

INVITED COMMENTARY

Editorial: Ecological processes are not bound by borders: Implications for marine conservation in a post-Brexit world

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1 | INTRODUCTION

In this short viewpoint editorial, I consider the mismatch of the scale of most ecological processes and resolution of legislative and statutory instruments to manage the oceans, sustainably exploit their living resources and conserve marine ecosystems. In a post-Brexit world I will ask the question (with apologies to M. Python et al., 1979) 'What has the EU ever done for the marine environment and its conservation?' At this stage, I wish to make it absolutely clear that this is a personal view; it does not reflect that of the institutions to which I am affiliated nor the publishers of this journal.


Many marine organisms have spatially extensive life histories. Most sessile organisms such as algae, seagrasses and marine invertebrates have a propagule stage (spores or zygotes in algae, seeds in seagrasses and larvae in invertebrates) that can disperse over various distances – but in some cases up to thousands of kilometres. Even direct developing invertebrates can raft on floating seaweeds (Ingólfsson, 1996), natural and artificial detritus (Barnes, 2002) to reach new habitat such as the intertidal zone of isolated seamount islets such as Rockall (Johannesson, 1988). Planktonic organisms are entrained in oceanic currents and then can drift over thousands of kilometres. Actively swimming or walking invertebrates, fish and marine mammals can undertake extensive migrations – in some cases across whole ocean basins. In the complicated regional seas of the North-east Atlantic many species, especially fish, marine mammals and seabirds, will spend their lives in the waters of several national jurisdictions or devolved administrations (in countries such as UK, Germany and Spain). This has long been recognized and the International Council of the Exploration of the Seas (ICES) and its Mediterranean equivalent (*Commission Internationale pour l'Exploration Scientifique de la Méditerranée*) were established (ICES in 1903, CIESM in 1908) to enable coordinated

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international research programmes to address problems such as management of fish stocks, pollution and sustainable use of the seas.

In no particular order (as increasingly real life converges with reality television), I will give a personal perspective on why as a British scientist I am so disappointed about leaving the European Union. I will briefly consider the generally good, the sometimes bad and the occasionally ugly sides of the contributions of the EU to sustainable seas (see also Boyes & Elliott, 2014). I will finish with a plea that both the British and European scientific community lobbies hard to maintain pan-European integration in both research delivery and policy development and implementation over the next decade and beyond.

2 | A SCIENTIFIC CAREER SHAPED BY EUROPE

Like many of my generation, my career has been shaped by active European collaborations since the mid-1980s. This started with work in Portugal in 1986. From the mid-1990s I was involved in major research grants with colleagues in Portugal, Spain, Italy, Ireland, Sweden, Denmark, Germany, The Netherlands, Greece, France and Belgium. This involvement progressed to major networks such as MARBEF (Marine Biodiversity and Ecosystem Functioning) involving all European countries with an interest in the oceans, and successor bodies such as EuroMarine. I have supervised over 80 PhD students of which more than a quarter have come from Europe (mainly Portuguese (16), but also two Italians, one Maltese, one French, one Greek, one Dane) and hosted or employed Spanish (three), German (two), Danish (one), Italian (three), French (one) and Irish (one) post-docs and research assistants. Of my over 300 research papers and book chapters published since 1979, around half have European co-authors. This work with European collaborators has shown how phylogeographic processes shape current patterns of biodiversity in the North-east Atlantic and Mediterranean, including colonization of the Atlantic Islands (Côte-Real, Hawkins, & Thorpe, 1996a, b; Faria 

et al., 2015; Pannacciulli, Bishop, & Hawkins, 1997; Ribeiro, Xavier, Santos, & Hawkins, 2009), biogeographic patterns in Europe (Boaventura, da Fonseca, & Hawkins, 2002) and recent shifts in relation to climate change (Lima, Ribeiro, Queiroz, Xavier, et al., 2007; Lima, Queiroz, Ribeiro, Hawkins, & Santos, 2006; Lima, Ribeiro, Queiroz, Hawkins, & Santos, 2007). European projects (e.g. EUROROCK) and European students have also enabled broad-scale comparisons of processes such as the relative importance of grazing and environmental stress along latitudinal gradients in setting distribution patterns (Boaventura, Alexander et al., 2002; Boaventura, da Fonseca, Della Santina et al., 2002; Boaventura, da Fonseca, & Hawkins, 2003; Coleman et al., 2006; Ferreira, Arenas, Martinez, Hawkins, & Jenkins, 2014; Ferreira, Hawkins, & Jenkins, 2015; Jenkins, Coleman, Hawkins, Burrows, & Hartnoll, 2005; Jenkins et al., 2000). Recruitment fluctuations have also been studied on very broad scales (Jenkins et al., 2000; Jenkins, Åberg et al., 2001; Jenkins, Arenas et al., 2001; O'Riordan et al., 2004). Most of the fixed term post-doctoral associates that worked on EUROROCK have progressed to full time academic research institute positions. None of this science would have been possible without freedom of movement of scholars in Europe, affordable tuition fees and large-scale multinational European Union funded projects.

In addition to pure research, progress on conservation has been facilitated. I have been involved in much work in the Azores (Hawkins, Burnay, Neto, Tristao da Cunha, & Frias Martins, 1990; Martins, Santos, Hawkins, & Nash, 1992; Santos, Hawkins, Monteiro, Alves, & Isidro, 1995) on the establishment and efficacy of MPAs, especially in protecting heavily overexploited limpets (Martins, Thompson, Neto, Hawkins, & Jenkins, 2010) at risk from overexploitation, particularly protandric species (Borges, Hawkins, Crowe, & Doncaster, 2016; Martins et al., 2017). The consequences of such overexploitation for community structure has also been shown (Martins et al., 2010, 2017; Borges, Hawkins, Doncaster, & Crowe, 2015).

Much work has also been done with engineers on environmentally sensitive design of sea defences (the EU DELOS project) and combating flood risk (the EU THESEUS project). This has led to the incorporation of secondary functions such as biodiversity enhancement in sea defences (Evans et al., 2016; Firth, Thompson et al., 2014; Firth et al., 2013; Firth, Schofield, White, Skov, & Hawkins, 2014; Martins, Jenkins, Neto, Hawkins, & Thompson, 2016; Moschella et al., 2005), an appreciation of the impacts of shore parallel structures on soft sediment assemblages (Martin et al., 2005) and advocacy of a more holistic approach to managing coastlines (Airoldi et al., 2005; Evans et al., 2017). The efficacy of marine protected areas has been assessed (Sciberras et al., 2015). An overview of work on restoration of both marine and freshwater ecosystems was completed recently (Geist & Hawkins, 2016).

3 | LEGISLATIVE FRAMEWORK PROVIDED BY THE EU

3.1 | The good

The European Union has provided a legislative framework for managing the coasts and regional seas predominantly (Baltic, North,

Celtic Seas and the English Channel (*La Manche*) and partially bordered (Mediterranean and Black Sea) by European Union states. When considering the extensive Economic Exclusion Zones (EEZ) of Spain (including around the Canaries), Portugal (plus the Azores, Madeira and Selvagem Islands), Ireland, Denmark (plus the Faroes) and the UK (including Shetland, Orkney, Hebrides, Rockall, St Kilda) this encompasses much of the North-east Atlantic – except the Norwegian and Icelandic EEZs. This provides a broad-scale, comprehensive arena to tackle environmental, living resource management and conservation problems at a legislative and regulatory scale that matches most ecological processes. Marine life does not respect national boundaries.

Successive EU Directives have helped clean up our beaches dealing primarily with public health and aesthetic impacts diminishing amenity use, as well as leading to ecological benefits (i.e. the Bathing Water Directive, 1976, Urban Wastewater Directive, 1991) and reducing local eutrophication. Sludge dumping has been banned at sea (Sewage Sludge Directive, 1986). The Nitrates Directive (1991) regulated nutrient inputs into fresh water and hence estuaries and coastal waters. All these directives were packaged into the comprehensive Water Framework Directive (2000). Together these measures have been important steps in combating eutrophication, especially in enclosed seas.

Successive directives on conservation built on the international conventions of the 1970s (e.g. Convention on International Trade in Endangered Species (CITES), Ramsar, Bern and Bonn Conventions). The Birds (1979, amended 2009) and Habitats Directives (1992) have led to designation of Special Protection Areas for Birds (and indirectly their habitats and food) and Special Areas of Conservation. These provide a network of sites with various levels of protection. These designations have also promoted much survey of features of interest, thereby cataloguing biodiversity and natural heritage and monitoring the condition of these sites. This approach has been taken further with designation of various kinds of marine protected areas (MPAs) and the broader concept of Good Ecological Status – all cornerstones of the 2008 Marine Strategy Framework Directive (MSFD) aimed at ensuring healthy, productive and well-managed seas, while in parallel enabling sustainable development of the Blue Economy. Interestingly British legislation (Marine and Coastal Access Act, 2009; Marine (Scotland) Act 2010) was developed in parallel to the MSFD, pursuing a similar holistic approach leading to designation of Marine Conservation Zones in England and Wales and nature conservation MPAs in Scotland.

In a post-Brexit world, it is important that the UK continues its traditionally strong commitment to the marine environment via OSPAR (the Oslo-Paris Commissions 1992, in force as the OSPAR Convention since 1998) plus other long-standing relevant international treaties (e.g. CITES 1973, Ramsar Convention 1971) and those stemming from the 1992 Rio Conventions on Biological Diversity and Climate Change such as the 2015 Paris Conference of Parties. The scientific process for transnational advice on fish stocks, side effects of fishing, and other marine environmental issues still remains with ICES. How its advice will be translated into management measures will be a major challenge, kicked off by the signalled withdrawal from the London Convention (1964). The rebuilding of cod stocks in the North

Sea by reducing fishing effort has been a recent success (ICES, 2016); although this may have been helped by several colder North Atlantic Oscillation Index negative winters since 2005 (Stige, Ottersen, Brander, Chan and Stenseth (2006), for review of the influence of North Atlantic Oscillation on cod recruitment). Fortunately the Intergovernmental Panel on Climate Change is a robust and rigorous process for assessing present and future trends in climate and their likely impacts on marine and other ecosystems.

Should the UK leave the EU and not remain in the European Economic Area (EEA), a raft of legislation will go. Remaining in the EEA (a very soft Brexit) will mean that, while many key Directives will be kept (e.g. the Water Framework Directive, Marine Strategy Framework Directive, Sewage Sludge Directive), the Habitats Directive, Birds Directive and Bathing Water Directive would be lost (Matthew Frost, pers. comm.; Baldock et al., 2016).

In summary, many good things for the marine environment and its conservation have stemmed from EU Directives and Regulations. The fear is a major bonfire of red tape will lead to massive deregulation, leading to non-sustainable use of British seas and coasts. Interestingly, on aquatic pollution and conservation, the UK has had in recent years a reasonable record on infringement of directives in comparison with many other EU Member States. The major environmental concerns in recent years have been on air pollution and the high cost of legal proceedings to challenge rulings in UK courts (European Commission, Environment website, 2016).

3.2 | The bad and the ugly

There have been several bad and occasional ugly things in terms of EU influence on conservation.

From a scientific viewpoint, a deficiency has been an over-reliance on classificatory approaches and often assuming that static base-lines exist. This has led to the concepts of 'typologies' and 'reference' sites that do not necessarily work well in highly dynamic and interconnected marine ecosystems. Classification runs deep in the European ecological science psyche stemming from the Zurich-Montpellier school of phytosociology that spilled into southern European marine ecology (Boudouresque, 1971, 1972; Coppejans, 1980). There has been a long-running discussion in the offshore benthic literature between the classic Petersen-based approach describing communities (Petersen, 1913) versus a view based on environmental gradients of depth, hydrodynamics and sediment type along which species are distributed independently of each other along continua (Jones, 1950). The EUNIS (1996) habitat classification scheme (by the European Environmental Agency) and its various national offshoots (e.g. JNCC Biotopes, Conner et al., 2004) are useful pragmatic units for mapping habitats – as long as it is realized that they are arbitrary classifications – not real entities. The only exceptions are probably those biotopes that are very strongly structured by biogenic habitat-forming species such as *Modiolus*, seagrass, maerl or dense kelp or *Ascophyllum* beds. Even these differ in species composition and relative abundance depending on local environmental gradients and biogeographic context. My own view is that biotopes work best at the biotope complex level – below that some biotopes will change over time and morph into others. Huge effort can be put into

describing individual elements of what is in essence a functional mosaic of fluctuating microhabitat patches and the outcomes of post-stochastic recruitment events and biological interactions (Hartnoll & Hawkins, 1985).

For me, the ugly has often been wrapped up in the 'one size fits all' philosophy of both the Common Agricultural Policy (1962, 1992, 2003, and 2013) and the Common Fisheries Policy (CFP) (1970, 1983, 1987, 2002, and 2013). How the land is managed has consequences for catchments and transitional and coastal waters. Intensification and overproduction of arable farming, driven by agricultural subsidies, has probably contributed to riverine and coastal eutrophication over the last four decades. At sea, the Common Fisheries Policy often operates at a scale divorced from ecological reality and actual stock definition (Hawkins et al., 2016). Often one size fits nobody – other than large conglomerates – rather than individual fishers and their local communities. Iceland and Norway are not part of the EU; some of the reasons for this are fishing-related. It will, however, be very interesting to see what replaces the CFP in British waters – and the consequences for sustainable exploitation of fish stocks and marine conservation. At least while a member of the EU reform of CFP could be lobbied for; from the side-lines the UK will be a spectator and a recipient of the outcome of management measures for stocks that spend large parts of their life histories outside UK territorial waters.

4 | CONCLUDING REMARKS

I will personally lament the exit of the UK from the EU. It will lead to talented European scientists leaving the UK owing to uncertainty, perceived xenophobia and the weaker pound devaluing their salaries. Fewer EU students and early career researchers are likely to come to the UK and enrich our scientific communities. The UK may not be able to participate in 'big' trans-boundary science nor might UK scientists have continued access to shared infrastructure. It is important that the UK (along with Switzerland and Norway) continues financial contributions to trans-national research initiatives (such as Biodiversa and hopefully EU Framework Programmes) in marine science and joined-up implementation plans for sustainable management and conservation of our seas and marine life.

The EU has been a respected, largely unified voice on climate change and sustainable use of the ocean. EU Directives and Regulations have largely driven improvements in the marine environment and promoted its conservation. I fear de-regulation and the risk of an increasing tendency for populist perspectives – rather than scientifically-based evidence – to drive the formulation and implementation of policy.

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