Institution: University of Aberdeen

Unit of Assessment: 7 (Earth Systems and Environmental Sciences)

Title of case study: Promoting sustainable tourism through new approaches to marine governance

Period when the underpinning research was undertaken: 2003-2020

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:
David Lusseau	Professor of Marine Sustainability	10/2007-08/2020

Period when the claimed impact occurred: 2016-2020

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

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

Research led by Professor David Lusseau at the University of Aberdeen has underpinned global governance and best practice in marine tourism activities worldwide, introducing methodological approaches to enable appraisal of potential conservation impacts, thereby informing management decisions in the marine tourism industry. Through policy development work and involvement in public information campaigns, Lusseau has raised awareness amongst public, government and industry of the risks associated with unregulated marine tourism activities – contributing to international best practice and educational resources globally, such as the UN World Ocean Assessment (2021) and the International Whaling Commission's 'Whale Watching Handbook'. His research has informed management approaches in the United States (U.S.) marine tourism industry and underpins guidance for management approaches in New Zealand such as the use of exclusion zones; his work also underpins new legislation in the U.S. and Canada dictating the minimum distance at which whales can safely be observed.

2. Underpinning research (indicative maximum 500 words)

As a result of increased human activity in marine environments, interactions with marine life is intensifying - these interactions act as stressors and can lead to significant behavioural disturbances. As reported in REF2014, research undertaken by Professor David Lusseau and his team has demonstrated that repeated exposure to human disturbances leads to significant changes in the behaviour of marine species, such as whales and dolphins.

The diversification and intensification of marine activities present complex regulatory challenges, due to associated social and ecological impacts, referred to as 'sub-lethal' impacts – that is, activities not directly extirpating value or resources from local communities and ecosystems. The sustainability of non-traditional marine activity sectors, including tourism, depends on the ability of individuals and organisations to manage these stress-mediated indirect sub-lethal impacts, particularly with regard to cetaceans. These impacts emerge from the complex interactions between human exploitation patterns and the way cetaceans use the seas. Managing them therefore requires an understanding of both human behaviour and sectorial microeconomics as well as the population ecology of targeted species or the affected habitat.

Establishing the effect of vessel disturbance

Behavioural responses can be used to detect short-term reactions to a stressor, such as vessel disturbances, which can affect the behaviour of the targeted cetacean populations primarily mediated by foraging disruptions. Since 2008, Lusseau and his team have undertaken studies to inform effects on targeted animal population conservation status. These include [3], which demonstrates that the foraging behaviour of Southern Resident Killer Whales, living in Puget Sound at the border of Washington State (U.S.) and British Columbia (Canada) was disrupted by

tourism to a point that it raised conservation concerns particularly due to severe depletions in their primary food source, Chinook salmon. Similar impacts were detected for bottlenose dolphins living in the Moray Firth, Scotland [6], and those living in Doubtful Sound, New Zealand [2] as well as Minke whales living in Iceland [5]. Using impact assessment approaches, Lusseau and his team were able to appraise the likely conservation threat tourism and marine traffic associated with other activities for a particular population, showing comparatively that whilst Minke whales in Iceland could sustain more tourism, this was not the case for bottlenose dolphins in Doubtful Sound (New Zealand) or killer whales in Puget Sound (U.S./Canada). Lusseau and team were also able to make predictions about the likely conservation impact of new developments (such as wind farms) in the Moray Firth, showing that a short-term demographic impact could be expected but that the population would be able to endure it for the duration of the reporting time frame as stipulated by the Habitats Directive (European Commission). Through his research, Lusseau has introduced seminal methodological approaches to enable appraisal of potential conservation impacts within the timescale required for management decisions, in turn has ensuring that the regulation of human disturbances is less open for mis-interpretation and strives to ensure the same regulatory targets as other form of impacts.

Developing governance structures and management models to maintain sustainable wildlife tourism

Lusseau first introduced the idea of exclusion zones to minimise overlap between tourism and the location where cetaceans are likely to engage in activities that are sensitive to the stressor elicited by vessel disturbance in 2003 [2] (see [S11] for corroboration). As outlined in REF2014, this proposal was implemented by and it is one of the rare instances in the world where a wildlife tourism management approach has been shown to be effective at reducing impact while maintaining the economic viability of the activities.

Building on this work at a local scale, Lusseau and research team have developed new socio-ecological agent-based models of wildlife tourism that can be directly applied to test new governance approaches using computer simulations to wildlife tourism, thereby informing policy. In [7], Lusseau and Pirotta (PhD student) introduced simulation approaches to test whether different management regimes (e.g. tax and subsidy) could provide socio-economically sustainable solutions for wildlife tourism, finding that scenarios where time quotas were enforced using a tax and subsidy approach or were traded between operators were more likely to be sustainable [7].

These findings conclude that public-private partnerships have the greatest potential to yield sustainable tourism and in turn, have helped to rationalise the impact assessment process, reducing economic risks for investors and businesses and has shown that all governance approaches can have the scope to yield socio-ecological sustainability.

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

References (citations via Scopus)

[1] **Lusseau, D**., 2003. Effects of tour boats on the behaviour of bottlenose dolphins: using Markov chains to model anthropogenic impacts. *Conservation Biology*, *17*(6), pp.1785-1793, doi: https://doi.org/10.1111/j.1523-1739.2003.00054.x, 435 citations

[2] **Lusseau, D**. and Higham, J.E.S., 2004. Managing the impacts of dolphin-based tourism through the definition of critical habitats: the case of bottlenose dolphins (*Tursiops spp*.) in Doubtful Sound, New Zealand. *Tourism Management*, *25*(6), pp.657-667, doi: https://doi.org/10.1016/j.tourman.2003.08.012, 122 citations

[3] **Lusseau, D**., Bain, D. E., Williams, R., and Smith, J. C. (2009). Vessel traffic disrupts the foraging behaviour of southern resident killer whales *Orcinus orca*. *Endanger. Species Res.* 6, 211–221, doi: https://doi.org/10.3354/esr00154, 114 citations

[4] Christiansen, F. & **Lusseau, D**. Understanding the ecological effects of whale-watching on cetaceans, chapter in book: Whale-watching, sustainable tourism and ecological

management. *Cambridge University Press, Cambridge, UK* (eds J. E. S. Higham, L. Bejder, & R. Williams) Ch. 13, 177-192 (Cambridge University Press, 2014).

[5] Christiansen, F. and **Lusseau, D**., 2015. Linking behavior to vital rates to measure the effects of non-lethal disturbance on wildlife. Conservation Letters, 8(6), pp.424-431, doi: https://doi.org/10.1111/conl.12166, 70 citations

[6] Pirotta, E., Merchant, N. D., Thompson, P. M., Barton, T. R. & **Lusseau, D**. Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. *Biological Conservation* **181**, 82-89,doi: https://doi.org/10.1016/j.biocon.2014.11.003 (2015), 93 citations

[7] Pirotta, E. and **Lusseau, D**., 2015. Managing the wildlife tourism commons. *Ecological Applications*, *25*(3), pp.729-741, doi: https://doi.org/10.1890/14-0986.1, 16 citations

Grants

The development of a framework to understand and predict the population consequences of disturbances for the Moray Firth bottlenose dolphin population. Scottish Natural Heritage; 2011-2012; GBP40,000

Predicting the ability of marine mammal populations to compensate for behavioural disturbances, Office of Naval Research; 01/13-12/13; GBP104,191

MASTS prize PhD studentship, Scottish Funding Council, 10/11-09/15; GBP40,000, Lusseau as Lead Supervisor

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

The research underpinning this case study has led to global impact by:

1) Raising global awareness through public information campaigns;
2) Informing global governance to improve vessel impact assessments in Canada and U.S and New Zealand;
3) Informing best practice for U.S. marine tourism industry

Informing global governance impact assessments and best practice

Lusseau and his team's research [7] underpinned the development of disturbance management objectives and research framework as well as informed management actions. The research led to the conclusion that conservation threats associated with disturbances are on the rise globally (as recognised by the United Nations World Ocean Assessment (WOA) II, Chapter 6D), a resource dedicated to the current assessment for threats not relating to direct physical injury, caused by shipping to marine mammals [S1i]. Lusseau's research formed the evidence base for Section 6.2, 'Non-lethal activities' (p157). [*text removed for publication*] [S1ii]. WOA 11 was adopted on 31 December 2020 and the finalised assessment, delayed by the current pandemic will be released in early 2021 [S1ii].

Lusseau's research [4,7] also underpins the 'Whale Watching Handbook´, an online toolkit developed by the International Whaling Commission and the Convention for Migratory Species to support managers, regulators, operators and members of the public, globally, to practice responsible management of whale watching across the world [S2]. Their work underpins 'Responsible Management': benefits and impacts of whale watching: https://bit.ly/3e3TvtH as well as management strategies and tools: https://bit.ly/307E5fP. The Handbook, which is reviewed each year at the meeting of the Scientific Committee of the International Whaling Commission is an evolving tool incorporating international best practice, educational resources and a summary of the latest, relevant scientific information. The research described in this case study [4] also underpins the development of a global research framework, which aims to understand the population consequences of disturbances produced by the U.S. National Academies [S3].

Raising global awareness through public information campaigns

Lusseau's research has received worldwide media attention, with synthesis articles published by *Nature* (2014), the BBC (2016), *Ecology for the Masses* (2020). These articles have raised the profile of the research, highlighting the need for a precautionary approach to mitigate the risk of unregulated marine tourism (mammal watching) and its consequences [S4].

Lusseau's research [3] has been featured in a blog (https://www.seattleaquarium.org/blog/orca-update-why-do-boats-matter) by the Seattle Aquarium [S5i]. This has been used to inform the public of the basis of Governor's Orca Emergency Response package; SB5577, a recent initiative to address the non-lethal impacts of whale-watching and vessel disturbance on Southern Resident killer whales. In relation to these concerns, the *San Juan Islander* (Washington, U.S.; daily circulation approximately 1,834) reported on a moratorium on whale watching (2020) on Puget Sound, which was recommended by the former Executive Director of the Marine Mammal Commission on the basis of Lusseau's research (and others) [S5ii].

Canada

In 2017, Federal Fisheries Minister (British Colombia) announced the government's plan to pass new regulations in the spring of 2018, which would require boaters to stay at least 200 metres away from resident killer whales in Canadian waters. This decision was based on the South Resident Killer Whale Symposium held in Vancouver, BC in October 2017, which drew on expertise from Lusseau and others. An article released by the B.C. Cetacean Sightings Network in 2017 listed [3] as one of the key references underpinning this decision [S6]. The symposium delegates agreed that rapid action and drastic changes would be needed to save the critically endangered southern resident population.

United States

In 2016, Orca Relief Citizen's Alliance, a non-profit organisation committed to conservation of orcas, submitted a petition to establish a whale protection zone for the southern resident killer whale due to disturbance by commercial and non-commercial vessels. The petition drew heavily on Lusseau's research to highlight noise and disturbance as major risk factors to the population, demonstrating that these factors increase as the numbers of vessels increase [S7].

Following increasing pressure as a result of this pressure and growing concern around the effect of vessel disturbance on south resident killer whales, in 2019, the National Marine Fisheries Service (U.S.) announced a public scoping process to determine how best to protect Southern Resident killer whales from noise and disturbance in Washington's inner body of water. Later in 2019, the Washington State Department of Fish and Wildlife (WDFW) was contracted to facilitate a scientific technical review of the best available science evaluating disturbance and noise impacts on southern resident killer whales caused by small vessels and commercial whale watching in response to SB5577 (2019). Lusseau was invited [S8i] to join the Washington State Academy of Sciences (WSAS) committee 'Underwater Acoustics and Disturbance' in March 2020, tasked with developing new whale watching rules per SSB5577 and to answer specific questions about underwater acoustics and disturbance to inform the development of new WDFW regulations for a commercial whale watching licensing program in Washington state [S8ii, iii].

The WSAS Committee's Underwater Acoustics and Disturbance report (August 2020) [S8] drew heavily on Lusseau and his team's research to identify current important regions of southern resident killer whales foraging and in reducing foraging southern resident killer whales exposure to vessels. The report supported the view that protecting key foraging hotspots would be a mechanism to support the population. Lusseau and team's research (amongst others) demonstrated that adaptive management would be critical for linking regulations to observed animal distributions rather than to a small geographical area. In turn, this would allow vessel spatial restrictions to be reviewed regularly to accommodate any documented or observed changes in southern resident killer whales foraging patterns. These recommendations can be directly linked to Lusseau and his team's research [3], and now underpin a U.S. federal rule proposed in 2019 in order to revise the critical habitat designation for southern resident killer whales to include the Strait of Juan de Fuca and coastal waters along the U.S. west coast (National Oceanographic and Atmospheric Administration, 2019) [S9].

Informing best practice in U.S. marine tourism industry

Lusseau's research presents an empirically-driven predictive modelling framework that provides an objective approach to plan for the cumulative impacts of tourism activities within the context of other maritime activities and subsequently manage their spatial and temporal operations [2, 4, 5]. Drawing on Lusseau's research, in 2016, the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), developed an ocean noise strategy roadmap and NOAA national guidelines in order to outline what constitutes marine harassment and highlighting the risks of feeding marine mammals [S10]. These guidelines have led to the innovation of public-private partnership governance models that are now implemented as global best practice by the World Cetacean Alliance in order to manage coastal development and marine tourism.

New Zealand

Research carried out independently in 2016 showed that the voluntary code of management approaches proposed by Lusseau in [1, 2, 7] were effective at reducing the effect of tourism, without disrupting the economic profitability of the sector in the region. The reduced effect was concordant with a demographic improvement for the dolphin population in Doubtful Sound. The authors conclude, '*The management measures established in 2008 appear to have benefitted the population of bottlenose dolphins of Doubtful Sound by reducing the frequency and duration of interactions with boats*' [S11].

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

[S1 (group)] (i) UN World Ocean Assessment (WOA) II, draft Chapter 6D, p149 and p157 (https://bit.ly/3sLePIx), (ii) [*text removed for publication*]

[S2] International Whaling Commission (IWC), whale watching handbook (Chapter on Responsible Management)

[S3] US National Academies global framework to inform best practice, https://www.nap.edu/read/23479

[S4 (group)] Media articles demonstrating the breadth of uptake of and awareness-raising achieved by Lusseau's research: Nature (2014) https://go.nature.com/3c83FYK; BBC (2016) https://bbc.in/3sai4JL; Ecology for the Masses https://bit.ly/3lEmoOX

[S5 (group)] (i) Seattle Aquarium blog and infographic (https://www.seattleaquarium.org/blog/orca-update-why-do-boats-matter); (ii) San Juan Islander media report on moratorium (2020), https://bit.ly/3cODUMb

[S6] News article (B.C. Cetacean Sightings Network) detailing new regulations to help protect resident killer whales (Oct, 2017)

[S7] Petition by Orca Relief Citizen's Alliance (2016), https://www.orcarelief.org/wp-content/uploads/2016/11/SRKW-Regulatory-Request.pdf

[S8 (group)] (i) WSAS invitation to join the study committee 'Underwater Acoustics and Disturbance'; (ii) WSAS report and (iii) acknowledgement of contribution to the enquiry

[S9] U.S. federal rule that was proposed in order to revise the critical habitat designation for SRKW

[S10] National Oceanic and Atmospheric Administration (NOAA), ocean noise strategy roadmap; Global best practice guidelines from World Cetacean Alliance (https://cetsound.noaa.gov/Assets/cetsound/documents/Roadmap/ONS_Roadmap_Final_Complete.pdf)

[S11] Evidence demonstrating that proposed management approaches were effective at reducing the effect of tourism without disrupting the economic profitability, link: https://www.sciencedirect.com/science/article/pii/S0261517716300802