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Points of view
Putting fisheries management back in places

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Except, miraculously, for Jules Verne's, scientific predictions always turn out to be wrong. However, the 3rd Millennium is coming, fisheries resources are going, and it is impossible to resist the urge to take the plunge and make a few predictions about the future of fisheries management, and of the scientific discipline. And no, the 's' at the end of the title is not out of place: I shall suggest that in the future, fisheries management and its associated science will have to deal with 'places' far more than they have in the recent past. Indeed, I shall suggest that they will have to return, in many cases, to ancient modes of allocating fisheries resources to local communities, rooted in physical places.

The trend now is going somewhere else, toward privatization of fisheries resources through Individual Transferable Quotas (ITQs) and similar instruments (Pauly, 1996), and there are also attempts to privatize the research scientists and the detailed assessment work that these instruments require (see e.g. Annala, 1996, and other contributions in Munro and Pitcher, 1996). However, this trend will crest when it is realized that, while eminently compatible with the acquisitive mood of our times, self-interested exploitation schemes do not resolve, any more than the open-access schemes they might replace, the basic discrepancy between human and natural time scales.

Many fisheries resource species, e.g. demersal fish in temperate waters and large predators on coral reefs, are long-lived, with natural mortalities of 0.1–0.2 year^{-1}, and often less (Pauly, 1980). This implies that, for exploitation to be sustainable, fishing must not extract more than about 10% of the stock biomass per year, especially in data-sparse situations (Walters and Pearse, 1996). Even such low level of fishing mortality is sufficient, however, to quickly remove accumulations of large, old females – the source of most of the eggs and subsequent recruitment to stocks of long-lived fishes. This is so because the relationship between fish size and egg production is highly non-linear, with large females being far more fecund than an equivalent weight of small ones. Indeed, this non-linearity is so pronounced that for example one single ripe female red snapper, *Lutjanus campecheanus*, of 61 cm and 12.5 kg, contains the same number of eggs (9 300 000) as 212 females of 42 cm and 1.1 kg each (Bohnsack, 1990).

The massive reduction of egg production, relative to unexploited stocks, coincident with the removal of such females, that occurs even when a very low fishing mortality is applied, is one of the reasons why exploited stocks fluctuate as much as they do,

notwithstanding the effect of environmental fluctuations (Hutchings and Myers, 1994; Myers *et al*., 1995). F.I. Baranov, one of the founders of fisheries science, was perhaps the first to realize that "by reducing the fish population, fishing itself provides the increment which, in turn, sustains the fishery" (Baranov, 1927). Let's not wait too long to admit that, similarly, fisheries also generate much of the fluctuations that beset fisheries, all the way to the occasional collapse – the ultimate fluctuation.

Further, even low fishing mortalities, when applied with a gear such as a bottom trawl, will have profound effects on the habitats of demersal fish species, notably by eroding often century-old bottom structures such as 'oyster reefs', sponge communities (e.g. of *Poterion* in South East Asia) and other beds of sessile, filtering organisms. The result is increased water turbidity, and a gradual transition, within coastal ecosystems, from a demersal to a pelagic food web – a very common type of transition (Pauly, 1988, provides a case study). A similar process occurs when coral reefs are stressed, except that the primary production, previously fuelling their repair and growth, tends to end up in filamentous green algae, and in whatever can eat those.

Thus, my contention is that even very low rates of fishing mortality are unsustainable in demersal stocks unless a sizeable fraction of their spawning adults are completely inaccessible, owing to some natural refuge (underwater canyons, large boulders, etc.). These refuges are, should I mention it, the very spots which good fishers must discover and drain if they are to maintain high individual catches and their reputation – whatever the average level of fishing mortality. But can we reconcile the vastly different time scales of humans and fish, and of benthic communities? Not through application of 'optimal' rates of fishing over large areas, however detailed the studies that led to their estimation. Rather, these different time scales require new refuges – marine reserve areas (MRAs) – providing shelter to a wide variety of species, including major commercial species thus protected from the ultimate fluctuation.

For this to work, though, there must be agreement not to fish in certain places, which can happen only if those who do not fish within the MRAs accept their rationale, and benefit from their existence, i.e. if a sense of place re-emerges within fishing communities, as they become the local guardian of the resources and not their roving executioners. Such agreement may emerge if our science continues to confirm that suitably placed and suitably sized MRAs will perform for us what is expected of them (see Roberts *et al*., 1995, for an attempt at a consensus statement). And, perhaps not surprisingly, given the wide scope of their work, we will be using, when assessing the suitability of places for MRAs, or of their sizes, ideas implicit in Beverton and Holt's classic, or explicitly dealing with MRAs, because yes, they also dealt with those (see pp. 365–368 of their 1957 book, either in the original, or the reprinted versions, and Pauly, 1993).

Though sometimes tempted by pessimism, I believe that we humans will, in the next Millennium, find ways to match our numbers and our demands with what our planet can provide (this is not so for the time being). This will require that we abandon rape and pillage as our major mode of interaction with natural resource. For fisheries, it will require rediscovering places for fisheries management.

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