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The SeafoodPrint and the revival of the primary production required

by Wilf Swartz and Daniel Pauly

The October issue of the National Geographic magazine featured a story titled 'Time for a Sea Change' [1] with contributions from the *Sea Around Us* Project. The focus of the story was the ecological footprint of our seafood consumption, or SeafoodPrint. Much like the Ecological Footprints of Rees and Wackernagel [2], the SeafoodPrint is an attempt to express the impact of seafood consumption in terms of the productivity of the ecosystems from which they are derived. For this purpose, we revived the concept of the Primary Production Required (PPR) to sustain global fisheries, originally proposed by Pauly and Christensen in 1995 [3].

the current level of seafood consumption. We used the PPR conversion (based on the mean trophic transfer efficiency of marine systems, estimated as 10% by Pauly and Christensen 1995) to compute the ecological footprints (i.e., SeafoodPrints) of fish-consuming countries. The higher on the food web a fish is, the larger the footprint resulting from consuming such fish (Figure 1). Consuming 1 kg of northern bluefin tuna, at a trophic level 4.43, would be equivalent to 2,700kg of SeafoodPrint. Compare that with the SeafoodPrint for consuming 1 kg of Peruvian anchovies, at a trophic level 2.7, calculated as the equivalent of 500kg.

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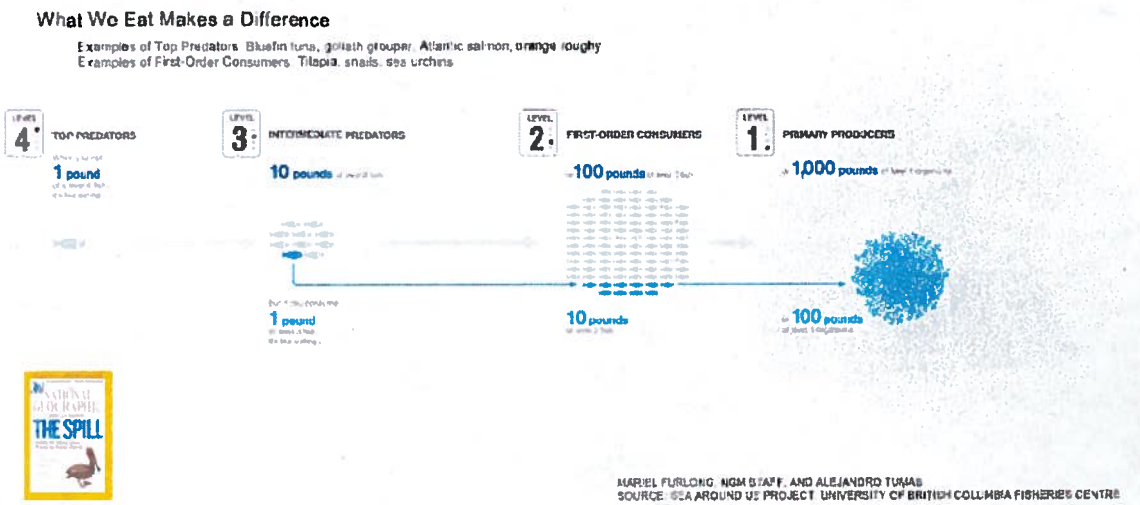

Figure 1. Schematics for computation of Seafood Print, estimated using 10% transfer efficiency between trophic levels, i.e., SeafoodPrint = (consumption)*$10^{(TL-1)}$.

PPR was designed to overcome the fact that every fish is different. Or more anthropocentrically, every kind of seafood is different. Since seafood covers a wide spectrum of species across marine food webs, the ecological impacts of seafood consumption also vary. While recognizing that assessments of the true ecological impacts of seafood consumption would require tremendous amounts of information about the status of each stock, fishing practices *etc.*, we defined, for our purpose, the ecological impacts (i.e., footprints) as the amount of marine primary productivity required to sustain

For the National Geographic piece, we computed the SeafoodPrint for all seafood consuming countries using the information on their fisheries landings, imports and exports. It has been widely recognized that seafood is one of the most traded food commodities in international markets, with the markets of the industrialized countries increasingly dependent on imports from foreign waters to meet their domestic demands [4]. Hence, rather than simply examining the fisheries of each country, it was important that the

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SeafoodPrints were applied to consumption. The result was not surprising with China as the largest consumer of seafood, followed by Japan and the United States. With benchmarks now established, we hope that the concept of SeafoodPrints will resonate with consumers and encourage a shift in demand from high trophic species to species that are sustainable and have lower ecological footprints.

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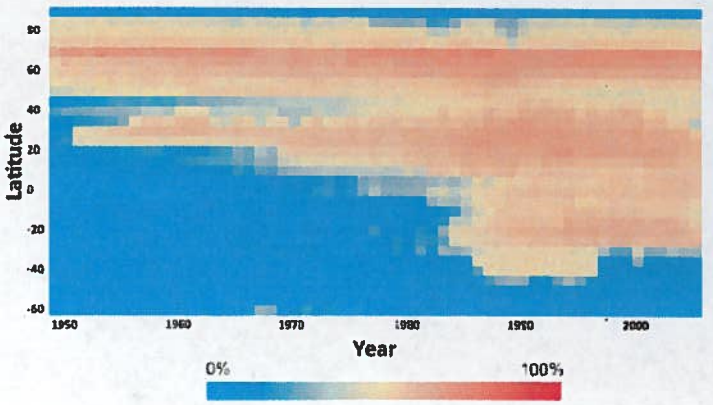

Figure 3. Time series of areas exploited by marine fisheries (PPR>10% PP) by latitude class, expressed as a percentage of the total ocean area.

Another outcome from the revival of the PPR is our new article in PLoS ONE [5] which applied the PPR of global fisheries for assessing the rates of their spatial expansion. For this study, we used three different threshold levels of PPR as percentage of local primary production to define 'fisheries exploitation,' and applied them to the *Sea Around Us* catch database (Figure 2). This approach allowed us to assign an exploitation status to each square of our ocean grid (exploited vs. unexploited) and trace the changes in their status over the years (Figure 3). Our analysis shows that fisheries expanded at the rate of about one million km² per year from 1950 to 1980, but this increased by 3-fold, following the series of EEZ declarations in the 1980s, with a large proportion of new fishing grounds coming from southern oceans.

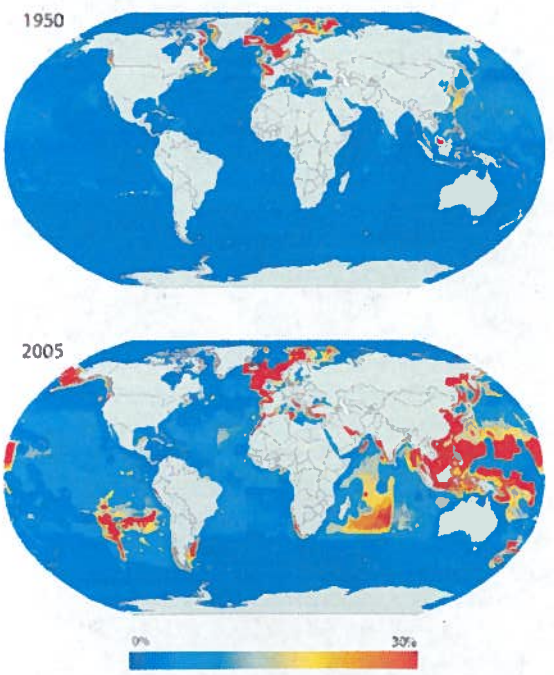

Figure 2. Primary production required to sustain global fisheries landings expressed as percentage of local primary production.

We also found that a third of the world's oceans and two-thirds of continental shelves are currently exploited at a level where PPR of fisheries exceeds 10% of local primary production, leaving relatively inaccessible waters in the Arctic and Antarctic as the last remaining 'frontiers.'

All of this should come as no surprise. The decline of newly exploited areas since the 1990s, which corresponds with the decline in the global landings, implies that the era of great expansion has come to an end. With limited room for expansion, the path toward sustainability of global fisheries must come through reduction of our SeafoodPrint. So let us hope that the article in National Geographic will raise a trickle then a flood of concerned citizen voices insisting that it is indeed "Time for a Sea Change".

References:

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