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The future of fisheries: from 'exclusive' resource policy to 'inclusive' public policy

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The current state of global fisheries. The reality of global overfishing is now well documented (e.g. Watson & Pauly 2001a, Pauly et al. 2002, Christensen et al. 2003). Thus, after a brief summary of overfishing, we will discuss what we believe is the more fundamental issue underlying the problem.

The generally invoked causes of global overfishing are: overcapacity and excessive effort by fishing fleets (Garcia & de Leiva Moreno 2003), driven by subsidies (Munro & Sumaila 2002) and technology 'stuffing', which increases the ability of fleets to fish in habitats and at depths previously off-limits, and dramatically amplifies the catching ability of gears (Valdemarsen 2001, Garcia & de Leiva Moreno 2003). This contributes to the problems associated with 'fishing down marine food webs' (Pauly et al. 1998), and removes the last natural refuges for many resource species (Pauly et al. 2002), and 'collateral impacts' in the form of unwanted by-catch and habitat degradation by mobile gears (Chuenpagdee et al. 2003). Until recently, such effects, sometimes likened to using large-scale forest clear-cutting in the pursuit of an industrial-scale deer hunt (Watling & Norse 1998, Pauly et al. 2002), were not accounted for in assessments and management, nor perceived by the public as having important impacts on ecosystems. In essence, fisheries are actively undermining the resource base underlying their productive capacity—directly through excessive removals, and indirectly through ecosystem modification.

The notion of 'freedom of the seas', introduced to the 'western' world by Hugo Grotius as *Mare Liberum*, has dominated humanity's approach to ocean use for nearly 400 yr (Russ & Zeller 2003). Historically, *Mare Liberum* was intended as freedom of navigation and trade during maritime conflicts between 17th century England and Continental Europe, yet over time was also increasingly interpreted as a 'right to fish' (Russ & Zeller 2003). It is this perceived 'right' which, in conjunction with modern market economics and taxpayer subsidies, has led to resource over-exploitation (Pauly et al. 2002). Until the late 20th century, much of the world's oceans were freely accessible to anyone wanting to fish. However, given that the majority of marine catches are taken within 200 nm of coasts (Jennings et al. 2001), one would have assumed that the potential for overfishing would have declined with the introduction of national responsibility via 200 nm Exclusive Economic Zones (EEZ). Yet, traditional approaches to setting and implementing management policy, based primarily on target species considerations (ignoring ecosystem effects), have failed to prevent stock declines, collapses and fisheries closures.

The way forward. The debate on how to deal with the specifics of overfishing is ongoing. Yet, the solutions are obvious.

(1) Drastically reduce effort and capacity. Many fisheries today suffer from significant overcapacity, with values of 30 to 50% estimated by Garcia & de Leiva

Moreno (2003), and even higher values suggested by, for example, Pauly et al. (2002). Economists argue that capacity reductions are best achieved through reductions of subsidies, and warn that even subsidies used for vessel decommissioning schemes can be negative in their impacts (Munro & Sumaila 2002).

(2) While technology usually cannot be 'dis-invented', we can mitigate some of the negative effects of the growth in technological capacity and fishing ability by removing a substantial fraction of all habitats from fishing. Thus, we can artificially recreate the natural refuges which are now lost to ecosystems, and which previously provided the key element of their apparent sustainability (e.g. Pauly et al. 2002, Russ & Zeller 2003). While debate continues on the optimal size and location of no-take zones, a growing consensus points towards extensive networks of protected areas of at least 20 to 30% of each habitat (e.g. IUCN 2003). Note that benefits of no-take areas extend well beyond those indicated here, both with regards to fisheries as well as non-extractive uses (genetic- and bio-diversity protection, bio-prospecting etc.). In essence, large-scale no-take zones are a precautionary ecosystem-based management tool par excellence (e.g. Walters 1998, Roberts et al. 2001). It is well recognised, and implicitly understood, that the establishment of such networks has to go hand in hand with overcapacity reductions, in order to avoid effort build-up in the areas still open to fishing.

(3) To address 'collateral impacts', we have to reconsider gear types and their use within an ecosystem framework, rather than target species issues alone. Technological improvements (e.g. bycatch reduction devices), and selective targeting of fishing grounds to reduce bycatch, are helpful in the short term, but not sufficient in the long run. This applies especially to more unselective mobile bottom gears, especially bottom trawls (Watling & Norse 1998, Chuenpagdee et al. 2003). The continued use of gears that inflict 'collateral impacts' also highlights the need for extensive networks of no-take areas and use-specific ocean zoning to mitigate these effects at an ecosystem scale (Chuenpagdee et al. 2003, Russ & Zeller 2003).

Science, management and inclusive public policy. If we are serious about implementing strategic solutions such as those outlined above, and hence move from the traditional focus on single-species to a precautionary ecosystem-based management, a fundamental shift in the governance of ocean resources will have to take place (Pauly et al. 2002, Russ & Zeller 2003). In the governance context, the deeper problem underpinning the fisheries crisis is neither a failure of science (despite the often used excuse provided by 'uncertainty'), nor one of management; rather it is a problem of public policy (Pauly & Zeller 2003). This relates to the dominant political role played, during management and catch allocation debates, by the users of the resource (i.e. the fishing industry, explicitly seen as 'client' by regulatory agencies) versus the true owners, the present and future citizens of those countries whose stocks are being fished (Macinko & Bromley 2002). Moreover, our heavy reliance on the concept of 'sustainability', which is often the legally enshrined goal of fisheries management, should be re-examined. Most optimistically, this concept implies maintenance of resource biomasses at current levels, usually much below any levels optimizing productive potential. More pessimistically, it implies a continuous erosion of the resource base (Pauly & Zeller 2003). Hence, we need to consider 'ecosystem rebuilding', rather than 'sustainability', as a default policy goal (Pitcher 2001).

In the long term, the changes called for above can only come about if the often politically 'exclusive' resource policy structure is altered to an 'inclusive' public policy with active participation by all stakeholders, including extractive and non-extractive interests. However, by default, overriding precautionary consideration must be given to the long-term interests of future generations. This implies the need for economic discounting practises that consider intergenerational equity, which accounts for the economic benefits of conserving resources (Sumaila & Walters 2004). Central to this shift is the realisation that fishing is a 'privilege' granted to fishers by society. Thus, fishing is not a 'right' in the enforceable sense normally accorded to this word (see Macinko & Bromley 2002). However, given that 'carrots' work better than 'sticks', we argue—as do others (e.g. Hilborn et al. 2003)—that positive incentives in an 'inclusive' public policy and governance framework are essential.

Unlike any other industrial-scale economic activity that humanity engages in, fishing is embedded in the high and inescapable uncertainty underlying natural marine systems, and our ability to understand and predict them (e.g. Walters 1998). Often ignored is the fact that fishing is not an agricultural activity, but rather the only industrial-scale form of hunting wildlife, which has important (but mostly ignored) consequences for management. Foremost, it requires a precautionary approach and, as an expression of society's ownership, the predominance of the public in policy debate. Indeed, reclaiming the ocean and its resources from excessive use will be a key task for humanity in the 21st century. This requires that information on the state of marine ecosystems and resources be widely available, and in a form accessible to the lay public.

Information access and distribution. 'Wissen ist Macht' (knowledge is power) is as crucial today as it was in the late 19th century when it was a rallying cry for political engagement in Germany (von Rüden &

Koszyk 1979). Examples also abound of the natural sciences being perceived as empowering, notably in Victorian England, where scientists such as T. H. Huxley regularly conveyed scientific insights to working class audiences (Desmond 1997). Public knowledge and the empowerment it bestows are particularly critical today, when we are witnessing some of the most extensive, and threatening, human induced changes to global ecosystems. Informing the true owners of marine resources, i.e. the public, and the law makers that represent them, about the impact of fisheries on ocean 'health' is often difficult. A strong lobby exists which, similar to the Tobacco Institute with regard to the effects of smoking, challenges the obvious to maintain the unacceptable (Pauly & Zeller 2003). This, in turn, requires that knowledge and information are transparent, accessible, freely available and compelling. Only then can an informed public engage in the decision making process as the major stakeholder with respect to *their* resources. This would ultimately lead to a modern form of community control, the contemporary equivalent of historical practises in, for example, parts of the Pacific (e.g. Johannes 1978). An example of the potential for success in such an approach is the compelling case of Rachel Carson's *Silent Spring* which, via its public impact, affected policy on pesticide use (Carson 1962). A step in this direction with regard to the effects of fisheries is attempted in Pauly & Maclean (2003).

The growing scientific knowledge on the effects of fishing on marine ecosystems needs to be made available in outlets other than the peer-reviewed specialist literature or government reports, neither of which are easily accessible for public scrutiny. This information should be synthesized and presented in a readily understood form, and not shrouded in technical jargon. Such public outreach must become part of our work, whether we engage in it directly or indirectly, with the help of the communication professionals available at many research institutions. And given today's wired world, one of the best media for dissemination of such information is the World-Wide-Web.

There are few examples of web-based vehicles for the presentation and dissemination of scientific knowledge. The web sites of most research groups emphasize only their existence and describe the minutiae of their activities. However, the Sea Around Us project at the University of British Columbia Fisheries Centre aims to provide an integrated analysis of the large-scale impacts of fisheries on marine ecosystems, and encourages direct information and data-accessibility through its data-oriented front-end web-structure (see www.seaaroundus.org). The project utilizes large-scale time series datasets, such as the United Nations Food and Agriculture Organization (FAO) global fisheries landings data (1950–present), and facilitates the development of complementary data series and approaches. Findings from the project are rooted in peer-reviewed outputs to ensure scientific accountability. However, emphasis is also placed on presenting, via the web, public-oriented information on the effects of fishing on ecosystems at a large spatio-temporal scale, through conceptually clear and graphically compelling presentations. Importance is placed on being as jargon-free as possible, e.g. through the use of common names. Time series of fisheries catches extracted from the waters now encompassed within the EEZ of a given country can be viewed by common or scientific names, or by countries fishing within these waters based on a fishing access agreement database that is also accessible. Additional outputs include animated catch, biomass and primary productivity maps that are visually compelling and easily understood (Watson et al. 2003), and soon will include economic outputs, notably catch value. Underlying data sources and background information are readily accessible, included via links to associated databases. Outputs from this project have already yielded important results (e.g. Watson & Pauly 2001b, Pauly et al. 2002, Christensen et al. 2003, Pauly & Maclean 2003), including, for example, the FAO itself acknowledging the problem of reliability of fisheries statistics reported to it by member countries. This has lead to a revision of global fisheries catches, identifying a downward trend in per capita food supply (see www.fao.org/fi/statist/nature_china/30jan02.asp). The public and media attention attracted by the 'compelling and easily understood maps' (Hall 2004) accompanying much of the project output has the potential to feed directly into the policy debate called for above.

However, besides being anchored in peer-reviewed literature, this knowledge must also be made available offline, i.e. in general interest scientific/nature magazines (e.g. Watson & Pauly 2001a, Pauly & Watson 2003). These, and other contributions using such media (e.g. Safina 1995) and the general press (e.g. Broad & Revkin 2003) have increased interest by the public in marine ecosystems and fisheries issues, and are encouraging. Clearly, as 'seekers of knowledge', scientists should feel compelled to contribute the results of their investigations in a manner accessible to all of society.

Biodiversity databases as information systems. Other examples of the usefulness of online knowledge dissemination relate to the growing need for public understanding of biodiversity issues. For example, Fish Base (Froese & Pauly 2000, see www.fishbase.org), presents key nomenclatural, distributional, biological and other information for all the over 28 000 extant species of finfish. It is maintained by a team of specialists who extract and standardize data from scientific publications. FishBase encourages contributions from the scientific community, in close collaboration with a global network of experts on various taxa and topics. It also provides access to more than 1.5 million records in over 30 other distributed databases, and acts as an electronic archive for historical datasets. FishBase now receives over 10 million hits per month from a wide variety of users from all over the world, thus demonstrating beyond doubt that there is substantial public interest in scientific information if it is presented in a user friendly manner.

However, ecosystems and fisheries are not comprised only of fishes. Hence, other taxonomic groups and data-sources also need to be considered, e.g. through joint initiatives such as the standardization and cross-linking of existing databases, as now achieved by linking the Sea Around Us database with the cephalopod database CephBase (see www.cephbase.org). Alternatively, new biodiversity data sources need to be created, such as the Scientific Expeditions Database being developed by M. L. D. Palomares, parts of which are currently accessible through FishBase. Such historic information, together with long-term data sets as derived from surveys (e.g. http://ram.biology.dal.ca/~myers/welcome.html), provide crucial historical baselines to inform public policy debate. Such information also counters the 'shifting baseline syndrome' (Pauly 1995), which describes humanity's general inability to fully understand the changes our actions have caused, once these changes are outside the observers generational memory. This implies that we do not readily appreciate what ecosystems were like on timelines outside of our personal experience.

Dealing with denial. Debate and critical evaluation of scientific investigations are an integral and valuable part of science, leading to improved insights into natural processes and contributing to scientific consensus. As mentioned above, the real problems arise from denying the obvious in order to maintain a status quo that benefits only a few. The most obvious recent example is that of B. Lomborg, whose self-serving argumentation about an environmental 'litany' in the *Skeptical Environmentalist* (Lomborg 2001) has been shown, by recognised experts in their field (see e.g. Grubb 2001, Pimm & Harvey 2001), to be a misleading, superficial treatment of environmental issues, founded on misrepresentation and selective quotations from the literature. This is also true for Lomborgs' treatment of fisheries (Pauly 2002), which includes, for example, the assertion that marine products provide a vanishingly small percentage of global protein intake, clearly ignoring the utter dependence on cheap fish by millions of people in developing countries, whose marine resources are increasingly exploited by distant-water fleets from developed countries, with little economic or food-security returns (Kaczynski & Fluharty 2002).

With regards to fisheries and the need for ecosystem-based management, the existence of overfishing is not disputed by the scientific community (as mentioned earlier), although specific aspects of the problem might be argued about as part of normal scientific debate (Hilborn et al. 2003). The real problem is not the technical quibble over the magnitude of decline in a stock or degradation of ecosystems, but rather the more fundamental problem of fisheries being a force exerting pressure on stocks and disturbing ecosystems, all with little or no 'counter-weight'. The recent trend towards evaluating fisheries in a conservation context, such as the growing influence of endangered species legislation and non-extractive interests in fisheries management, are examples of 'counter-weights' that may lead to more precaution and balance.

Putting fisheries in their ecosystem context. No one seriously argues that ecosystem-based management is about abandoning traditional single-species stock assessments. Indeed, most modeling approaches providing ecosystem-based information for improving fisheries management and re-building ecosystems rely on single-species assessments as a sizeable part of their input data (e.g. Christensen et al. 2003). Nor is ecosystem-based management only about thoughtlessly setting up no-take marine reserves, leading to the common accusation that all this would do is concentrate the same fishing effort into the remaining, reduced fishing areas (Hilborn 2003). Such oversimplified arguments completely miss the major point of the solutions offered by proponents of ecosystem-based management. Put simply, the point is that the various factors act in combination, and need to be addressed as such—combined—and, hence, ecosystem based. To achieve this requires a truly 'inclusive' public policy environment, leading to better governance of these public resources (i.e. the ecosystems) than is currently the case with most fisheries around the globe.

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