Institution: Plymouth University

Unit of Assessment: Earth Systems and Environmental Sciences B7

Title of case study: Informing sustainable management of the deep-sea

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

This case study highlights the research at Plymouth University evidencing the problems of deep sea fishing in European waters. Working with policy makers, NEAFC, GOs, NGOs, and industry the researchers have contributed to solutions to deep-sea management problems across Europe. They have developed new techniques for habitat mapping which, coupled with human use data, has helped establish large offshore Marine Protected Areas (MPAs) that have minimized the effects of displacement on the industry while providing key refuges for ecosystem recovery and conservation.

2. Underpinning research (indicative maximum 500 words)

Plymouth University is one of the leading institutions in the field of conservation and sustainable management of deep-sea ecosystems. As coastal fisheries around the world have collapsed, industrial fishing has spread deeper in pursuit of the last economically attractive concentrations of fishable biomass. Hall-Spencer (Professor of Marine Biology, based in Plymouth from 05-present) and Howell (Lecturer in Marine Ecology, based in Plymouth from 05-present) has evidenced the problem of deep sea fishing in European waters through peer-reviewed publications and supporting reports. Hall-Spencer et al. (2002) was the first to report widespread ecological damage to deep-water (>200m) coral reefs in the NE Atlantic, including in UK waters. This work was followed up with numerous peer reviewed papers by Howell and Hall-Spencer that catalogue an increasing problem of long-term habitat damage and deep sea biodiversity loss due to damaging deep sea fishing activities. Davies et al. (2007) provide a robust review of anthropogenic pressure on the deep-sea ecosystem and identified future concerns.

Having evidenced human induced degradation of the deep sea ecosystem, Howell and Hall-Spencer have worked proactively with FAO, UNESCO and other NGOs and GOs to provide scientifically robust data on which to base policy decisions, particularly in relation to the challenges identified by the International Convention on Biological Diversity to conserve 10% of the World's eco-regions within MPAs by 2020. Hall-Spencer et al. (2009) describe how scientific evidence was used to engage with industry and Governments to establish large MPAs both in UK waters and on the High Seas to prevent long-term destruction of ancient habitats that are refuges for rare species and reservoirs of healthy deep-sea ecosystems. Information on seabed habitats is essential both for the development of new economic activities and for assessing the impact of these activities on the marine environment. Decisions regarding location of MPAs rely on an understanding of the extent and distribution of marine habitats, and increasingly marine habitat mapping is recognised as critical to this process. Howell et al. (2010), which was first published in the form of a series of Government reports (Narayanaswamy et al., 2006; Howell et al., 2007; Davies et al., 2007; Howell et al., 2009), used a combination of acoustic multibeam survey coupled with video transect survey to describe and map the distribution of the benthic communities of the banks, seamounts and canyons of the UK deep-sea area. Howell demonstrated there were significant areas of cold water coral reef habitat and coral gardens habitat at all these sites.

Howell (2010) identifies the inadequacy of current deep-sea habitat classification systems, including the pan-European system EUNIS, to represent deep-sea biodiversity in any meaningful sense. The paper proposes a new system based on a review of our current understanding of deep-sea benthic biology (bottom up approach), which would be more appropriate for use in planning marine protected areas. Howell et al., (2011) demonstrates the application of statistical models that predict species presence from environmental characteristics, to habitat mapping using the reef-forming cold water coral *Lophelia pertusa* as a case study. The study is the first to apply species niche modelling techniques to whole assemblages, demonstrating a new approach to habitat mapping. It also demonstrates the relative rarity of *Lophelia pertusa* reef compared to the distribution of the isolated colonies of the species.

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

All research is from peer reviewed papers. Authors in bold at Plymouth University

1. **Hall–Spencer, J**., Allain, V., & Fosså, J. H. (2002). Trawling damage to Northeast Atlantic ancient coral reefs. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 269(1490), 507-511. Royal Society's flagship biological research journal. *JIF: 5.415. Scopus total citations: 88.* Data gathered at sea off Spain and France by Allain, off Britain and Ireland by Hall-Spencer and off Norway by Fossa. Hall-Spencer led the writing and was PI of the Royal Society grant to support this work.
2. Davies A, Roberts JM, **Hall-Spencer JM** (2007) Preserving deep-sea natural heritage: emerging issues in offshore conservation and management. *Biological Conservation* **138**, 299-312. *JIF:4.115. Scopus total citations: 59.* Hall-Spencer was PI of the Esmee Fairbairn grant to support this work and carried out the fisheries displacement analyses, Roberts contributed data on deep-sea impacts and Davies led the writing.
3. **Hall-Spencer JM**, Tasker M, **Soffker M**, Christiansen S, Rogers S, **Campbell M**, Hoydal K (2009) The design of Marine Protected Areas on High Seas and territorial waters of Rockall. *Marine Ecology Progress Series* **397**, 305-308. *JIF: 2.711. Scopus total citations: 11*. This work was undertaken on behalf of the ICES. Hall-Spencer led the study and the writing, his students Soffker and Campbell analysed the data that were provided by Tasker from JNCC, Christiansen from WWF, Rogers from CEFAS and Hoydal from NEAFC.
4. **Howell KL** (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, 1041–1056. *JIF: 4.115. Scopus total citations: 16.*
5. **Howell KL**, **Davies JS**, and Narayanaswamy BE (2010). Identifying deep-sea megafaunal epibenthic assemblages for use in habitat mapping and marine protected area network design. *Journal of the Marine Biological Association of the United Kingdom* **90**, 33-68. *JIF:1, Scopus total citations: 11* The Plymouth University based authors conceived the idea, gathered the raw data, analysed the data and wrote the paper, the contribution of the non-Plymouth University author was minimal. Narayanaswamy aided in the collection of the raw data.
6. **Howell KL**, **Holt R**, **Pulido Endrino I**, and Stewart H (2011) When the species is also a habitat: comparing the predictively modelled distributions of *Lophelia pertusa* and the reef habitat it forms. *Biological Conservation*, **144**, 2656-2665**.** *JIF: 4.115, Scopus total citations: 7.* the Plymouth University based authors conceived of, gathered the raw data, analysed the data and wrote the paper. The non-Plymouth University based author (Stewart) collected the acoustic data on which the biological model was partly based.

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

Following the 1992 International Convention on Biological Diversity, National and International legislation has been put in place to improve sustainable management of the marine environment. Hall-Spencer and Howell conducted applied research that influenced national and international marine policy (Hall-Spencer, 2007) and directly informed and shaped implementation of global, European 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, (Hall-Spencer et al., 2009; Howell, 2010). It has had a huge impact on public policy and services.

Policy decisions or changes to legislation, regulations or guidelines have been informed by research evidence. Howell and Hall-Spencer's research played a pivotal role in supporting ICES advice to NEAFC in recommending area closures to bottom-trawl fisheries on Hatton and Rockall banks. Deep sea coral distribution maps developed from historical data (Hall-Spencer et al., 2007), supplemented with new data produced by Howell (Narayanaswamy et al., 2006; Howell et al., 2007; Howell et al., 2009, 2010) were subsequently integrated with satellite tracking data (Davies et al., 2007; Hall-Spencer et al., 2009), to inform recommendations of suitable areas for closure to bottom-trawl fishing for the protection of vulnerable coral ecosystems. These recommendations

were subsequently adopted by NEAFC. Howell and Hall-Spencer's research has therefore directly resulted in the establishment of fisheries closures on Rockall and Hatton Banks, NE Atlantic, by the North East Atlantic Fisheries Commission (NEAFC). (Sources 2, 3, 4, 7).

The data on both community composition and distribution presented in Howell et al., 2010 (and the grey literature reports that preceded the paper) has been the key information underpinning the designation of 3 deep-sea MPAs (Special Areas for Conservation) by the UK Government, including the largest MPA in Europe Hatton Bank. Through highlighting the presence of listed vulnerable marine ecosystems at these sites Howell's research has directly informed the designation of these areas as SACs by the UK Government. (Source 5).

Research by Hall-Spencer highlighting the damage to cold water coral reefs (Hall-Spencer et al., 2002), implementation of Marine Protected Areas in the deep sea and possible monitoring and enforcement methods (Davies et al 2007; Hall-Spencer et al. 2009) have been used by UK Government to inform policy and to identify gaps in marine research knowledge, develop the monitoring programmes as required under the Marine Strategy Framework Directive, and produce an initial assessment for the Marine Strategy Framework Directive. Hall-Spencer's research has directly informed the assessment of the state of the UK's marine area. (Source 8).

Howell's research on the NE Atlantic continental shelf break region (Howell et al., 2010) and on deep-sea ecology in general informed the case for support proposing Hatton Bank, Rockall Bank and the Hatton-Rockall Basin as an Ecologically and Biologically Significant Area (EBSA). Identification of such areas underpins implementation of Marine Protected Areas under the international Convention on Biological Diversity (CBD), to which the UK Government is a contracting party. Through identifying this area as an EBSA the North East Atlantic Fisheries Commission (NEAFC) and contracting parties to OSPAR are now in the process of considering the area for protection. Both Howell and Hall-Spencer's research directly informed the process of identifying this Ecologically and Biologically Significant Area (EBSA). (Source 10).

The research *has been adopted or an existing technology or process improved*: The importance of seabed habitat mapping has been increasingly recognised in recent years. Both the UK and EU marine habitat maps developed using the methods proposed by Howell (for the deep-sea region), will be used by both UK Government and the European Commission's Directorate-General for Maritime Affairs and Fisheries, to support the implementation requirements of the European Marine Strategy Framework Directive (MSFD), specifically the Initial Assessments which all Member States must undertake in 2012. Howell has developed a biologically meaningful habitat classification system for the NE Atlantic deep-sea which has been adopted by the UK Government and Europe in their development of both a revised single UK marine habitat map and a unified European marine habitat map. (Sources 1, 6).

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

1) Final Report of EUSeaMap summarising the work of the project: Cameron, A. and Askew, N. (eds). 2011. EUSeaMap - Preparatory Action for development and assessment of a European broad-scale seabed habitat map final report. Available at http://jncc.gov.uk/euseamap. The report details the rationale, methodology and results of the project and provides evidence of the international importance of Howell's research in mapping the deep sea areas of Europe.

2) ICES. 2007. Report of the Working Group on Deep-water Ecology (WGDEC) 26-28 February 2007. ICES CM 2007/ACE:01 Ref. LRC. 61 pp. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2007/WGDEC/WGDEC07.pdf. This report evidences the use of Howell and Hall-Spencer's research in developing advice to the North East Atlantic Fisheries Commission and European Commission on marine protected areas in the NE Atlantic deep sea for the protection of cold water corals. The report predates 2008 but the area closures that constitute the impact were implemented in 2008.

3) ICES. 2008. Report of the ICES-NAFO Joint Working Group on Deep Water Ecology (WGDEC), 10–14 March 2008, Copenhagen, Denmark. ICES CM 2008/ACOM:45. 126 pp. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2008/WGDEC/WGDEC_2008.pdf. This evidences the continued use of Howell and Hall-Spencer's research in developing advice to both the NE Atlantic Fisheries Commission and the European Commission

on marine protected areas in the NE Atlantic deep sea for the protection of cold water corals.

4) Official letters of communication between the International Council for the Exploration of the Sea and the North East Atlantic Fisheries Commission where recommendations for area closures (MPAs) are made. An annual series from 2007 to 2013 are at www.ices.dk

5) Joint Nature Conservation Committee (UK Government)JNCC, 2009. Offshore Special Area of Conservation (SAC) Selection Assessments. All available http://jncc.defra.gov.uk/page-4534. (For convenience, direct links to each of three offshore sites are:http://jncc.defra.gov.uk/pdf/HattonBankSelectionAssessment_1.1.pdf, http://jncc.defra.gov.uk/pdf/NWRockallBank_SACSAD_5_0.pdf, andhttp://jncc.defra.gov.uk/pdf/WTR_SACSAD_v6_0.pdf) The report provides detailed information about and evaluates their interest features according to the Habitats Directive selection criteria and guiding principles. They provide the information required under Regulation 7 of the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007, to enable the Secretary of State to transmit to the European Commission the list of sites eligible for designation as Special Areas of Conservation (SACs). Howell's research is heavily cited as the evidence base in these three sites in their first published format of grey literature reports, which were later published in the peer reviewed literature as Howell et al., 2010.

6) McBreen, F., Askew, N., Cameron, A., Connor, D., Ellwood, H. & Carter, A. (2011). UKSeaMap 2010: Predictive mapping of seabed habitats in UK waters. Joint Nature Conservation Committee Report, No. 446. http://jncc.defra.gov.uk/PDF/jncc446_web.pdf. This is the final report of the UKSeaMap 2010 project, established to produce an ecologically relevant, full-coverage map of seabed habitats across the entire UK marine area. It details the project rationale, methodology and results, evidencing the importance of Howell's research in mapping the deep sea areas of the UK.

7) NEAFC. Recommendations 2008-2012. These two documents show that NEAFC adhered to the advice provided by ICES, which was based upon Howell and Hall-Spencer's research (see sources 2, 3, and 4), and closed areas of both Hatton and Rockall Banks to bottom trawling, creating Marine Protected Areas. This was the ultimate impact and occurred since 2008.
http://archive.neafc.org/measures/current_measures/docs/09-rec_corals.pdf
http://neafc.org/system/files/rec-viiil++-+Hatton+extension+corrected+rev4.pdf

8) UK Marine Monitoring and Assessment Strategy (2010). Charting Progress 2 Healthy and Biological Diverse Seas Feeder report. (Eds. Frost, M. & Hawkridge, J). Published by Department for Environment Food and Rural Affairs on behalf of UKMMAS. 278pp. http://chartingprogress.defra.gov.uk/feeder/HBDSEG-FeederReport-sec3_1.pdf. This is an independent report commissioned by Defra and presenting an updated and improved assessment of the status of the UK marine environment. The report is based on a robust, peer-reviewed evidence base and describes progress made since the first Charting Progress report, published in 2005. It is a source of the key findings from UK marine research and monitoring and is used in policy-making to help protect our oceans and seas. Hall-Spencer's research is cited by this report.

9) Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic. Hyères, France: 8 – 9 September 2011 *http://www.cbd.int/doc/meetings/sbstta/sbstta-16/information/sbstta-16-inf-05-en.pdf*. Both Howell and Hall-Spencer's research contribute to this report outlining the evidence base for the designation of the Hatton-Rockall Plateau as an Ecologically or Biologically Significant Marine Area (EBSA) as defined under the International Convention of Biological Diversity.

10) Letter from the Deep Sea Conservation Coalition. The coalition is made up of over seventy non-governmental organizations (NGOs), fishery organizations and law and policy institutes, worldwide, all committed to protecting the deep sea. http://www.savethehighseas.org/.