Institution: Queen's University Belfast

Unit of Assessment: 7

Title of case study: Conservation of maerl (calcareous red seaweed) in Europe

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

The application of legislation and policy protecting European maerl habitats under the EC Habitats Directive has been strengthened by research at QUB showing that maerl, coral-like seaweed, is slow-growing, intolerant of disturbance and burial, and supports high biodiversity. A new marine *Natura 2000* Special Area of Conservation (SAC) in Northern Ireland was designated for maerl in 2010. Maerl beds in the Fal and Helford SAC, the largest in England, were protected in 2009 from channel dredging until a Scientific Panel including a QUB academic has considered the results of a maerl-relocation trial in 2013.

2. Underpinning research (indicative maximum 500 words)

Context: Maerl beds, formed by unattached coralline red algae, are marine habitats with high conservation importance due to their high biodiversity. They are threatened globally by commercial extraction as a calcareous resource for agricultural and industrial applications. The EC Habitats Directive, which forms the cornerstone of Europe's nature conservation policy, gives legislative protection to maerl. The maerl-forming species *Phymatolithon calcareum* and *Lithothamnion corallioides* are the only seaweeds included in Annex V, as "species of Community interest whose taking in the wild and exploitation may be subject to management measures". Maerl habitats are protected in the *Natura 2000* network of Special Areas of Conservation (SACs) within the Annex I category "Sand banks which are slightly covered by sea water all the time".
QUB research: From 1983 onwards, when Christine Maggs (initially postdoctoral fellow; lecturer from 1995) joined phycologist Matthew Dring, QUB researched the ecology and conservation of maerl. In 1998, new analyses of their data on the biodiversity of maerl beds in Britain and Ireland were reported in a comprehensive synthesis for the UK Marine SACs LIFE project.[1] This showed that the biodiversity of seaweeds on maerl beds equalled that of shallow Mediterranean algal communities, the highest previously recorded in Europe.[1] Their analysis highlighted two of the most serious knowledge gaps concerning management of maerl: growth rates and longevity[1]. In 2001- 2004, Maggs and PhD student Charmaine Blake used a novel vital staining technique to demonstrate slow growth rates (0.5-1.5 mm per annum) of *P. calcareum* and *L. corallioides* in the field and laboratory.[2] The results confirmed previous speculation that commercial harvesting cannot be sustainable and that maerl habitats are very vulnerable to physical disturbance.[2]

Maggs, algal physiologist John Berges (who moved to the University of Wisconsin Milwaukee in 2006) and students Blake and Sian Wilson found with PAM fluorometry that maerl species are highly sensitive to disturbance by burial, particularly by anoxic sediments.[3] Radiocarbon-dating of dead maerl beds in Northern Ireland by Blake, in collaboration with Paula Reimer (who leads QUB's ^{14}Chrono Centre), showed that catastrophic maerl bed extirpation had occurred in Strangford Lough during a period of rapid sedimentation associated with climatic change 4200 years ago.[4] In Belfast Lough a maerl bed had died contemporaneously with extensive 19th century channel dredging that re-mobilised toxic sediment. Combined with our experimental evidence that sedimentation kills maerl, we concluded that channel dredging probably caused the

death of the Belfast Lough maerl bed[4]. These results accorded with field observations in Scotland by Jason Hall-Spencer on damage to maerl by sediment from scallop dredging and aquaculture.

Maggs, marine ecologist Mark Johnson (who moved to NUI Galway in 2009) and their research group found that in Northern Ireland there was a suite of rare seaweeds confined to maerl habitats[5]. Experimental stabilization of maerl showed that biodiversity of maerl beds is particularly dependent on the nature and extent of adjacent habitats, requiring conservation measures to take the spatial context of beds into account[6].

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

1) Birkett, D.A., Maggs, C.A. & Dring, M.J. (1998). An overview of dynamics and sensitivity characteristics for conservation management for marine SACs. Vol 5. Maerl. Scottish Association for Marine Science (UK Marine SACs Project). 116 pp. [http://www.ukmarinesac.org.uk/pdfs/maerl.pdf]
2) *Blake, C. & Maggs, C.A. (2003). Comparative growth rates and internal banding periodicity of maerl species (Corallinales, Rhodophyta) from northern Europe. *Phycologia*, 42: 606-612.
3) *Wilson, S., Blake, C., Berges, J.A. & Maggs, C.A. (2004). Environmental tolerances of free-living coralline algae (maerl): implications for European marine conservation. *Biological Conservation*, 120: 283-293.
4) Blake, C., Maggs, C.A. & Reimer, P. (2007). Use of radiocarbon dating to interpret past environments of maerl beds. *Ciencias Marinas* 33: 385–397.
5) Wilson, S., Johnson, M.P., Kelly, J., Clarkin, P.E. & Maggs, C.A. (2007). Assessment of extent and abundance of maerl beds and their associated biodiversity along the East Antrim coast. *NIEA Research & Development Series* (ISSN 1751-7796 Online).
6) *Hinojosa, G., Johnson, M.P. & Maggs, C.A. (2009). Like a rolling stone: the mobility of maerl (Corallinaceae) and the neutrality of the associated assemblages. *Ecology*, 90: 517-528.

*References that best indicate the quality of the underpinning research

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

Our impact on legislation, designations, policy and practice: QUB research on maerl beds and their biodiversity (Sections 2, 3) has had impact since 2008, in the context of member states' obligations to protect maerl under the 1992 Habitats Directive. QUB research has benefitted the environment through traceable inclusion in current government policy papers, legislation and planning decisions designed to reduce or mitigate anthropogenic impacts on maerl in Northern Ireland, Great Britain and Europe.

Northern Ireland: QUB research contributed to setting specific targets and actions of the Northern Ireland Environment Agency (NIEA)'s Habitat Action Plan (HAP) for maerl beds, published in 2003 and still in effect.[S1] The HAP was designed to deliver Northern Ireland's contribution to the UK Biodiversity Action Plan (UKBAP) for maerl. It cites our published research[1] and describes (Sections 1.1, 3.2) ongoing QUB projects, some commissioned by the NIEA, that were later published[2,3] and contributed to achieving the HAP targets. Maerl beds and *Phymatolithon calcareum* are respectively a Northern Ireland Priority Habitat and Species.

In 2010 our research on the extent and biodiversity of a maerl bed off the Antrim coast near Red

Bay[5] (commissioned through *Quercus*, our biodiversity partnership with the NIEA) was used to designate a new marine SAC for this Annex 1 habitat: "The Red Bay sandbanks are dominated by both living maerl and sub-fossil maerl and have been thoroughly mapped and characterised as part of this SAC selection assessment".[S2] This new SAC with its ancient maerl beds was welcomed by local media as "Northern Ireland's answer to the great tropical reefs" and NIEA spokesman Joe Breen cited our research: "It's the only known site in Northern Ireland for the orange northern starfish … Some of the surface sub-fossil [maerl has been] carbon-dated to 650 years".[S3]

Great Britain**:** The Habitats Directive was implemented in Great Britain as The Conservation (Natural Habitats, &c.) Regulations 1994 (now The Conservation of Habitats and Species Regulations 2010). The Joint Nature Conservation Committee (JNCC) designated *Phymatolithon calcareum* as a UKBAP Priority Species in 2007 (updated 2010)[S4] using criteria including the slow growth rate.[2] From July 2012, under the *UK Post-2010 Biodiversity Framework*, UKBAP work is carried out at country level and has moved to BARS (Biodiversity Action Reporting System).[S5] The current Vision Statement for the National Action Plan for maerl beds notes "Our knowledge of the maerl resource is continuing to grow although it remains incomplete.… recent completion of postgraduate projects at University Marine Biological Station Millport and Queen's University Belfast (and subsequent publications in the scientific literature) has significantly improved understanding of maerl ecology and sensitivity to impacts…"[S5]

The Fal and Helford SAC includes the largest maerl bed in England; the SAC Management Scheme[S6] cites our research.[1] In 2009 Falmouth Harbour Commissioners applied to the Marine Management Organisation (MMO), as the 'competent authority' under the Regulations, to licence work involving dredging a channel through the maerl beds. The Environmental Statement by Royal Haskoning cites our research.[1]

An independent maerl recovery report by Jason Hall-Spencer cited our paper on extinction of maerl beds[4] and considered that there would be potential loss of maerl habitat.[S6] Natural England advised the MMO that the proposal was likely to have a significant effect on the designated features of this protected European site. Therefore, under the Regulations, an appropriate assessment was required to assess the impact of the proposed development on the conservation objectives of the site. The MMO's assessment was that "it cannot be concluded that there would be no adverse effect on the integrity of the Fal and Helford SAC" and the application to dredge was rejected.[S8] The MMO required further research into mitigation measures, and in 2011 recruited Maggs (QUB) to an Independent Science Advisory Panel (ISAP) of "five independent scientists who have significant and recognised expertise in maerl ecology, experimental design and the wider impacts on benthic ecology from dredging operations".[S9] In 2012 the MMO approved a licence for a maerl-relocation trial to take place, overseen by the ISAP, to determine whether this novel approach can safeguard Falmouth's maerl.

Europe: In 2008, Maggs and Jason Hall-Spencer (University of Plymouth) were commissioned to prepare an assessment of maerl for OSPAR on behalf of the Department of the Environment, Heritage (now Community) & Local Government, Ireland [S10]. The 1998 OSPAR Convention, the instrument guiding international cooperation on the protection of the North-East Atlantic marine environment, lists maerl beds (Agreement 2008-6) as threatened and/or declining. Our assessment, with recommendations for actions and measures that could be taken to improve the conservation status of maerl, delivers one of Ireland's commitments under OSPAR.

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

S1) Northern Ireland Habitat Action Plan: http://www.doeni.gov.uk/niea/biodiversity/habitats-2/northern_ireland_habitat_action_plans.htm
[gives link to] Maerl Beds Final Draft – April 2003 [currently in force – July 2013]
http://www.doeni.gov.uk/niea/maerl_beds_web_version_april_03-3.pdf

S2) Red Bay marine SAC
http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030365

S3) Belfast Telegraph 3 March 2010 Protected: the ancient coral-like seaweed off Northern Ireland's coast
http://www.belfasttelegraph.co.uk/news/local-national/protected-the-ancient-corallike-seaweed-off-northern-irelands-coast-14705369.html#ixzz1kMZVqpKN

S4) *Phymatolithon calcareum* UK Biodiversity Action Plan Priority Species
http://jncc.defra.gov.uk/_speciespages/2508.pdf

S5) Biodiversity Action Reporting System archived maerl Biodiversity Action Plan status
http://webarchive.nationalarchives.gov.uk/20110303145213/http://www.ukbap-reporting.org.uk/plans/national_plan.asp?HAP=%7BF8A12650%2D4C02%2D4FA8%2DB549%2D160D29156658%7D&SAP=

S6) Fal and Helford SAC management scheme
http://publications.naturalengland.org.uk/file/3118614

S7) Hall-Spencer, J. (2009) Port of Falmouth Development Initiative: maerl 'recovery' report.
http://www.marinemanagement.org.uk/licensing/public_register/cases/falmouth.htm

S8) http://marinemanagement.org.uk/licensing/public_register/cases/documents/falmouth/evidence_summary.pdf

S9) http://www.marinemanagement.org.uk/
licensing/public_register/cases/documents/falmouth/friends_factsheet.pdf

S10) Hall-Spencer, J.M., Kelly, J. & Maggs, C.A. (2010) Background document for maërl beds. OSPAR Commission, 491/2010, 36pp. ISBN 978-1-907390-32-6.
www.ospar.org/documents%5Cdbase%5Cpublications%5CP00491_maerl.pdf

Individual users/beneficiaries who can be contacted to corroborate claims
Principal Scientific Officer, Marine Conservation and Reporting, Northern Ireland Environment Agency.