Institution: University of Plymouth

Unit of Assessment: UoA7

Title of case study: Advancing spatial management of the deep sea

Period when the underpinning research was undertaken: 01.05.2005-31.12.20

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Kerry Howell	Professor in Deep Sea Ecology	2005 to present

Period when the claimed impact occurred: 01.08.2013-31.12.2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Howell has pioneered the development of habitat mapping approaches in the deep sea, and the application of modelled maps to environmental management and decision-making. Mapping is the cornerstone of marine spatial management, providing spatial information on the distribution of species and habitats to feed into wider marine spatial planning. Howell's research has: 1) directly contributed to a change in policy, resulting in a ban on deep-water bottom trawling below 800m in European Waters; 2) supported the implementation of policies for the protection of the environment. Under (2) the research has directly resulted in the designation of 14 Marine Protected Areas in the UK and on the High Seas (international waters). Howell's research directly contributed to the production of a unified European marine habitat map now used to support marine spatial planning throughout Europe. In the North Atlantic and central Pacific, Howell's research is supporting spatial management of the High Seas and seabed (international waters).

2. Underpinning research (indicative maximum 500 words)

The deep sea is the largest and least explored biome on earth. Anthropogenic impacts on this system are increasing, with the deep sea now subject to multiple stressors including fishing, hydrocarbon extraction, mining, climate change, contaminants and litter. With increasing human use comes the need for effective management practices that align with internationally agreed conventions and goals, specifically the UN Convention on Biological Diversity and Sustainable Development Goal 14: To conserve and sustainably use the oceans, seas and marine resources for sustainable development. Marine Spatial Planning is a fundamental part of sustainable management. It requires at its base an understanding of the distribution of species and habitats such that informed decisions on spatial use can be made. However, the mechanisms to produce ecologically meaningful maps of deep-sea habitats were lacking, as was guidance on how maps may then be applied to spatial management. This contributed to poor management of deep-sea fisheries, and specifically failure to protect vulnerable coral, sponge, and seamount ecosystems from adverse impacts of highly destructive bottom fishing.

Howell developed a new habitat classification for the deep sea to enable the development of ecologically meaningful maps [3.1]. This classification system was adopted by the UK Government (2010) and the EU (2011) in their development of UK-wide and unified European marine habitat maps respectively. Following this, Howell applied this mapping approach to the assessment and design of marine protected area networks in the High Seas [3.2 & 3.3]. She demonstrated how this approach could be used to assess representativity within a Marine Protected Area (MPA) network and identify additional areas that may be required for inclusion within a network.

Howell also demonstrated how habitat suitability modelling techniques could be applied to fill data gaps in deep-sea knowledge, specifically focusing on mapping the distribution of habitats of conservation concern [3.4 – 3.6], including habitats listed under Annex I of the EU Habitats Directive, OSPAR Threatened and Declining Species and Habitats, and Vulnerable Marine Ecosystems (VMEs) as defined by the UN General Assembly Resolution (UNGA) 61/105. She demonstrated how such modelled maps could be used to make decisions about spatial management of the deep sea and represent best available data. Effective implementation of UNGA 61/105 particularly has been hampered by a lack of understanding of where VME are "known or likely to occur". Howell has pioneered the use of habitat suitability modelling to identify areas where VME are "likely to occur".

2. References to the research (indicative maximum of six references)

3.1 **Howell**, K.L., 2010. A benthic classification system to aid in the implementation of marine protected area networks in the deep/high seas of the NE Atlantic. Biological Conservation, 143(5), pp.1041-1056.
This paper was the first to consider biologically meaningful mapping approaches for the data poor deep sea. It develops an innovative method of mapping.

3.2 Evans, J.L., Peckett, F. and **Howell**, K.L., 2015. Combined application of biophysical habitat mapping and systematic conservation planning to assess efficiency and representativeness of the existing High Seas MPA network in the Northeast Atlantic. ICES Journal of Marine Science, 72(5), pp.1483-1497.
This paper was the first to apply systematic conservation planning approaches to the High Seas and demonstrate how marine spatial planning in the data-poor High Seas could be achieved.

3.3 Dunn, D.C., Van Dover, C.L., Etter, R.J., Smith, C.R., Levin, L.A., Morato, T., Colaço, A., Dale, A.C., Gebruk, A.V., Gjerde, K.M., Halpin, P.N., **Howell,** K.L, et al 2018. A strategy for the conservation of biodiversity on mid-ocean ridges from deep-sea mining. Science Advances, 4(7), p.eaar4313.
This paper builds on the previous and presents an alternative approach to High Seas and deep-sea Marine Protect Area network design. Its significance lies in its influence on scholarly thought and the number of subsequent publications that cite this paper given the size of the field (39 citations in 2 years)

3.4 Ross RE & **Howell** KL 2013 'Use of predictive habitat modelling to assess the distribution and extent of the current protection of 'listed' deep-sea habitats' Diversity and Distributions. 19, (4) 433-445
This paper was the first to model the distribution of cold-water coral reef habitat on a regional scale and demonstrate how this approach could be used to assess progress toward stated policy conservation targets. Its significance is evidenced by the change in policy this research helped to bring about documented in this case study.

3.5 Ross, L.K., Ross, R.E., Stewart, H.A. and **Howell**, K.L., 2015. The influence of data resolution on predicted distribution and estimates of extent of current protection of three 'listed' deep-sea habitats. PloS ONE, 10(10), p.e0140061.
This paper builds on the previous paper and is the first to demonstrate how resolution of data changes the outcome of assessments toward conservation targets. It contributes important knowledge in the application of these modelling techniques to conservation planning and will have a lasting influence on how models are applied.

3.6 **Howell**, K.L., Piechaud, N., Downie, A.L. and Kenny, A., 2016. The distribution of deep-sea sponge aggregations in the North Atlantic and implications for their effective spatial management. Deep Sea Research Part I: Oceanographic Research Papers, 115, pp.309-320.
This paper is the first to model the distribution of a critical habitat across the northern North Atlantic Basin and show how the burden of management falls to different nations and the UN. Its novelty lies in demonstrating how we might begin to think about basin scale spatial management.

4. Details of the impact (indicative maximum 750 words)

Howell's research has directly contributed to a **change in policy**, resulting in a ban on deep-water bottom trawling below 800m in European Waters (2017). Howell's research has also supported the **implementation of multiple policies** relating to marine environmental management. Her research has directly resulted in: 1) the designation of Marine Protected Areas in UK waters, European waters, and on the High Seas; and 2) the development of the first ever biologically relevant habitat classification system for the deep sea, enabling a unified approach to deep-sea habitat mapping across Europe, and providing the base map for all future spatial management of the European deep-sea marine area.

Change in policy

Deep-sea bottom trawling, where the gear drags along the seabed, is widely accepted to be amongst the most destructive forms of fishing in use today and the subject of extensive scientific concern and international debate over the past 10 years. Since 2004, the General Assembly of the United Nations (UNGA) has repeatedly called on countries to take urgent action to either regulate deep-sea fishing, in particular deep-sea bottom trawling, to protect vulnerable marine ecosystems, or to stop deep-sea fishing on the high seas. United Nations General Assembly resolution 61/105 (2006) requires member states and competent authorities to close areas to bottom fishing where vulnerable marine ecosystems (VMEs) are known or are likely to occur based on the best available scientific information. In addition, member states are required to ensure that fishing activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on VMEs (UNGA61/105).

Howell's modelled maps of VME distribution were a key piece of scientific evidence used by a non-governmental organisation, the Deep-Sea Conservation Coalition, to lobby for changes to EU regulations for the management of deep-sea fisheries. Following Howell's speech [5.1] at an invite-only cross party House of Commons event in January of 2015, ministers adopted a position supporting a ban of bottom trawling below 800 meters, a compromise between those rejecting any limit and the body of scientific evidence, which included Howell's research, supporting a shallower 600 meter limit. A political agreement was finally reached by negotiators from the EU Council and Parliament at the end of June 2016, which was subsequently endorsed by the Council of Ministers, and in December 2016 approved by the vote of the Parliament. In January 2017, a new EU regulation on deep-sea fishing came into force including a ban on bottom trawling below 800 meters in EU waters, and an obligation to close deep-sea areas to bottom fishing to protect vulnerable marine ecosystems [5.2]. The measures adopted in the new deep-sea fishing regulation represent a considerable improvement to the previous regime. The policy change has protected approximately 143,000 km2 of fishable seabed (800-1500m), as well as approximately 70 seamounts fished by EU vessels in international waters.

Implementation of policies

Following the 1992 International Convention on Biological Diversity (CBD), national and international legislation has been put in place to improve sustainable management of the marine environment. Howell's applied research has directly informed and shaped implementation of global, regional and national policies such as the Oslo-Paris Convention (OSPAR), the European Habitats and Species Directive, the European Marine Strategy Framework Directive, as well as the UK Marine Act. These overarching policies have been implemented in the following specific ways:

Howell's mapping research underpinned the designation of 12 deep-sea Marine Protected Areas (MPAs) by the UK and Scottish Governments and devolved administrations in the period spanning 2013-2019. In September 2020, it underpinned the designation of the West of Scotland MPA, the largest MPA in Europe [5.3]. Collectively, these MPAs total 171,268 km^2, 19% of the total UK marine protected area network, and 7% of the UK's marine area.

Howell's research was used by the International Council for the Exploration of the Sea (ICES) to provide advice to the North East Atlantic Fisheries Commission (NEAFC) recommending an area closure to bottom-trawl fisheries in the Hatton-Rockall Basin. This recommendation was adopted in 2014, thus Howell's research has directly resulted in the establishment of a fisheries closure in the Hatton-Rockall Basin, NE Atlantic, by the NEAFC

[5.4 & 5.5]. This closure protects vulnerable marine ecosystems from the impacts of bottom trawling activities.
Howell's research established a biologically meaningful habitat classification system for the NE Atlantic deep sea, which subsequently has been adopted by the UK Government and the EU in their development of both a revised single UK marine habitat map and a unified European marine habitat map [5.6]. These maps have supported the development of EU policies protecting the marine environment, informed states' achievements against policy obligations, fed into governmental assessments, and been utilised in marine spatial planning over the period August 2013-2017 [5.7].
Howell's maps informed the case for support proposing two areas of the North Atlantic as 'Ecologically and Biologically Significant Areas (EBSA)' under the international Convention on Biological Diversity. Through identifying these areas as EBSAs, the UN recognises their ecological importance, and these areas are now being considered for protection. Delays to the Conference of Parties as a result of COVID-19 mean that no decision has yet been taken on this issue [5.8].
Howell's mapping approaches have been used in the assessment of representative MPA networks on the High Seas as part of the development of regional environmental management plans with respect to deep-sea mining activities. Howell's research featured in an International Seabed Authority (ISA) workshop in 2019, where it directly highlighted deficiencies in the current MPA network [5.9]. The ISA are now considering whether additional areas of particular environmental interest might be required in the Clarion-Clipperton Zone region of the Pacific. COVID-19 has led to delays in further consideration of these findings by the ISA.

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1 Speech to Houses of parliament
http://www.savethehighseas.org/2015/01/30/dr-kerry-howell-speaks-house-parliament-deep-sea-event/
5.2 *Regulation EU 2016 2336 of the EU parliament*
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R2336&rid=4
5.3 *JNCC Offshore Marine Protected Areas (MPAs) site designation documents. Sites in question are: Anton Dohrn Seamount, Darwin Mounds, East Rockall Bank, Faroe-Shetland Sponge Belt, Hatton Bank, Hatton-Rockall Basin, North East Faroe Shetland Channel, North West Rockall Bank, Rosemary Bank Seamount, Barra Fan and Hebrides Terrace Seamount, The Canyons, Wyville-Thomson Ridge, West of Scotland MPAs.* https://jncc.gov.uk/our-work/offshore-mpas/
5.4 NEAFC Vulnerable deep water habitats
https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2013/Special%20requests/NEAFC_Vulnerable_deep-water_habitats.pdf (See page 6)
5.5 NEAFC Recommendation on the protection of vulnerable marine ecosystems
https://www.neafc.org/system/files/Rec9_amend-VME-protection.pdf
5.6 JNCC Marine habitat UK Sea map
http://jncc.gov.uk/euseamap
5.7 Seabed Habitats use cases
https://www.emodnet-seabedhabitats.eu/resources/use-cases/
5.8 COBD Report on description of ecologically or biolocally significant marine areas in the north east Atlantic Ocean
https://www.cbd.int/doc/c/7d96/2418/5a119cb332dbc741312d97b6/ebsa-ws-2019-01-04-en.pdf
5.9 Deep CCZ Biodiversity Synthesis Workshop Report
https://www.isa.org.jm/files/files/documents/Deep%20CCZ%20Biodiversity%20Synthesis%20Workshop%20Report%20-%20Final-for%20posting-clean-1.pdf (See ITEM 7 and 9)