

## ECOPATH: FROM THE FRENCH FRIGATE SHOALS TO THE PHILIPPINES AND TO UBC<sup>1</sup>

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In the early 1980s, the emphasis of most researchers on tropical fisheries, both local and foreign experts, was on applying to exploited fish stocks, and further developing the methods then becoming available for data-sparse situations, length-based stock assessment methods (see, e.g., contributions in Pauly & Morgan, 1987; Roedel & Saila, 1980). It was already becoming clear, however, that single-species approaches were not adequate in the tropics, because the target species, if there even was one, represented an even smaller fraction of the total catch (e.g., of trawlers) than in temperate waters (Pauly, 1979). Hence, applying the then standard yield per recruit (Y/R) models yielded essentially useless solutions (see e.g., Pauly & Martosubroto, 1980).

The extension of single-species Y/R to a number of stocks, which for a while became known as ‘multi-species modeling’, while straightforward in principle, and successfully applied to a few fisheries turned out to be too unwieldy to be used routinely (Munro, 1980), despite several attempts at revivals. Also, this approach did not make use of the fact that a large number of fisheries biologists in the tropics, as in temperate areas, were collecting huge amounts of stomach content data with at least the tacit expectation that such data might be useful for some sort of understanding of the role of exploited species within ecosystems (see, e.g., bibliography in Pauly, 1982).

I was then based in Manila, the Philippines, and worked at the International Center for Living Aquatic Resources Management, or ICLARM (which despite its unwieldy name was at the time a powerhouse of new ideas), deeply engaged in these research initiatives, including teaching the methodologies they generated (see Venema *et al.*, 1988). This included attempting to organize ecosystem biomass flow estimates into functional groups linked by feeding arrows, a technique I had used earlier (Pauly, 1979, 1982) and taught to others (see, e.g., Yap, 1983).

Thus, my mind was ready for Ecopath (Polovina, 1984a, 1984b), whose gradual development I was following through frequent visits to Jeff Polovina in Hawaii. Indeed, I encouraged him to make the code of Ecopath available, so others could follow up on it. He took the advice (Polovina & Ow, 1983; see Polovina, 1993), and I began to apply, use and teach it to other people, notably to visitors and colleagues who came to ICLARM, like Ms. Yap Siaw-Yang earlier, to learn fish stock assessments and, more pertinently, what had turned from multispecies into ecosystem modeling.

This led to some additions to Polovina’s Ecopath software, most, however, dealing with the inputs to Ecopath and the interpretation of its outputs. In particular, I realized that Ecopath would be a straightforward way of parameterizing the network approach then launched by Ulanowicz (1986). The first application of this insight was to the Peruvian upwelling system (Pauly, 1987).

This work led to the reprogramming of Ecopath by Ms. Mina Soriano, and the development of ‘Ecopath II’, providing more outputs than the original version. Ecopath II was presented at a workshop in Kuwait, in December 1987. However, the first version of the paper documenting this was destroyed, along with much of the assets of Kuwait Institute of Scientific Research during the subsequent invasion of Kuwait by Iraqi forces; it was included in a book published in the early 1990s (Pauly *et al.*, 1993).

The work documented above having established the potential of Ecopath in assembling and harmonizing previously underutilized data, I convinced the then Director-General of ICLARM, Ian Smith, to reserve the

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## Opening Session – Pauly

position then offered by the Danish international development agency (DANIDA) for a modeler who could take over our Ecopath work. I met young Villy Christensen during a trip to Kiel in 1989, and he was hired. Villy quickly reprogrammed Ecopath II, and released it in the summer of 1990. We could then jointly prepare the extremely successful poster session at ICES in 1990, in which tropical countries were for the first time dominant at an ICES event, and which we documented in a book (Christensen & Pauly, 1993). As well, Villy documented our software, which led to a detailed manual (Christensen & Pauly, 1991), of which numerous updates and translations (in French and Spanish) were subsequently published. Also, he was the lead author of a paper (Christensen & Pauly, 1992), which anchored Ecopath II in the peer-reviewed literature, and which today stands as the third-most cited paper published in the key journal *Ecological Modelling*.

The mid-1990s were a period of consolidation and expansion, where we simultaneously defended the logic of Ecopath – then still much contested – in various fora, and applied it to numerous ecosystem types, often in the context of training courses in many countries on all continents. This is also the time where colleagues in Mexico (F. Arreguin-Sanchez), France (J. Moreau with M.L. Deng Palomares) and others elsewhere began to support the use of the approach and software independently. Also, the trophic levels that were being estimated, and other insights gained through various Ecopath applications, were used in a high profile publication (Pauly & Christensen, 1995).

But what contributed most to Ecopath 'breaking through' was the development of Ecosim by C.J. Walters, a result of his participating at the Ecopath workshop, documented in Christensen & Pauly (1996), i.e., in the first of many Fisheries Centre Research Reports devoted to Ecopath and related issues. This workshop, held in November 1995, was a result of my transition (September 1994) to the University of British Columbia, and the first in which models were built by a team, whose members were responsible for different functional groups, thus allowing more expertise to be incorporated into the resulting model. Walters (1996), however, saw Ecopath not as an end product, but as the starting point for dynamic simulation, which first included Ecosim (Walters *et al.*, 1997), then later Ecospace (Walters *et al.*, 1998). What happened then is best told by Villy.

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