Institution: University of Aberdeen

Unit of Assessment: 5 - Biological Sciences

Title of case study: Changing the way nations manage the impacts of human disturbances to protect the conservation status of wild animals

1. Summary of the impact

Dr Lusseau's work at the University of Aberdeen into the impact of man's activities on wild animals has led to changes in public and environmental policies in several nations as well as changes in international policies. He developed insights as well as modelling approaches to understand the consequences of human disturbances on the viability of animal populations.

The Aberdeen work has led to a change in the way the environmental impact of a range of industries - including tourism, marine renewable energy and oil & gas - is assessed. Lusseau developed best approaches to manage the disruptions of animal behaviour that those activities created to ensure that those disturbances do not endanger the viability of wild animal populations.

Specifically this research resulted in impact that influenced international policy development and international planning processes. It also informed planning decisions and changed the way environmental risks and hazards are managed in the UK, USA, and New Zealand, and informed changes in legislations and regulations in the USA, UK and New Zealand.

2. Underpinning research

Research conducted by Dr David Lusseau, Senior Lecturer, and his team at the University of Aberdeen has changed our perception of the risks for the viability of animal populations caused by the impact from man's activities on the behaviour of long-lived, slow reproducing marine species such as whales and dolphins. Previously, such disturbances were perceived to be only a welfare issue. However, work - dating back to 2003 - by Lusseau and his team has demonstrated that repeated exposure to human disturbances leads to significant changes in the amount of time animals spend carrying out vital activities. This can alter their probability of survival, their reproductive success, and the way they use their habitat [1, 2, c]. Also when significant numbers of individual animals are affected, the growth rate of the targeted population can be negatively impacted [c]. This work showed that disturbances that cause changes in animal behaviour can affect the conservation status of animal populations [2, c]. Lusseau's work has led to a complete change in the way disturbances on marine mammals caused by human activities are managed at a global scale (International Whaling Commission [e, f]).

This work forms the basis for a paradigm shift in the way human disturbances are managed. Rather than taking a risk-adverse precautionary approach to management of these activities, Lusseau developed an approach that can effectively estimate likely effects on targeted animal population conservation status within the time scale needed for management decisions. This now ensures that the regulation of human disturbances is less open to interpretation and strives to have the same regulatory targets as other form of impacts. This shift in regulatory target interpretation rationalises the impact assessment process, thereby reducing the risks investors have to take during the application process for new developments. At an international level, the findings have prompted a change in the management of developments and activities that could impact on animal behaviour. The burden of proof has shifted from having to demonstrate that such impacts exist, to demonstrating that such impact does not occur [e, f].

Since 2008, the Aberdeen team has been directly involved in several impact assessment studies in the USA [a], the UK [2, g, h], Canada, New Zealand [b, c], and Iceland [3], particularly focusing on marine tourism and marine renewables. These have led to changes in management and regulatory frameworks for the maintenance of the conservation status of cetaceans [a, b, d, e, g].

Since this seminal work, Lusseau's team at Aberdeen has developed mechanistic models linking behavioural disturbances to population dynamics, as part of a working group funded by the US Office of Naval Research, developing models to assess and predict the population consequences

of disturbances on cetaceans.

In collaboration with others, these models have been used to determine under which conditions the growth rate of certain animal populations would be affected by disturbances caused by man's activities. Lusseau, and colleagues at Aberdeen and other institutions, developed a statistical approach to fit these mechanistic models to observations [2, 5]. This work has been translated in the UK to develop the scientific foundations for an adaptive management scheme for the development of marine renewable energy plants in the light of existing cumulative impacts on wildlife populations living in the area of these developments. This was used for the first time in August 2013 to advise Scottish Natural Heritage and Transport Scotland and Marine Scotland ministers on the likely cumulative effects of the developments of three ports in the Moray Firth on the conservation status of the only bottlenose dolphin population in the North Sea. These developments are deemed of national importance [i].

Finally, Lusseau has instigated a research programme [j] at the International Union for Conservation of Nature Sustainable Use and Livelihoods specialist group, (IUCN-SuLi) to extend this modelling approach. This extension aims to account for the interaction between conservation status targets and the economic viability of activities and local community welfare in defining levels of activities such socioecological systems can sustain.

3. References to the research

[1] Lusseau D. 2003. The effects of tour boats on the behaviour of bottlenose dolphins: Using Markov chains to model anthropogenic impacts. Conservation Biology 17(6): 1785-1793.
156 cites. For the first time shows that tourism interactions affect wildlife population activity budget.

[2] New L.F., Harwood J., Thomas L., Donovan C., Clark J.S., Hastie G., Thompson P.M., Cheney B., Scott-Hayward L. & Lusseau D. (2013) Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology 27: 314-322.
This article is one of several emerging from the following grant: the article and grant developed the first implementation of a simulation platform to inform management by linking disturbances to annual physiological condition of individual dolphins. This modelling approach is now required in Scotland for Environmental Assessments and Habitat Regulation Appraisal.

[3] Christiansen, F., Rasmussen, M. & Lusseau, D. 2013. Whalewatching boats disrupt the foraging activities of Minke whales in Faxaflói bay, Iceland. Marine Ecology Progress Series 478: 239-251.
This study shows for the first time that baleen whale activity budget can be impacted by boat exposure.

[4] Lusseau D. & Higham J.E.S. 2004. Managing the impacts of dolphin-based tourism through the definition of critical habitats: the case of Doubtful Sound, New Zealand. Tourism Management 25(6): 657-667.
111 cites. Proposed multi-level spatial planning as management tool that is now used in many locations.

[5] Lusseau D., Christiansen F., Harwood J., Mendes S., Thompson P.M., Smith K. & Hastie G.D. 2012. Assessing the risks to marine mammal populations from renewable energy devices – an interim approach. http://tinyurl.com/bxazp8b

[6] Higham J.E.S., Bejder L. & Lusseau D. 2008. An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. Environmental Conservation 35(4):294-302.
22 cites. This provides the scientific foundation for the development of adaptive management schemes for disturbance-related impacts.

Research funding:

- Lusseau D. (PI), et al. 2011-2012. The development of a framework to understand and predict the population consequences of disturbances for the Moray Firth bottlenose dolphin population. Scottish Natural Heritage (£40k) http://tinyurl.com/a4j95pb .
- Lusseau D. (PI) 2012. Developing an interim approach to assess the risks to marine mammal populations from renewable energy devices. JNCC, CCW and NERC Knowledge Exchange (£28k)
- Lusseau D. (PI) 2013. Effects of development at three ports in the inner Moray Firth on the bottlenose dolphin interest of the Special Area of Conservation. Scottish Natural Heritage (£18k)
- Lusseau D. (co-PI) 2012-2014. Determining the factors contributing to human-dolphin interactions in a long-term resident inshore bottlenose dolphin community. NOAA Seagrant ($111k)
- Lusseau D. (PI) 2013-2014. Predicting the ability of marine mammal populations to compensate for behavioural disturbances. US Office of Naval Research ($167k)

4. Details of the impact

The research led to several changes in laws and regulations in the USA [a,d], New Zealand [b,c], and in the inter-governmental organisation responsible for advising nations on the sustainable use of whale stocks (International Whaling Commission, IWC [e]). For example, (i) in 2008, the New Zealand government established the Doubtful Sound Marine Mammal Code of Management [b], including the establishment of our proposed Dolphin Protection Zone [4]. (ii) In 2011, US Federal regulations were changed to introduce protective regulations for killer whales in the Northwest Region under the Endangered Species Act and Marine Mammal Protection Act [a]. (iii) In 2011, the International Union for Conservation for Nature listed the Fiordland subpopulation of *Tursiops truncatus* as critically endangered following our recommendations [c].

The Internal Whaling Commission shifted the burden of proof in whalewatching impact assessment in 2006 [e] and established the Large-scale Whalewatching Experiment (LaWE) project initiative in 2008 [f] to inform the international management of tourism centred on interacting with whales and dolphins. On the basis of his research Lusseau was elected to chair this research programme for the Commission. This international research initiative provides scientific information to inform an adaptive management framework proposed by Lusseau [6]. It focuses on defining sustainable levels of tourism whale and dolphin populations can support [b] depending on their habitat and their life history characteristics.

As a direct result of Lusseau's findings, the IWC established the inter-committee Joint Working Group for Whalewatching in 2011 [f]. This included changes in rules and procedures of the International Whaling Commission to develop management procedures for whalewatching by allowing direct communication and collaboration between its Scientific and Conservation Committees. Finally, following Lusseau's research [10], the Group is, since 2012, developing an adaptive management plan for whalewatching to coordinate the management of the industry in the 89 member nations [f].

This research also led to a paradigm shift in the way non-lethal impact on cetaceans is managed in the UK [g, h]. The management objective for disturbances have been clarified and aligned to favourable conservation status. Adaptive management schemes [6] have become preferred for these activities. A unified scientific foundation for monitoring and assessing objective compliance has been adopted in 2012 [5]. A series of management tools has been developed in direct response to Lusseau's research. In July 2013, the Joint Nature Conservation Committee (JNCC) established the UK Marine Mammal Renewable Advisory Committee [5]. The role of this national committee will be to implement the management scheme we have developed for the JNCC, NERC KE and CCW, in relation to the development of marine renewable energy plants. From 2012, our scientific and management advice to the Scottish government and SNH [2] has been implemented**.** Those institutions now use our modelling approach and management framework to consent and manage multiple development proposals in the Moray Firth, UK. Lusseau advised Scottish ministers, in August 2013, on the likely effects of the development of three harbours in the Moray

Firth, to supply windfarm and oil and gas exploitation sites in the North Sea, on the Moray Firth Special Area of Conservation using this modelling approach [i].

Finally, this modelling approach is also adopted at the International Union for the Conservation of Nature (IUCN) with the creation in 2012 of a modelling working group by the IUCN SSC/CEESP Sustainable use and Livelihoods Specialist Group (initiated and now led by Lusseau) to further apply this approach to other socioecological systems within the remit of IUCN [j].

Claimed impact as defined by REF: influenced national and international environmental policy decisions and informed national and international planning decisions. Also led to changes in both the management of natural resources and the management of an environmental risk and hazard.

5. Sources to corroborate the impact

[a] Federal Register entry of the new Rule: http://www.gpo.gov/fdsys/pkg/FR-2011-04-14/pdf/2011-9034.pdf. *Following demonstration of impacts on killer whale's activity budget by Lusseau new regulations guiding boat behaviour around whales are imposed and zoning proposed.*

[b] NZ new Code of Management: http://tinyurl.com/a7s5jlp. *Following demonstration of impact of tourism on bottlenose dolphin population by Lusseau, new boat behaviour regulations are imposed and the zoning advised by Lusseau proposed.*

[c] IUCN listing of Fiordland subpopulation of bottlenose dolphins: http://tinyurl.com/6f42k99. *Bottlenose dolphin populations inhabiting Fiordland are listed as critically endangered with wildlife tourism being listed, for the first time at IUCN, as a key cause for the population's conservation status and a key threat to the population recovery.*

[d] Changes to criteria for Environmental Impact Statement for Oil and Gas operations (pertaining to cumulative impacts): e.g., Recommendation of the US Marine Mammal Commission to the US Bureau of Ocean Energy Management, Regulation, and Enforcement http://tinyurl.com/ao9rn2k International Whaling Commission reports detailing steps above:

[e] IWC/58/Rep1 2006 Report of the Scientific Committee, p.54, (http://tinyurl.com/a4umhdj): *"The Committee agrees that there is new compelling evidence that the fitness of individual odontocetes repeatedly exposed to whalewatching vessel traffic can be compromised and that this can lead to population level effects. The Committee recommends that similar studies looking at individual fitness of cetaceans be carried out where ever possible. However, in the absence of these data it should be assumed that such effects are possible until indicated otherwise."*

[f] IWC/60/Rep1 2008 Report of the Scientific Committee p.57, (http://tinyurl.com/a4umhdj): *Establishment of the LaWE Steering Group*
and subsequent IWC/63/CC3 2011 Report of the Standing Working Group on Whalewatching of the Conservation Committee (http://tinyurl.com/a74bk2t): *Propose the establishment of the Working Group on Whalewatching as a joint Working Group between the Scientific and Conservation Committees to develop worldwide management procedures for whalewatching.*

[g] JNCC development of interim guidance for English and Welsh territorial waters and the UK offshore marine area on the deliberate disturbance of marine European Protected Species (2007): http://tinyurl.com/b3c4z9q. *Research used to define a disturbance offence under the EU Habitats Directive* (pp.9;13)

[h] The Moray Firth Special Area of Conservation Management Scheme: http://tinyurl.com/amc7muc and http://tinyurl.com/a6a5chn *Changes in management action plan in response to Lusseau's research*

[i] Marine Scotland consideration of a proposal affecting a designated SAC or SPA (11 Oct. 2013) http://www.scotland.gov.uk/Resource/0043/00436017.pdf *Scottish government decision on port development based on Lusseau's research and advice.*

[j] Creation of a modelling working group IUCN SSC/CEESP Sustainable use and Livelihoods Specialist Group: http://tinyurl.com/9wen3w2 and http://tinyurl.com/b7bktzj.