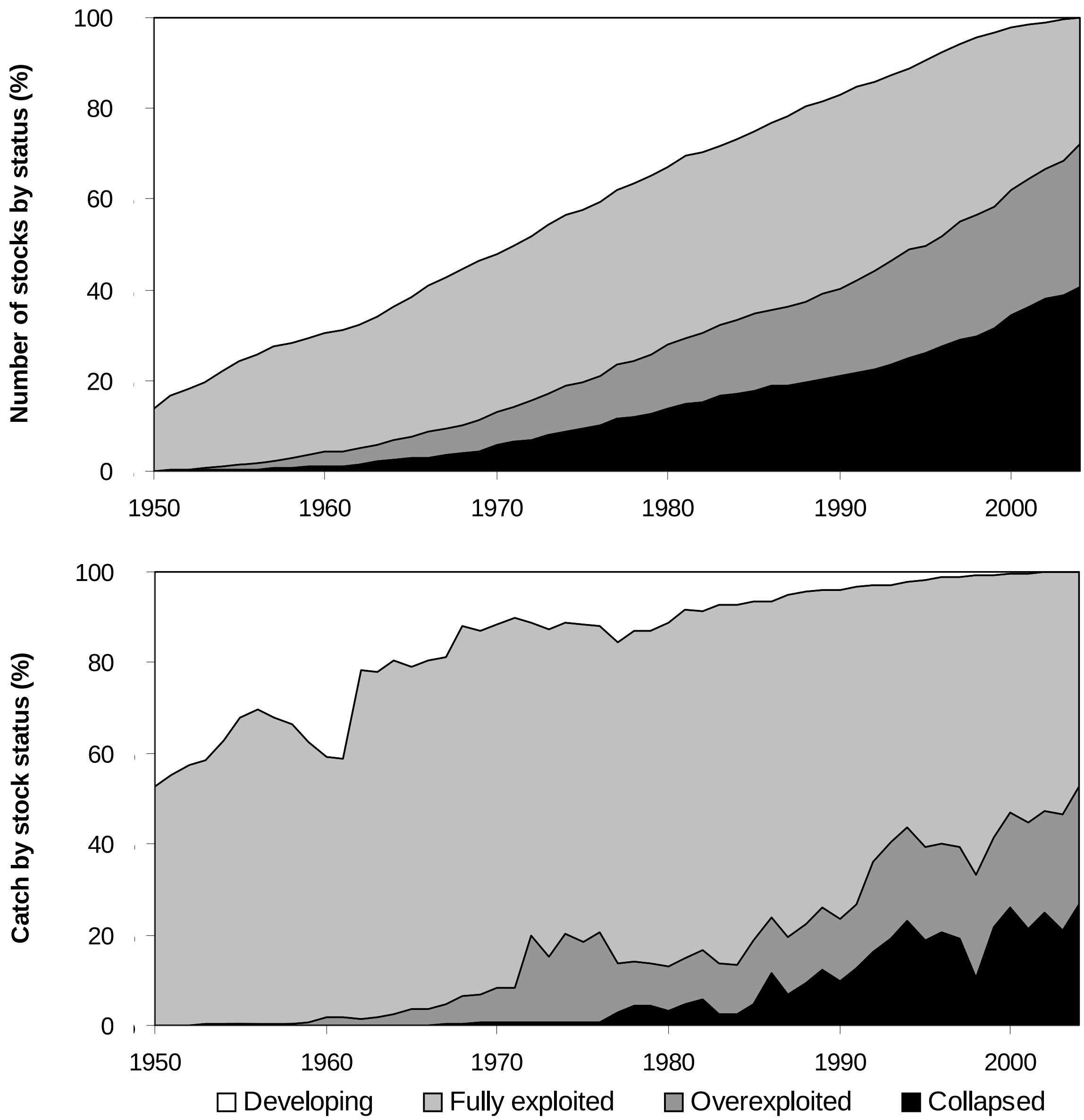

Figure 2. A newly proposed type of paired 'Stock-Catch-Status Plots' (here presented for all LMEs in the world combined), wherein the status of stocks, i.e., taxa with a time series of landings in an LME, is assessed, based on Froese and Kesner-Reyes (2002), using the following criteria (all referring to the maximum catch in the series): Developing (catches < 50 %); Fully exploited (catches >= 50%); Overexploited (catches between 50% and 10%); Collapsed (catches < 10%). Top: Percentage of stocks of a given status, by year, showing a rapid increase of the number of overexploited and collapsed stocks. Bottom: Percentage of catches extracted from stocks of a given status, by year, showing a slower increase of the percentage of catches that originate from overexploited and collapsed stocks. Note that the number of 'stocks', i.e., individual landings time series, only include taxonomic entities at species, genus or family level, i.e., higher and pooled groups have been excluded.

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