Accepting a BBVA Frontiers of Knowledge Award [1]

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Abstract

This is the slightly edited speech given by the author upon accepting the 2019 Edition of the BBVA Frontiers of Knowledge Award in Ecology and Conservation Biology in Bilbao, Spain in September 2021. Relevant references were added to better define the topics successively covered in that speech, i.e., the tropicalization of fisheries science, the creation of FishBase, the study of fisheries as a global system, the products of Sea Around Us research initiative, and the development of the Gill-Oxygen Limitation Theory (GOLT).

Introduction

Ladies and Gentlemen,
It is a privilege to be able to stand here and to thank you as a co-winner of the 2019 BBVA Frontiers of Knowledge Award in Ecology and Conservation Biology because it means that one's work has been recognized by the jury of what is now one of the most prestigious awards in these fields.

But what is my field? I normally describe myself as a fisheries biologist, or when I feel very bold, as a 'fisheries scientist.' However, let's face it, fisheries science is not very prestigious, and it usually provokes a flight reaction when, in the rare instances when I attend parties, I respond to innocent questions about what I do.

The point is that most people perceive fisheries as the art of catching one kind of fish, using one kind of gear, in a lake or marine embayment… - what is the science in that? The point is that fish are the big group of wild animals that we hunt. And because we live in an industrial age, we hunt fish industrially.

People think that fishes know no borders, no limits. This is wrong: fishes have borders that they don't cross, of temperature and of depth. Also, they have limits to the extent that they can maintain their abundance when under human exploitation. It is our industrial fishing which knows no borders and no limits, because we can fish inshore and in the high seas, in polar and tropical waters, at the surface and at depths of thousands of meters. Moreover, the global market for fish is tightly integrated, and the demand it generates is essentially insatiable.

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Fisheries as a Global System

All of this suggests that fisheries must be understood as a global system, similar to the global weather systems[2] or the global financial system, whose calms and storms at any place can be understood only by considering what occurs at other places on Earth.

I did the field work for my first graduate degree studying the ecology of a coastal lagoon in Ghana[3], and the two years spent on surveying fish abundance in Indonesia in the mid-seventies[4] inspired my doctoral thesis. The job I then got in an international research center in the Philippines included developing and teaching throughout the Tropics, in Africa, Asia, Oceania and South America, 'tropicalized' methods for what fisheries scientists call 'stock assessments,' i.e., assessing have much fish are (still) is the waters, and how much could be taken sustainably[5]. This is when I noted that fisheries issues are similar between countries, despite the different traditions that maritime anthropologists so painstakingly describe[6]. Also, I noted that the response of exploited ecosystems exhibited common patterns, irrespective of location or the identity of the species that were targeted.

However, there was another worrying pattern: the results of multiple fisheries and ichthyological studies conducted in the tropics, by both local scientists and by short-term 'experts' from the Global North, were not widely available, and remained largely unused by the fisheries and aquatic science community. The creation of FishBase[7], a free online database with scientific information of all (35,000 +) species of fish in the world was my answer to this challenge, obviously with hundreds of colleagues helping to make it the success that it is.

Having key biological data on all exploited fishes of the world made it t easy to demonstrate global patterns of fisheries activities and catches. This is how much-cited papers emerged, on "the primary production required by global fisheries", on "fishing down marine food webs," or on the geographic, bathymetric and taxonomic expansions of fisheries, the latter group referring to fishing vessels going further, and fishing deeper for previously spurned species. Doing this work required getting familiar with the database of fisheries catches that is assembled by the Food and Agriculture Organization of the United Nations, which assembles annual catch reports from its member countries and releases them as "the" world's fisheries catch data. This very useful database has flaws, however, such as ignoring the fish discarded by industrial fisheries, or that caught by small-scale fishers. This is important, because catching fish is one of the major ways we interact with the ocean, the other being for transportation and for dumping refuse.

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[2] See Edwards, P.N. 2010. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. MIT Press, Cambridge, MA. 552 p.

[3] Pauly, D. 1975. On the ecology of a small West African lagoon. *Berichte des Deutschen wissenschaftlichen Kommission für Meeresforschung,* 24(1): 46–62.

[4] See Pauly, D., P. Martosubroto and J. Saeger 1996. The Mutiara 4 surveys in the Java and southern South China Sea, November 1974 to July 1976, p. 47–54. *In:* D. Pauly and P. Martosubroto. (eds.) *Baseline studies in biodiversity: the fish resources of western Indonesia*. ICLARM Studies and Reviews 23, Manila.

[5] Pauly. D. 1998. Beyond our original horizons: the tropicalization of Beverton and Holt. *Reviews in Fish Biology and Fisheries,* 8(3): 307–334.

[6] Pauly, D. 2006. Major trends in small-scale marine fisheries, with emphasis on developing countries and some implications for the social sciences. *Maritime Studies (MAST)*, 4(2): 7–22.

[7] See www.fishbase.org

The Emergence of the *Sea Around Us*

Thus, with the support of various philanthropic foundations, the *Sea Around Us*, an initiative I founded in 1999 at the University of British Columbia, in Vancouver, Canada, undertook the huge task of correcting the world's catch, as reported by coastal countries since 1950. The correction process, which we call 'catch reconstruction' took about 15 years and involved over 400 persons from all over the world.

Its first results were that the world's marine catch was not about 90 million tonnes per year, but over 130 million tonnes, and that since 1996, this catch declines by 1-2%, which was unreported by the FAO[8]. Another result is that in the process of catch reconstruction generated a huge database of spatialized catch data and derived statistics which we also made freely available through the *Sea Around Us* website[9]. This website is now used – as is FishBase – by thousands of university-based and other researchers, NGO staff and government over the entire world.

And the Gill-Oxygen Limitation Theory (GOLT) at the End

Besides helping with dealing with fisheries management issues, this database of reconstructed and spatialized catches from 1950 help us assess the impact of climate change, specifically ocean warming on fish. We were able to model rather well the poleward movement of fish that started in the 1970s and 1980s, due to fishes being exquisitely sensitive to temperature changes[10].

The reason for this sensitivity is that fish breathe water, which contains little oxygen, and use gills, i.e., a 2-dimensional surface, to meet the oxygen demand of a 3-dimensional body. This means that the gill area per volume must decline as fish grow, causing oxygen stress. This intensifies until a size is reached at which they don't get enough oxygen to grow further. I wrote my doctoral dissertation about this idea, which, although simple, was idea[11], but later, I could work only occasionally on this topic, which at first interested no one. Now, these long-neglected considerations are becoming a major explanation for what fish are forced to do in the face of global warming[12]. It is a sad way to be right.

I thank the BBVA Foundation and the Jury of its Frontiers of Knowledge Award in Ecology and Conservation Biology for having realized that developing concepts, software tools and freely accessible database on the biology of fishes and their catches are contributions to Ecology and Conservation Biology.

[8] Pauly, D. and D. Zeller. 2016. Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. *Nature Communications*, 7:10244. doi.org/10.1038/ncomms10244\
[9] See www.seaaroundus.org.
[10] Cheung, W.W.L., R. Watson and D. Pauly. 2013. Signature of ocean warming in global fisheries catch. *Nature*, 497: 365–368.
[11] Pauly, D. 1979. Gill size and temperature as governing factors in fish growth: a generalization of von Bertalanffy's growth formula. Doctoral thesis, Berichte aus dem Institut für Meereskunde an der Universität Kiel. No. 63. xv + 156 p. oceanrep.geomar.de/41323/
[12] See Pauly, D. 2021. The Gill-Oxygen Limitation Theory (GOLT) and its critics. *Science Advances*, 7(2). doi.org/10.1126/sciadv.abc6050