Institution: 10007857 Bangor University

Unit of Assessment: 07 Earth Systems and Environmental Sciences

Title of case study:
Quantification of ecosystem effects of fishing underpins the policy and practice of government, industry and retailers in relation to sustainable fisheries

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

Bangor Research since 1998 has pioneered, through experimental, comparative and modelling studies and industry collaborations, quantification of the wider ecosystem effects of fishing, specifically on seabed habitats. Novel findings gave policy and economic benefits to the fishing industry and led to the sustainable, continued profitable development of the UK's largest blue mussel fishery and Isle of Man scallop fishery, with a combined value of £22M. It directly led to Marine Stewardship Council (MSC) certification of these fisheries and underpinned certification of dozens of other demersal fisheries. Additionally, the research has influenced UK retailer policies on sustainable fish sourcing, providing direct environmental and commercial benefits and improving public knowledge and sustainable consumption.

2. Underpinning research (indicative maximum 500 words)

Context
Through a combination of large-scale experimental (e.g. Kaiser et al. 1998) and comparative (e.g. Hiddink et al. 2006) approaches, Bangor University research led by Kaiser (at Bangor 1988-1991 and 1998-present), with additional research led by Hiddink (at Bangor 2002-present), has pioneered the quantification and prediction of the direct effects of fishing disturbance on seabed biota and habitats. Prior to this work, virtually no evidence was available for fisheries managers, policy makers and conservationists to utilise in assessing fishing impacts on marine benthic habitats, potential recovery rates, or to prioritise sustainable management and conservation issues. This research has innovated in three main areas:

Main innovations of the research
a) A **global meta-analysis** of published empirical studies (Collie et al. 2000 – revised in Kaiser et al. 2006) quantified the mortality rate of benthic biota associated with trawling by different fishing gears in different habitats. These remain the only quantitative meta-analyses of fishing impacts on benthos, and this work provided the essential tool for assessing habitat sensitivity and vulnerability to fishing disturbance to inform science-based fisheries management plans.

b) This synthesis also provided the underpinning mortality and recovery rates for size-based ecological modelling approaches to **predict trawling impacts on benthic communities**, developed in collaboration with the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) Lowestoft and Jennings (University of East Anglia) and extended by Hiddink in collaboration with Jennings (e.g. Hiddink et al. 2006). We then applied this ecological modelling approach to evaluate how different management approaches could **mitigate the wider ecosystem effects of fishing** on the seabed through area closures or other measures.

c) The Menai Strait is home to the UK's largest blue mussel fishery that utilises bottom fishing dredges to collect seed mussels from the wild, and to harvest the crop from cultivated sub-tidal plots after a period of relaying on the seabed. Our research extended into collaborations with Government Agencies (Countryside Council for Wales and Natural England) and shell-fishing industries to deliver specific advice and management tools. Early research (since 1999, NERC-LINK funded) focused on **improving yield and minimising environmental impacts of the Menai Strait fishery**. This demonstrated how the implementation of a novel mussel seed stocking strategy in the high intertidal areas stimulates thick shell growth, thereby reducing losses by predation and improving yield (Beadman et al., 2003). We further demonstrated that changes in benthic invertebrate communities were restricted to the footprint of the cultivated plots and that

mussel cultivation had no negative effects on other species but enhanced populations of oyster catchers (Beadman et al., 2004). Subsequent research (BBSRC-funded) focused on the wider ecosystem effects of shellfish cultivation in a restricted body of water, demonstrating the low environmental impact of mussel fishing in the Menai Strait and the resilience of species and communities on mussel beds. Follow-up research to determine optimal mussel stocking densities was funded by Defra and the Seafish authority). Similarly, specific research in other important shell fishing areas (Isle of Man, Cardigan Bay) has resulted in extensive research-based advice to the Isle of Man scallop fishery (IoM Government funded) since 2006 and to the management of the Cardigan Bay Special Area of Conservation (SAC) with regard to its scallop fishery (e.g. Lambert et al. 2011).

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

Bangor authors are shown in **bold**. Citations are from Google Scholar (October 2013).

Benthic fishing impact assessment

Kaiser M.J., Edwards D.B., Armstrong P.J., Radford K., Lough N.E.L., Flatt R.P. & Jones H.D. 1998. Changes in megafaunal benthic communities in different habitats after trawling disturbance. *ICES Journal of Marine Science* **55:** 353-361. In peer-reviewed journal, 119 citations. DOI: 10.1006/jmsc.1997.0322

Collie J.S., Hall S.J., **Kaiser M.J.** & Poiner I.R. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. *Journal of Animal Ecology* **69:** 785-798. In peer-reviewed journal, 415 citations and one of the top-10 most cited papers in the field. DOI: 10.1046/j.1365-2656.2000.00434.x

Kaiser M.J., Clarke K.R., **Hinz H.**, Austen M.C.V., Somerfield P.J. & Karakassis I. 2006. Global analysis of response and recovery of benthic biota to fishing. *Marine Ecology Progress Series* **311:** 1-14. In peer-reviewed journal, 222 citations, submitted to RAE 2008. Available at: http://www.int-res.com/abstracts/meps/v311/feature/

Modelling fishing impact on different habitats

Hiddink J.G., Jennings S., **Kaiser M.J.**, **Queirós A.M**., Duplisea D.E. & Piet G.J. 2006. Cumulative impacts of seabed trawl disturbance on benthic biomass, production and species richness in different habitats. *Canadian Journal of Fisheries and Aquatic Sciences* **63:** 721-736. In peer-reviewed journal, 119 citations, submitted to RAE 2008. DOI: 10.1139/F05-266

Mussel and scallop industry applied research

Beadman H.A., Caldow R.W.G., **Kaiser M.J.** & Willows R.I. 2003. How to toughen up your mussels: using mussel shell morphological plasticity to reduce predation losses. *Marine Biology* **142:** 487-494. In peer-reviewed journal, 26 citations. DOI: 10.1007/s00227-002-0977-4

Beadman H.A., **Kaiser M.J.**, **Galanidi M.**, **Shucksmith R**. & Willows R. 2004. Changes in species richness with stocking density of marine bivalves. *Journal of Applied Ecology* **41:** 464-475. In peer-reviewed journal, 47 citations. DOI: 10.1111/j.0021-8901.2004.00906.x

Lambert G.I., Jennings S., **Kaiser M.J.**, **Hinz H.** & **Hiddink J.G.** 2011. Quantification and prediction of the impact of fishing on epifaunal communities. *Marine Ecology Progress Series* **430:** 71-86. In peer-reviewed journal, 11 citations. DOI: 10.3354/meps09112

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

This pioneering research has **informed NGOs, industry and managers** about the ecosystem effects of fishing, different fishing gear-habitat interactions and the consequences of displacing fishing activity on seabed biota as a result of area closures (marine protected areas, MPA). The research **improved fisheries management in two main areas**:

1) Impacts on fisheries industries and Special Area of Conservation management

The research has been crucial to the **development of sustainable management of the UK's largest mussel fishery** (since 1999) and Isle of Man (IoM) (since 2006) and Cardigan Bay (since 2009) **scallop fisheries, and is ongoing**. The research has significant **economic impacts** on these fisheries and improved relationships between fishermen, conservation bodies and local governments, as illustrated below.

Through implementation of management strategies, the research has an ongoing and **direct positive impact on yield** for the Menai Strait mussel industry. Through reduced losses to crab predation and costs of excessive stocking, it has increased harvested mussel:seed ratios by 50%, without harmful impacts on the environment[1]. Importantly, the research demonstrated the lack of harmful environmental effects of the fishery and allayed the concerns of government regulators (Countryside Council for Wales and North Western North Wales Sea Fisheries Committee) regarding impacts of the fishery on birds. The research and reports delivered by Kaiser et al. **continue to provide the science-base for new management decisions, area closures and fishery practices**.

Statutory nature conservation bodies, e.g. Countryside Council for Wales (CCW)[9], Natural England (NE)[2], have used Bangor research on mussels and scallops to **inform policy with respect to fishing in Special Areas of Conservation (SACs)** and other marine protected areas. Our quantification of the effects of mussel cultivation on diversity of associated benthic communities demonstrated that these impacts were entirely restricted to within the cultivated areas. This finding **has been applied to many management decisions** for the Menai East and West Fisheries, including the 2009 lease renewals and ongoing applications for new and renewed Fishing Orders to Government[10]. Similarly, our Defra-funded research (Kaiser et al. 2006, Hinz et al. 2011) benefited the relationship between SAC managers (CCW, NE) and Welsh Government and provided them with empirical scientific evidence that the mussel seed and scallop fishing practices were compatible with the Menai Strait (2010), Morecambe Bay (2008) and Cardigan Bay (2009/2010) SACs and therefore could continue without further intervention[2].

Bangor research was **fundamental in the reorganisation of the Isle of Man scallop fishery** since 2006; leading to the first catch quota for scallops in Europe (2010), and implementation of five new closed areas to underpin sustainable fisheries. It provided the science evidence for a by-law introduced in August 2010, critical in protecting the fishery, and for improved management[3]. As a result **landings have increased by around 30% and scallop abundance has more than doubled**. These led directly to recent improvements to the processing sector, by justifying the long-term £5-M redevelopment of the Isle of Man food park (2012-2014), resulting in 30% more jobs in the processing sector within the REF period (an additional 100 jobs are expected by 2014). The current value of the fishery is in excess of £2.5M and of the entire sector an estimated £12M[3]. In 2011, the fishery won the prestigious Billingsgate Sustainable Fisheries award, in recognition of the innovative ways in which it implemented research findings towards sustainability.

In 2010 implementation of the Bangor research evidence led directly to **MSC accreditation of sustainability of the Menai Strait mussel fishery**, becoming the first enhanced fishery in the world to be certified[1,6]. The MSC ecolabel provided the industry with access to better quality markets and ensured the future of its 20 employees. Accreditation of the IoM scallop trawl fishery followed in 2011[3,6]. **Close linkage of Bangor research with both fisheries is on-going, continuously improving knowledge on fishing impacts and advising on best sustainable practices**[1,3]. In addition, the research has benefitted the majority of benthic fisheries that have passed the MSC assessment process, by providing evidence of their environmental footprint, as indicated by referencing in the certification reports of a further 28 MSC-certified fisheries[4,6].

2) Impact on industry sustainable food sourcing and public knowledge

Global companies cite our research as evidence to inform the public about their choices of food origin. For example: our research is central to the public documentation of Young's Seafood, the UK's leading frozen fish brand with over £200M sales per year[7], and it contributes to the scientific

reference base of 11 fisheries represented on FishSource, the global online fisheries database of the Sustainable Fisheries Partnership that is used by major seafood buyers to inform on the sustainability of fisheries, and other publically-available databases **informing market supply chains, consumers and retailers on sustainable fish sourcing** [e.g. 8]. Through this research, Kaiser has become established as a world-leading authority in the field as reflected by his board membership (since 2006) of the Seafish Industry Authority and board membership (since 2012) of the Joint Nature Conservation Committee, and his frequent representation in the media as an authority on sustainable fishing.

In 2008, Kaiser and the team supplied the **essential expertise that allowed the Cooperative supermarket to introduce a risk assessment framework for wild caught fish and introduce a sustainable fish sourcing policy**. In addition to Kaiser's crucial role in the development of the policy, the Bangor Research Vessel Prince Madog was used to 'launch' the brand and help publicise the cooperative approach. The ship, with Bangor scientists and journalists on board, was taken to London and up the Thames, which exposed the journalists and public to the science behind sustainable fisheries and led directly to greater dissemination and public awareness of the Cooperative's approach to sustainable fish sourcing. The policy is still used today and **has formed the cornerstone of the Cooperative's pioneering responsible fish sourcing policy, and their claims that all own brand fish is responsibly sourced**. Since its introduction, the Cooperative has twice topped the MCS Supermarket Sustainable Fish ratings exercise, and was also named as one of only five worldwide recipients of a prestigious Seafood Champion Award for 2010; in recognition of their outstanding leadership in promoting environmentally responsible seafood, and directly resulting from input from Kaiser's research[5].

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

Formal statements from corroborating individuals:

1. Director, Bangor Mussel Producers Ltd.
2. Fisheries Lead Adviser, Natural England
3. Minister for the Environment, Food and Agriculture, ThieSlieauWhallian, Isle of Man
4. Senior Country Manager, Marine Stewardship Council
5. Food Policy Development Manager, Commercial Team, Co-operative Food

Documents available in the public domain:

6. MSC accreditation document. Available at: http://www.msc.org/track-a-fishery/fisheries-search/north-menai-strait-mussel/@@assessments and http://www.msc.org/track-a-fishery/fisheries-search/isle-of-man-queen-scallop-trawl. A list of all MSC-certified fisheries referencing the work by Kaiser et al. is available on request.
7. Young's Bottom (Benthic) trawling public information sheet. Available at: http://www.fishforlife.co.uk/web/policy-bottomtrawling.asp or a copy can be made available on request.
8. Weeber (2009) Best Fish Guide 2009-2010, and 2011-2012: How it works (Assessment Methodology). Royal Forest and Bird Protection Society of New Zealand Inc., Wellington. Available at: http://www.forestandbird.org.nz or a copy can be made available on request
9. Countryside Council for Wales letter to WAG. Available at: http://www.ccgc.gov.uk/about-ccw/newsroom/press-releases/idoc.ashx?docid=1626b5ec-bbed-4807-b008-6073e0f22a54&version=-1 or a copy can be made available on request.

Internal documents:

10. King, J.W. (2013). Assessment of an application for a Several Order for Menai Strait (West) mussel and oyster fishery, Gwynedd and Ynys Môn, North Wales, on behalf of the Welsh Government. A copy is available on request.