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Viewpoint

Importance of fish biodiversity for the management of fisheries and ecosystems

J.G. Hiddink[a], B.R. MacKenzie[b,*], A. Rijnsdorp[c], N.K. Dulvy[d], E.E. Nielsen[e], D. Bekkevold[e], M. Heino[f], P. Lorance[g], H. Ojaveer[h]

[a] School of Ocean Sciences, University of Wales Bangor, Askew Street, LL59 5AB Menai Bridge, Anglesey, Wales, UK
[b] Technical University of Denmark, National Institute for Aquatic Resources, Department of Marine Ecology and Aquaculture and University of Århus, Kavalergården 6, DK-2920 Charlottenlund, Denmark
[c] Wageningen IMARES, Institute for Marine Resources and Ecosystem Studies, PO Box 68, 1970 AB Ijmuiden, The Netherlands
[d] Centre for Environment, Fisheries and Aquaculture Science, Lowestoft Laboratory, Lowestoft NR33 0HT, UK
[e] Technical University of Denmark, National Institute for Aquatic Resources, Department of Inland Fisheries, Vejlsøvej 39, DK-8600 Silkeborg, Denmark
[f] Institute for Marine Research, Postboks 1870 Nordnes, 5817 Bergen, Norway
[g] IFREMER, Nantes, France
[h] Estonian Marine Institute, University of Tartu, Vana-Sauga 28, 80031 Pärnu, Estonia

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Abstract

A group of fisheries scientists participating in a European Union Network of Excellence (MARBEF) summarizes risks to the biodiversity of fish in European seas and recommends ways how existing fish diversity can be conserved, restored and managed.

Keywords: Fish; Biodiversity; Ecosystems; Management

Biodiversity is the quantity, variety and distribution across biological scales ranging through genetics and life forms of populations, species, communities and ecosystems (Mace et al., 2005). Biodiversity affects the capacity of living systems to respond to changes in the environment, underpins ecosystem function and provides the ecosystem goods and services that support human well-being (e.g., nutrient cycling, clean water; Costanza et al., 1997; Hooper et al., 2005; Diaz et al., 2006). As well as having intrinsic value, biodiversity has aesthetic value: many of us have admired the wonderful colours and shapes of fishes on coral reefs and in other coastal habitats. Some benefits of biodiversity are not apparent today but may be unlocked in the future (known as the option value): compounds derived from marine animals and plants may serve as medicine to prevent and cure more of our ills in the future. Biodiversity also has cultural value when it is directly linked to the cultural fabric of human societies.

Moreover, biodiversity is important for the future sustainability of marine natural resources that include commercial fisheries. While it is axiomatic that biodiversity is essential for sustainable productive fisheries there is surprisingly little supporting evidence. Fisheries that exploit a range of species or a range of populations may have more stable catches than fisheries that exploit a single species (Dulvy et al., 2000; Hilborn et al., 2003). The Pacific salmon fishery in Bristol Bay, Alaska exploited a stock complex of several hundred discrete spawning populations. The contribution of some geographic components and of different life histories and populations to fisheries yield has been minor in one climate regime yet dominant in another (Hilborn et al., 2003). Maintaining such diversity or biological complexity of population structures can only build resilience and insure against climate change (Yachi and Loreau, 1999).

According to WSSD (2002) and other international agreements, countries have to manage their natural resources in ways which conserve both the resource and biodiversity (e.g., Biodiversity Action Plans for the Conservation of Natural Resources, Agriculture and Fisheries (WSSD, 2002; DARDNI et al., 2005; EU, 2005a)).

* Corresponding author. Tel.: +45 3396 3403.
E-mail address: brm@difres.dk (B.R. MacKenzie).

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1. Threats to fish biodiversity

The main factor that threatens marine fish biodiversity globally is fishing (Dulvy et al., 2003; Garcia et al., 2006). For example, worldwide over 40 local populations of marine fishes have gone extinct as a result of overexploitation (Dulvy et al., 2003). These local losses represent an erosion of global biodiversity. Moreover, stresses due to other factors such as climate change, habitat loss, invasive species, eutrophication and pollution can accentuate fishing-induced declines and inhibit or prevent recoveries (Garcia et al., 2006). For example, cod populations in the Baltic and North Seas declined due to high fishing mortality rates combined with deteriorating climate and oceanographic conditions (Beaugrand et al., 2004; Köster et al., 2005). These factors reduced young cod survival, and have been inhibiting recovery (Beaugrand et al., 2004; Köster et al., 2005; ICES, 2006).

Population assessments are available for only a small fraction (<100 populations, <30 species) of Europe's marine species and the long-term viability of many targeted and non-targeted fishes is unknown. This situation applies for example to large parts of the Mediterranean and to deepwater species, that are particularly vulnerable to overexploitation (Leonart and Maynou, 2003; EEA, 2005). Even when assessed, that knowledge may be insufficient to guarantee sustainability, for some species e.g. bluefin tuna. Threats to the sustainability of this species include unreported catches and the landing of fish below legal size (Fromentin and Powers, 2005; ICCAT, 2006). Many other fish species which previously provided substantial catches are now so rare that they are no longer targeted. However, such species (e.g. common skate, spurdog, angel shark) have sometimes been caught as bycatch in sufficient quantities that they have become vulnerable to local extinction (Brander, 1981; Rogers and Ellis, 2000; Hammond and Ellis, 2005),

2. Detecting biodiversity change and its ecosystem consequences

Traditionally, fish biologists have focused on studying population and species-level biodiversity captured in routine fishery surveys. Fisheries scientists have long viewed fish populations as large, open and relatively homogeneous with widespread larval dispersal ensuring genetic uniformity (Hutchings et al., 2007). Genetic tools and "common garden" experiments are unveiling previously hidden biodiversity with evidence for sub-population structure and isolation by distance (Carvalho and Hauser, 1994; Nielsen et al., 2001). Some genetically distinct populations appear adapted to local conditions and have specific behaviours (e.g., migration and mating behaviour) and life history reaction norms for growth and survival (Rowe and Hutchings, 2006; Hutchings et al., 2007). Modern genetic approaches provide deeper insight into the complex lives of fishes and can improve models to enable better predictions of how marine fish biodiversity responds to fishing and changes in the environment. Detecting such changes will require ongoing support for standardized and long-term research surveys of fish communities, and the taxonomic and genetic basis for correct species identifications. Standardized research surveys, when combined with historical fisheries information (e.g., from written archives or archaeological studies (Jackson et al., 2001; MacKenzie et al., 2002)), provide baselines against which future changes in species richness and size composition can be detected and allow identification of the causative factors. Many fishery-induced changes in species and size composition of fish communities are now well documented (Garcia et al., 2006). What has recently become clearer is that these changes affect the structure and functioning of marine ecosystems, including the biomass of species at lower trophic levels (Frank et al., 2005). As a consequence fisheries managers and policy makers have adopted more precautionary and responsible approaches and the development of an ecosystem-based approach to fisheries management (Sinclair and Valdimarsson, 2003).

3. What the EU and its citizens can do to promote conservation and recovery of fish biodiversity

The EU has made substantial progress in recent decades in developing the legislative framework for conservation and recovery of fish biodiversity: the European Parliament and Council have passed several regulations designed to protect fish stocks, conserve fish biodiversity, and move towards an ecosystem-based approach to fisheries management. The EU is also committed to many international fishery and biodiversity agreements (EU, 2005b). Despite the legislative progress, 22–53% of the exploited fish populations in north-east Atlantic waters have fallen below safe biological limits (Piet and Rice, 2004; EEA, 2005) and many of these continue to be exploited at levels that hamper recovery; moreover some of the populations for which recovery plans have been developed and implemented have not recovered, partly because of high by-catches in fisheries targeting other species (e.g., North Sea cod).

These observations suggest that some of the well-intentioned legislation does not work in practice, or is not being fully implemented and enforced by political and national authorities. To solve this problem, we support the EU efforts to reduce fishing mortality on overexploited stocks and in considering a broader range of conservation measures based on improved scientific knowledge and process understanding (e.g., more and larger MPAs where and when appropriate, improved effort control, restoration of habitats) and the member states of the EU to increase the transparency of their actions to stakeholders. We also encourage the EU and member states to support the conservation measures by ensuring *effective*, *prompt implementation and enforcement*. *This action alone would probably have greatest positive impact on fish biodiversity*. In this context we urge both the EU and its member states to prioritise a focus on building resilient fisheries and securing the long-term sustainability of fish stocks and the fishing industry rather than focussing on shorter-term interests when negotiating quotas and recovery plans. Such an approach should also apply to the activities of EU fleets in waters other than those under EU control. These waters include for example parts of the Atlantic, the Baltic, North, Adriatic, Mediterranean, and Black Seas.

Fish consumers in the EU have increasing opportunity to choose fish from sustainable sources and by doing so to drive market demand favouring and supporting sustainability and fish biodiversity. For example, consumers, including individuals, organisations, companies and fish processors can purchase fish which are caught in a sustainable way. Identifying such fish at the local fish shop would become easier if a sustainable fishery certification mechanism were developed and became available in all European countries. Such an approach however necessitates traceability for which appropriate genetic tools are required. Through increasing choice, consumers have the power to influence businesses and politicians and support moves toward more widespread sustainability.

Development of a longer-term management view, the reconciliation of fisheries and conservation objectives toward sustainability and the support for consumer choice can reduce the likelihood of losing fish biodiversity and guarantee that European marine ecosystems can continue to provide the goods and services that support human well-being.

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