Institution: Heriot-Watt University (HWU)

Unit of Assessment: UoA7 Earth Systems and Environmental Sciences

Title of case study: Science in support of sustainable fishery management

Period when the underpinning research was undertaken: Jan 2009 – Dec 2020

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:
Michael Bell	Research Fellow	Dec 2008 – present
Michel Kaiser	Professor	Feb 2019 – present
Joanne Porter	Associate Professor	Jul 2009 – present
William Sanderson	Associate Professor	Sep 2010 – present
Sandy Kerr	Associate Professor	Oct 1993 – present
Kate Johnson	Assistant Professor	Mar 2010 – present
Teresa Fernandes	Professor	Feb 2011 – present

Period when the claimed impact occurred: Aug 2013 – Dec 2020

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

1. Summary of the impact

Sustainable fishery management depends on high quality scientific evidence. HWU support has provided critical leadership and acquisition of underpinning information on fishery/stock trends. Biological studies filled key knowledge gaps to understand responses to fishing pressure and sustainable exploitation limits. Fishing gear studies supported sustainable practice. A Fishery Improvement Project and knowledge/skills transfer to industry (more broadly) has demonstrated sustainable practice and thereby providing benefit from market access to major retailers. Impacts are regional (Orkney), as well as national and international through export of science and good practice. Beneficiaries include fishers, local communities, fisher representative bodies, local/national government agencies, a charity and wider international stakeholder groups.

2. Underpinning research

The main impact of this research is through provision of scientific support for the Orkney fishing industry, principally through Orkney Sustainable Fisheries Ltd (OSF) and Orkney Fisheries Association (OFA). OSF is an industry led initiative aimed at implementing and demonstrating sustainable fishing practice for inshore shellfisheries, now designated by the Scottish Government as the Regional Inshore Fishery Group (RIFG) for the Orkney Scottish Marine Region. OSF are constituted through an industry board and employ three full-time scientists. HWU have provided scientific support for OSF since 2009, and are contracted to provide 24 days support annually, and undertake an extensive programme of additional collaborative research with OSF and OFA, that has included:

- Research has developed a programme of essential population and catch monitoring of shellfish species (edible crab, lobster and scallops), including the use of log-book schemes, biological sampling at sea, the use of vessel monitoring systems to gain spatial information

on creel fishing, observer trips to record catch composition, discards and bycatch, providing the basis for assessing stock and fishery dynamics (stock assessment) to understand fishery processes and sustainable exploitation thresholds.

- Collaborative research projects funded through Marine Scotland under the Fishing Industry Science Alliance (FISA) programme that included: 1) a study of the spatial dynamics of scallops with OFA which resulted in the development of a new population model based on tagging and depletion fishing, demonstrating for the first time that spatial turnover rates of up to 50% per month exist at small spatial scales, hence the local depletion risk is significantly reduced for the dive fishery targeting small-scale patches [3.1]; 2) a study of discard survival and condition in Orkney brown crab fisheries (2016-17) that demonstrated negligible mortality rates in discards, which indicates that discarding undersized crabs is an effective conservation measure [3.2]; 3) diver surveys of the occurrence of juvenile scallops (2015-2017) demonstrated that this was an effective method for fishers to be able to identify the importance and presence of important nursery habitats [3.3].
- Other outputs include assessment of size at maturity in brown crabs, providing first estimates for Orkney, essential for determining sustainability of fishing with respect to spawning output [3.4], and an understanding of geographic differences in moult increment for lobsters, thereby providing insight into the impacts of increasing or decreasing technical measures such as minimum landing size [3.5].
- Modelling of harvest control rules for Orkney brown crab, using insights on growth, maturity and natural mortality to examine risk of over-exploitation in relation to potential sustainability criteria [3.6].
- Additional science has examined the feasibility of scallop ranching as an alternative to current wild capture techniques, a characterisation of juvenile brown crab habitat, overlap of anglerfish fisheries with endangered, threatened and protected species (on behalf of the Marine Stewardship Council) and an investigation of velvet crab pathology in relation to salmon aquaculture (for Scottish Fishermen's Trust).
- ICIT research has influenced international and national policy, as well as the implementation of marine spatial planning (MSP) at regional and local levels. Our lead on a case study of the Pentland Firth and Orkney Waters (PFOW) marine plan involved close working with Marine Scotland. This relationship continues with our participation in the implementation of regional MSP for PFOW (see below). For example a meta-analysis of environmental data for PFOW (European Maritime and Fisheries Fund/OIC GBP15,000) [Kerr, Porter, Johnson, Bell, Fernandes] is improving the quality of environmental data used in regional planning. Research in collaboration with Scottish Wildlife Trust (SWT GBP15,000) [Johnson] seeks to improve community consultation processes and the communication of science within the PFOW MSP.

3. References to the research

[3.1] Bell, MC & Matheson, H 2015, 'Spatial dynamics of scallops in relation to the Orkney dive fishery', *Scottish Marine and Freshwater Science*, vol. 6, no.15. https://doi.org/10.7489/1664-1

[3.2] Rodrigues, E, Bell, M & Mesquita, C 2018, *Discard survival and condition in brown crabs (Cancer pagurus).* Fishing Industry Science Alliance. Project 05/15. Final Report.

[3.3] Matheson, F, Porter, J, Bell, MC, Mair, JM, Sanderson, W & Dobby, H 2018, *Verification of important areas for juvenile shellfish in Orkney waters*. Marine Scotland Science.

[3.4] Haig, JA, Bakke, S, Bell, MC, Bloor, ISM, Cohen, M, Coleman, M, Dignan, S, Kaiser, MJ, Pantin, JR, Roach, M, Salomonsen, H & Tully, O 2016, 'Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe', *ICES Journal of Marine Science*, vol. 73, no. 10, pp. 2572-2585. https://doi.org/10.1093/icesjms/fsw081

[3.5] Coleman, MT, Agnalt, A-L, Emmerson, J, Laurens, M, Porter, JS & Bell, MC 2020, 'From the Adriatic to Northern Norway—geographic differences in moult increment and moult probability of the European lobster (Homarus gammarus), across the natural range', *ICES Journal of Marine Science*. https://doi.org/10.1093/icesjms/fsaa172

[3.6] Bell, M 2017, *Egg per recruit analysis in support of a Harvest Control Rule for the Orkney brown crab creel fishery*. Orkney Sustainable Fisheries Ltd.

4. Details of the impact

Heriot-Watt University's scientific support for sustainable fisheries in Orkney has reportedly added in the region of GBP1,000,000 to the value of the brown crab fishery (Orkney Sustainable Fisheries Chair, pers. comm.) by strengthening the market position with quality retailers such as M&S, Waitrose, Aldi and Tesco and providing resilience to the impacts of Covid-19 (Orkney Fishermen's Society General Manager, in litt.) [5.1]. Orkney is second only to Shetland in terms of employment in the Scottish fisheries sector, with 291 fishers operating in the inshore fishery. A further 130 workers are employed in the processing sector. Landings into Orkney, mostly shellfish, are worth GBP9,000,000 at first sale value (Scottish Government, sea fisheries statistics 2019), around GBP5,000,000 of which is brown crab; this value is doubled through the local processing sector. Over GBP400,000 of grant funding to the fishing industry, supported by HWU science, has resulted in 4 new market opportunities identified, 36 instances of new market opportunities being identified, 22 instances of fisheries communities being enhanced, 12 diversification measures developed [5.2].

Working with high profile stakeholders such as Marks & Spencer (M&S) and WWF-UK, the work has underpinned a Fishery Improvement Project (FIP) for the Orkney creel fishery for brown crab. A FIP is a stepwise programme of work aimed at improving a fishery to meet the Marine Stewardship Council sustainable fishery standard. The Orkney FIP was the first in the UK, and the first anywhere to use the Marine Stewardship Council's benchmarking and monitoring tool. The FIP was completed in 2017, providing the baseline for underpinning science and research activities that have continued throughout 2014-2020. The project was supported by M&S Spencer, WWF-UK [5.3], The Crown Estate (though the Orkney Shellfish Project) and Orkney Islands Council, and involved close collaboration with Marine Scotland (both Science and Policy divisions) and seafood industry representatives, and has been seen as a flagship project at an EU level through the Fisheries Local Action Group (FLAG) programme.

Through demonstrating continuing progress towards sustainability, the FIP has enabled access to markets that demand seafood products with high standards of sustainability, and has thus underpinned fishers' and processors' livelihoods in Orkney (through the fishermen's cooperative Orkney Fishermen's Society) [5.1, 5.4]. Plan A, which is a commitment by M&S to tackle issues of climate change, waste, resources, fair partnerships and health, has been crucial to this process: M&S has provided support, guidance and publicity for the FIP, and the resultant categorisation by WWF as 'Sustainable Practices in Place' has allowed the retailer to market

Orkney brown crab as a flagship product. The M&S Fisheries & Aquaculture Sourcing Manager stated, "

"Heriot-Watt's scientific support for this project….has been a crucial element of this work. The FIP, and hence our retail of Orkney crab as a responsibly sourced product, has been made possible through Heriot-Watt support." [5.5].

Substantial progress has been made in underpinning Orkney fisheries with robust evidence in support of sustainable development, 128 fishing vessels operate out of Orkney, 85% engaging in creel fishing. HWU has supported OSF in implementing data collection for the creel fleet, initiating long-term data series on stock and fishery trends, starting 2009-2012. Spatial records of catch data provide a resource for marine energy developers in planning to minimise interactions with fisheries in leasing areas for renewable energy development in the Pentland Firth and Orkney Waters. Research into regionally applicable biological and fishery parameters provide a basis for rigorous modelling of sustainable limits (note 2017 report on harvest control in brown crabs). Ongoing work by OSF and HWU on movement patterns in brown crab is determining geographical stock structure, crucial for stock assessment and regionally appropriate fishery management. Given the substantial development of the scientific evidence base for Orkney fisheries, the main barrier to fully demonstrate fishery sustainability in Orkney (and other Scottish Marine Regions) is governance. Presently, fishery management at a national level is limited largely to technical measures such as use of minimum legal size for non-quota species, and rests centrally with Marine Scotland. Scottish Government intends a move towards regional fishery management in the inshore; thanks to development of data, science and the skills base, Orkney fisheries are well prepared to lead the way in developing and implementing such management through the RIFG. Scientific underpinning for industry-led sustainable fisheries initiatives, supported by HWU, is having a significant impact on placing this direction of development firmly on the political agenda [5.6, 5.7].

Orkney shellfish research, through the brown crab FIP and related work, is closely engaged with industry (catching, processing and retail sectors), NGOs (principally WWF), local government (Orkney Islands Council), the fisheries science community (ICES Working Groups on crabs and scallops) and regulators (Marine Scotland Science and Marine Scotland Policy). More widely, the Orkney science [3.4] has been used in educational workshops designed for fishermen (Introduction to Sustainable Fishing) delivered in part by Kaiser through the charity Fishing into the Future (Kaiser is a trustee from 2019) [5.8].

5. Sources to corroborate the impact

[5.1] Letter from Orkney Fishermen's Society (an organisation representing fishers' interests in Orkney).

[5.2] Annual Review of Orkney LEADER/EMFF Programme 2014-2020 to December 2019.

[5.3] Letter from WWF-UK (NGO that supports sustainable fishing practice).

[5.4] Letter from Orkney Fisheries Association.

[5.5] Letter from Marks & Spencer's.

[5.6] Letter from Industry-led Regional Inshore Fishery Group - Orkney Sustainable Fisheries.

[5.7] Article confirming implementation of FIP by Orkney Sustainable Fisheries & relationship with HWU http://www.orkneysustainablefisheries.co.uk/

[5.8] Letter from Fishing into the Future.