



Full fathom five...

Effects of deep-sea fishing in the Atlantic

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By Sarah Helyar

During the 1960s and 1970s, the catch from traditional coastal fisheries began to suffer serious declines. The combination of technological improvements, subsidies and the shrewd renaming of species meant that deep-sea trawling was soon seen as a lucrative alternative to the depleted shallow-water fisheries. However, deep-sea fishes are remarkably unproductive and highly vulnerable to overfishing and, as a result, dramatic declines have been seen in many of the species that have been targeted.

Over-exploitation of traditional coastal stocks and a rising demand for seafood have resulted in the shift of commercial fishing towards less known deep-sea species in many parts of the world. Originally, this small fleet consisted of slightly modified coastal trawlers with longer, thicker cables on the winching gear. However, they encountered problems with corals and rocks tearing the nets, and this led to the addition of heavy metal chains and steel rollers to the front edge of the nets. These became known as rock-hoppers, and while they may 'hop' over rocks and boulders, their effect on corals, sponges and other deep-sea life is more like that of a bulldozer. But these changes to the fishing gear opened up huge new areas to the trawlers, including the extremely profitable sea-mounts, which are known oases for oceanic life. Together with improvements in the technology for visualising the sea floor and for locating large aggregations of fish, and encouraged by government subsidies to diversify fishing fleets, a new market was created. Many species were creatively renamed so as not to deter the customers (for example, *Hoplostethus atlanticus*, a member of the slimehead family, was rebranded as the Orange Roughy, while the Patagonian Toothfish became Chilean Seabass. However, many of the deep-sea fish are so unpalatable that the only use for them is as fish meal, or in the case of the deep-

sea sharks, the oil from their liver is used as an ingredient in cosmetics. There were still large incentives for deep-sea fishing, though, and by 2000, 40% of the world's trawling grounds were classed as deep sea.

The deep sea is defined as extending from the edges of the continental shelves at a depth of 200m to the maximum depth of the sea. It is a permanently dark and cold environment and most of the animals that live there depend almost entirely on organic matter that originates from the shallower continental shelves and the open ocean above, where plant growth is fuelled by sunlight. (Rarely, communities such as those surrounding hydrothermal vents include primary producers.) Consequently, deep-sea species frequently have biological characteristics that make them extremely vulnerable to over-exploitation: they live a very long time, they are slow-growing and they mature late in life. To add to the management problems, the aggregations targeted by fishermen on sea-mounts and the sea floor are, in some species, spawning aggregations, which further increases their susceptibility to overfishing, and ultimately extinction. The future prospects for deep-sea species, and particularly the slower-reproducing sharks and rays, are gloomy.

By the turn of the millennium, many species were known to be seriously over-exploited. For some species this was largely through the serial depletion of aggregations such as those around the sea-mounts. As the fish in one area become commercially unviable, vessels move on to the next aggregation, and so, many stocks have collapsed to <20% of their pre-exploitation abundance in just a few years (Koslow *et al.*, 2000). Other species such as the large, deepwater Barndoor Skate (*Dipturus laevis*) have been driven to the edge of extinction, not as an exploited species, but as bycatch (Casey *et al.*, 1998), and according to criteria from the World Conservation Union (IUCN), several commercial deep-sea species have now been evaluated as critically endangered (Devine, 2006).

The effects of trawling on the ocean floor go far further than the effects on individual species. The problems associated with trawling are made worse by the fact that deep-sea fishing devastates the deep-sea habitats that the fish species require. When fishermen run their trawls across deepwater coral or sponge reefs or target structures such as richly diverse sea-mounts, a single passage can destroy something which has taken hundreds or perhaps thousands of years to develop.

But the news isn't all bad; pressure on industry and governments has had some success over the last few years: in industry, many leading cosmetic companies have now stopped using shark liver oil. Known as squalene, it is used as a moisturising base in creams, lotions and lip-glosses, but because of concerns over the survival of the deep-sea elasmobranch species, many have started switching to plant sources for the compound.

Atlantic & North Sea



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Two views of Fangtooth Fish, a deep-sea species.

The North East Atlantic Fisheries Commission (NEAFC) is responsible for implementing, by the end of 2008, a United Nations General Assembly resolution adopted in 2006 (61/105). In July this year, the member countries met and reached an agreement which states that all high-seas bottom-fishing will be subject to impact assessments and that they will agree on areas that require protection at the annual meeting of NEAFC in November this year, and that fishing areas will be closed or fishing prohibited where damage to corals, sponges and other deep-sea species cannot be prevented by the end of the year.

But getting legislation put in place is very hard when we know so little. To date, biologists have studied only about a millionth of the deep-sea floor, and more is thought to be known about the moon than the depths of our own oceans. However, there are a number of projects within the MARBEF framework that are addressing these uncertainties. As part of the Census of Marine Life, MAR-ECO addresses the lack of basic knowledge that we have of deep-sea ecosystems by investigating the diverse animal life along the vast underwater mountain chains of the Mid-Atlantic Ridge.

The DEEPSETS project is studying deep-sea and extreme habitats at a number of long-term study sites. This will allow an unprecedented insight into long-term change in deep-sea ecosystems on a large scale.

A key to our ability to manage deep-sea fisheries and protect their ecosystem is an understanding of the underlying demographic and life-history characteristics of deep-sea species, including their migratory behaviour and

spatial population structure. DEECON is a current EU study of several economically important deep-sea fishes across the continental slopes, sea-mounts and trenches between the Azores and northwestern Norway. By combining population genetics with otolith microchemistry, we hope to detect any existing population structure, and this will then be integrated with bathymetric data, life-history traits and oceanographic models of ocean currents to unravel mechanisms for population connectivity such as passive larval drift and active migration. This fundamental biological knowledge can then be used to develop scientifically sound management plans for one of the world's most valuable ecosystems.

The DEECON project is focusing on five deep-sea species that have different life-histories and that are all affected by commercial fisheries: the Black Scabbardfish (*Aphanopus carbo*), the Roundnose Grenadier (*Coryphaenoides rupestris*), the Onion-eye Grenadier (*Macrourus berglax*), the Ling (*Molva molva*) and the Longnose Velvet Dogfish (*Centroselachus crepidater*).

The objective is to identify stocks that will react independently to exploitation – and so provide a platform for evidence-based management strategies – and evaluate the potential for biodiversity loss caused by deep-sea fisheries and other anthropogenic pressures. DEECON is an opportunity to utilise modern techniques to advise on management strategies.

Too often we have overlooked the risks of exploiting natural resources, without a clear understanding of the biological dynamics, resulting in some well-known and at times

irreversible consequences. This is a timely contribution to the conservation and sound management of deep-sea ocean resources, before irreversible overexploitation occurs.

References

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Devine, J.A., Baker, K.A. and Haedrich, R.L. (2006). *Nature* **439**(5), 29.
Koslow, J.A. et al. (2000). *ICES J. Mar. Sci.* **57**, 548-557.

For more information:

Roberts, C.M. (2002). Deep impact: the rising toll of fishing in the deep sea. *Trends in Ecology & Evolution* **17**(5), 242-245.

Web links:

DEECON: <http://www.imnr.no/deecon/home>.
MAR-ECO: <http://www.mar-eco.no/>.
DEEPSETS: <http://www.marbef.org/projects/deepsets/index.php>.

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