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Overfishing and the replacement of demersal finfish by shellfish: an example from the English Channel

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The worldwide depletion and collapse of major fish stocks through intensive industrial fishing has raised many concerns about the sustainability of current fishing practices and the effectiveness of existing management measures (Christensen et al., 2003; Baum and Worm, 2009; O'Leary et al., 2011). Long-term data series such as fishery statistics have been analysed extensively in recent decades to assess changes in fish populations and ecological communities (Pauly et al., 2001; Pinnegar et al. 2002; Pauly and Chuenpagdee, 2003). Since Pauly et al.'s (1998) pioneering work, the phenomenon of "Fishing Down Marine Food Webs" has been investigated worldwide. The trend for fisheries shifting towards much smaller species found lower in the food chain as predatory species have been depleted has been demonstrated in many marine regions around the world through declines in the mean Trophic Level (mTL) of fisheries landings (Table 1). A study by the authors focused on the English Channel, a region with a long history of human exploitation where this assessment has never been performed before.

Over the whole time-series of fishery landings which comprises 90 years of data (1920-2010), the mTL has declined significantly from 4.0 units in 1920 to 3.0 in 2010, a 0.1 unit drop per decade, the fastest rate observed so far in Europe (Figure 1A). Meanwhile total landings have increased substantially since the 1920s thanks to an industrialization of fishing that allowed vessels to exploit deeper grounds further away from the coast with greater efficiency (Figure 1B).

Table 1: Instances of "Fishing Down Marine Food Web" across the globe, showing rates of decline in mean trophic level (mTL).

Country/Area	Period	mTL decline	Source
Cuba EEZ	1960-1995	0.10 decade^{-1}	Baisre (2000)
Canada (West and East coast)	1950-1997 and 1873-1996	0.03-0.1 decade^{-1}	Pauly et al. (2001)
Celtic Sea	1982-2000	0.04 year^{-1} (ICES catch data) and 0.03 year^{-1} (scientific survey)	Pinnegar et al. (2002)
Thailand	1965-1997	0.05-0.09 decade^{-1}	Pauly and Chuenpagdee (2003)
Iceland	1918-1999	0.06 decade^{-1}	Valtysson and Pauly (2003)
Chile	1979-1999	0.175 decade^{-1}	Aranciba and Neira (2005)
Greece	1950-2001	0.02 decade^{-1}	Stergiou (2005)
Indian States and Union Territories	1950-2000	0.058 decade^{-1}	Bathal and Pauly (2008)
Argentinean-Uruguayan Common Fishing Zone (AUCFZ)	1989-2003	0.03 year^{-1}	Jaureguizar and Milessi (2008)
Portugal	1970-2006	0.005 year^{-1}	Baeta et al. (2009)
Brazil	1978-2000	0.16 decade^{-1}	Freire and Pauly (2010)

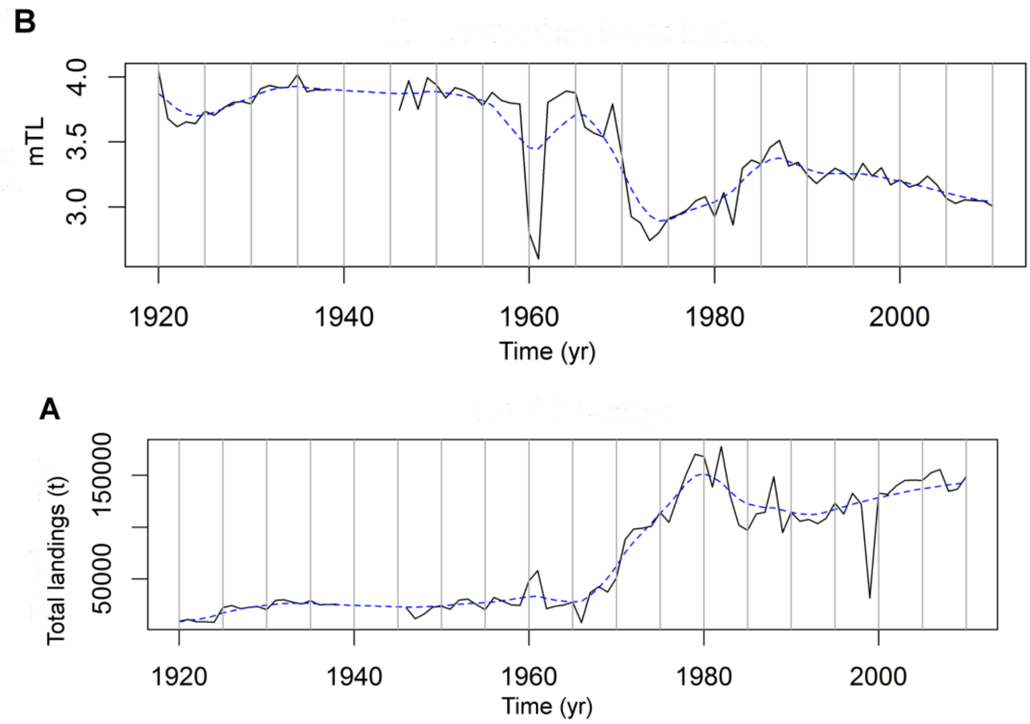

Figure 1: ICES data for the English Channel for the period 1920-2010. Analysis excludes pelagic species. (A) Changes in the mTL over time, (B) Annual landings from the English Channel. The blue dashed line is a smoothing function, "supsmu" (Friedman, 1984) available as standard with the R software package (R Core Team, 2013).

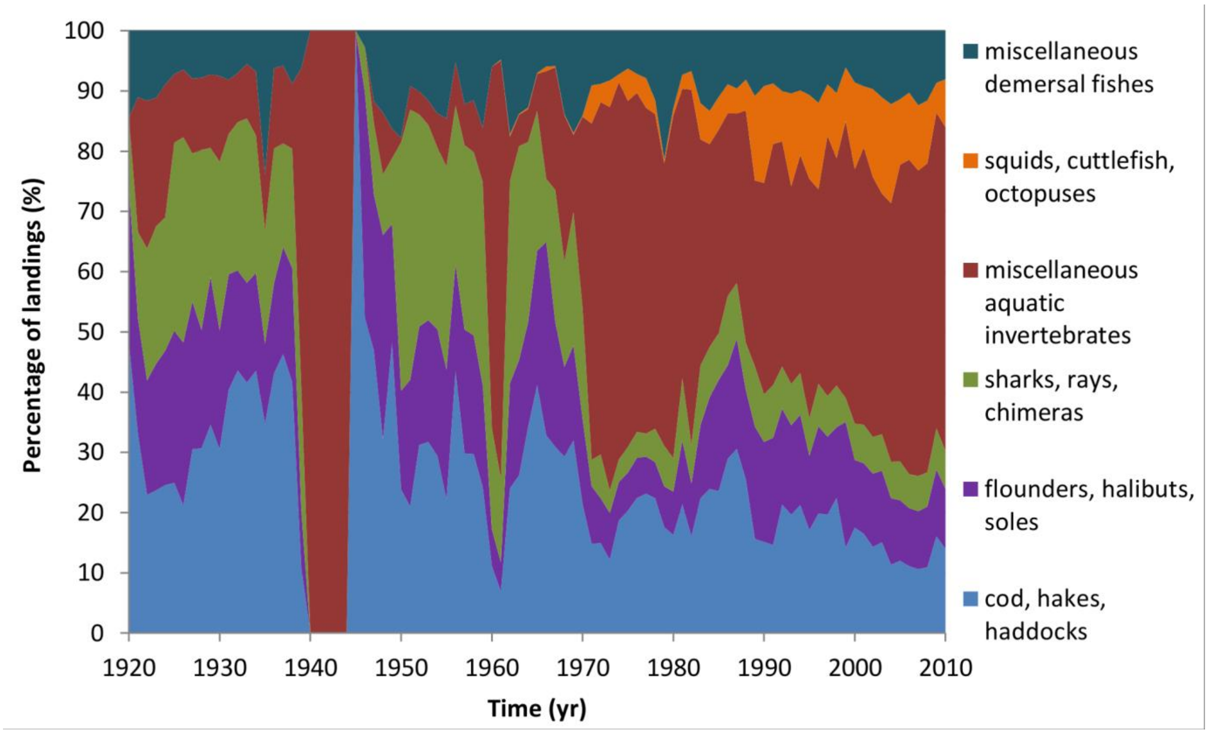

Figure 2: ICES data on changes in catch composition for the English Channel 1920-2010. Species grouped into ISSCAAP categories.

These figures aren't all about what's in the sea. Market mechanisms create 'perverse incentives' which reinforce the shift to reduced biodiversity. By raising the value of species like scallops or crab it becomes profitable to keep degraded marine habitats as they are. Indeed, if we consider the footprint of beam trawlers and scallop dredges produced by Campbell et al. (2014), it seems obvious that it is only scavengers and tiddlers that survive the tremendous pressure exerted by heavy fishing gear on Britain's seabed. Besides, the UK is a net importer of fish: in 2010 most of the cod and haddock supply was freighted in from Iceland and Norway where fishing with trawls and dredges is banned in coastal waters due to the damage it does to fish spawning areas. We simply cannot catch enough of those species in UK waters to meet consumer demand.

Centuries of intensive fishing have upset the ecological balance of the seas around us by removing important components of the food web and by damaging marine habitats essential for the survival of certain species (Thurstan and Roberts, 2010; Thurstan et al., 2010). Our study documented a shift in the landings from the English Channel towards the cockroaches, rats and mice of the sea to the demise of signature species of the 20^{th} century. As with monocultures on land, invertebrate fisheries are easy to manage and initially there's a good return, but the habitat becomes less stable too, more vulnerable to disease, parasites and climate change (Anderson et al., 2011; Howarth et al., 2013). That is why we recommend a network of recovery areas closed to fishing to allow the regeneration of marine life and increase the resilience of this highly impacted marine ecosystem.

Full details of the author's research project can be accessed at http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0101506

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