Institution: University of Exeter

Unit of Assessment: UoA 5 Biological Sciences

Title of case study:
Developing tools and evidence for increased protection of marine predators

Period when the underpinning research was undertaken: 2013–2020

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:
Dr Richard Sherley	Lecturer	October 2014 to present
Dr Stephen Votier	Associate Professor	September 2013 to July 2020

Period when the claimed impact occurred: December 2014 to December 2020

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

1. Summary of the impact

Research by the University of Exeter (UoE) has increased understanding of fisheries' impacts on the spatial ecology, population dynamics, and conservation of endangered marine predators. This research has developed analytical approaches that have:

(1) informed **policy debate,** leading to evidence-based **legislative change** in the designation of a 580km^2 Marine Protected Area (MPA), which has increased protection for two highly threatened seabird species in South Africa, and improved the management of marine environments;

(2) supported **capacity building** in Southern Africa (South Africa, Namibia, Angola) through the development of a decision-support tool adopted by the International Union for Conservation of Nature (IUCN) Shark Specialist Group and governments in Southern Africa. This has improved reliability and transparency in status assessments of heavily exploited marine predators such as sharks and rays;

(3) influenced international policy leading to **international regulation changes** for two threatened shark species (Shortfin Mako and Oceanic Whitetip) resulting in their addition to international conventions managing the international trade and retention of key species.

2. Underpinning research

Although we know that industrial fisheries can negatively affect individual marine predators via direct exploitation, bycatch and competition for prey stocks, we still have an incomplete understanding of how these pressures manifest themselves at the population level. Since 2013, Sherley and Votier have conducted research under three cross-cutting themes to address this critical knowledge gap. This research, conducted in collaboration with host-country partners, has developed cutting-edge analytical techniques to inform protected area designations and fisheries management at a national scale, and efforts to increase the protection of highly threatened marine predators at the global scale.

Ecologically relevant MPAs for predatory seabirds: In Southern Africa, four endemic seabirds are considered *Endangered* by the IUCN as a result of population declines in excess of 50% over the last 50 years. These declines were linked to competition with fisheries. To understand whether fishing closures might mitigate these declines, in 2008 the South African government, in partnership with a number of stakeholders including (from 2013) UoE, initiated a unique experiment that saw alternating 3-year fishing closures of 20 km around four African Penguin *Spheniscus demersus* colonies (Figure 1). UoE-led research highlighted the importance of prey close to these colonies for penguins (which eat commercially targeted forage fish) [**3.1,**

3.2] and Bank Cormorants *Phalacrocorax neglectus* [**3.3**] (which eat benthic, reef associated prey, including the commercially valuable rock lobster *Jasus lalandii*). The UoE modelling approach revealed that Bank Cormorants populations would respond positively to localised closures of the rock lobster fishery [**3.3**], and that excluding fishing improved penguin chick survival and condition, which in turn increased their population growth rate [**3.2,3.4**]. **This body of research was the first to demonstrate that a pelagic (open ocean) fishing closure could drive bottom-up biodiversity benefits.**

Matching the scales of conservation and ecological processes:

UoE research has also highlighted that the population decline of African Penguins was happening too rapidly to be driven only by poor reproductive success [**3.2,3.4**]. Tracking juvenile penguins during their initial dispersal from colonies spanning central Namibia to Bird Island, South Africa (Figure 1) revealed that these birds travelled long distances to cool, plankton-rich waters that no longer supported large stocks of sardines and anchovies because of overfishing and climate change. **This provided the very first example of a marine ecological trap** [**3.5**], highlighted the importance of protecting prey for non-breeding African Penguins [**3.4,3.5**], and demonstrated that the existing MPA network, including the 12,000 km^2 Namibian Islands' MPA (NIMPA, Figure 1), were insufficient to protect all key penguin foraging habitats.

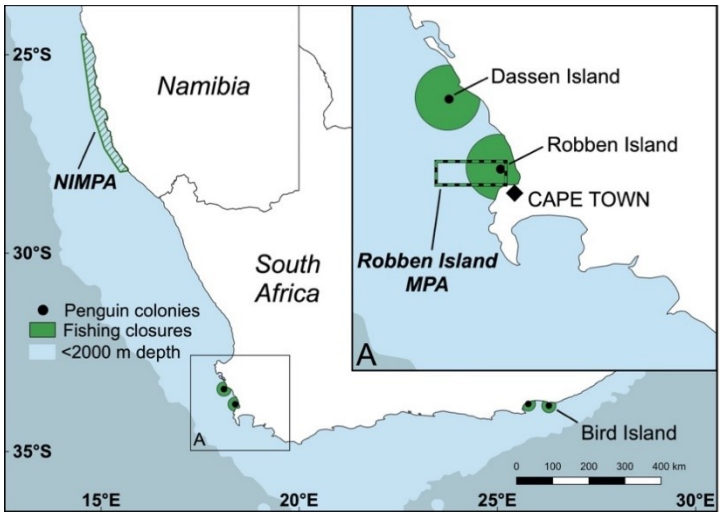

Figure 1. Experimental fishing closures (green circles), the new 580km^2 Robben Island Marine Protected Area (black and green dashed box) in South Africa, and the Namibian Islands' Marine Protected Area (NIMPA, green hashed box).

Informing the global conservation status of pelagic predators: Studying the ongoing seabird declines in South Africa and Namibia led Sherley to begin working with Henning Winker (EU Joint Research Centre) on Bayesian state-space models. This collaboration led to the development of a decision-support tool called JARA (Just Another Red-List Assessment). By combining Bayesian state-space modelling and abundance data, **this new tool improves the transparency and robustness of IUCN Red List species assessments**. To date, five species have been identified as highly threatened (globally *Endangered* or *Critically Endangered*) for the first time using JARA, including the Shortfin Mako *Isurus oxyrinchus* [**3.6**] and the Oceanic Whitetip Shark *Carcharhinus longimanus (Critically Endangered).* All five species suffer high mortality in fisheries, highlighting that existing conservation actions have been ineffective.

3. References to the research

Selection of key peer-reviewed papers undertaken at Exeter (**University of Exeter authors highlighted in bold**) underpinning our impact:

3.1 Campbell KJ, Steinfurth A, Underhill LG, Coetzee JC, Dyer BM, Ludynia K, Makhado AB, Merkle D, Rademan J, Upfold L and **Sherley RB**. 2019. Local forage fish abundance influences foraging effort and offspring condition in an Endangered marine predator. ***Journal of Applied Ecology*** 56: 1751–1760. DOI: 10.1111/1365-2664.13409.

3.2 Sherley RB, Winker H, Altwegg R, van der Lingen CD, **Votier SC** and Crawford RJM. 2015. Bottom-up effects of a no-take zone on endangered penguin demographics. ***Biology Letters*** 11: 20150237. DOI: 10.1098/rsbl.2015.0237.

3.3 Sherley RB, Botha P, Underhill LG, Ryan PG, van Zyl D, Cockcroft AC, Crawford RJM, Dyer BM and Cook TR. 2017. Defining ecologically relevant scales for spatial protection with long-term data on an endangered seabird and local prey availability. ***Conservation Biology*** 31: 1312–1321. DOI: 10.1111/cobi.12923.

3.4 Sherley RB, Barham BJ, Barham PJ, Campbell KJ, Crawford RJM, Grigg J, Horswill C, McInnes A, Morris TL, Pichegru L, Steinfurth A, Weller F, Winker H and **Votier SC**. 2018. Bayesian inference reveals positive but subtle effects of experimental fishery closures on marine predator demographics. ***Proceedings of the Royal Society B: Biological Sciences*** 285: 20172443. DOI: 10.1098/rspb.2017.2443.

3.5 Sherley RB, Ludynia K, Dyer BM, Lamont T, Makhado AB, Roux J-P, Scales KL, Underhill LG and **Votier SC**. 2017. Metapopulation tracking juvenile penguins reveals an ecosystem-wide ecological trap. ***Current Biology*** 27: 563–568. DOI: 10.1016/j.cub.2016.12.054.

3.6 Sherley RB, Winker H, Rigby CL, Kyne P, Pollom R, Pacoureau N, Herman K, Carlson JK, Yin JS, Kindsvater HK and Dulvy NK. 2020. Estimating IUCN Red List population reduction: JARA – a decision-support tool applied to pelagic sharks. ***Conservation Letters*** 13: e12688. DOI: 10.1111/conl.12688.

4. Details of the impact

Fishing is having major negative effects on the marine environment, preventing countries from meeting their commitments under the Convention on Biological Diversity and UN Sustainable Development Goals. UoE-led research has **developed innovative analytical approaches and tools** (such as JARA) that have informed **policy debate** [**5.1**]**,** led to evidence-based **legislative change** [**5.2**], supported **capacity building** in Southern Africa (South Africa, Namibia, Angola) [**5.3**], and **informed regulation changes** around species status under international conventions [**5.4**].

Process and beneficiaries: through long-term collaborations with NGOs working in the region, governmental departments and academic partners, UoE research has had a demonstrable impact on capacity in Southern Africa and international efforts to robustly assess the status of globally threatened species:

> "*The publications arising from [projects with UoE] in highly regarded journals, give increased credibility to the conservation work that we do*" – *Chief Executive Officer, Southern African Foundation for the Conservation of Coastal Birds (SANCCOB)* [**5.5**].
>
> "*Research from the University of Exeter has been of great importance to the South African government, especially its role in investigating the impact of fisheries on seabirds*" – *Chief Director: Oceans and Coastal Research, Department of Environment, Forestry and Fisheries (DEFF), South Africa* [**5.2**].
>
> "*JARA has resulted in far greater objectivity and transparency in the Red List Assessment of sharks and rays [and] greater stakeholder trust in the resulting species classifications*"– *IUCN Shark Specialist Group Co-Chair* [**5.4**].

1.a Informed policy debate, leading to evidence-based legislative change: **Marine Protected Area (MPA).** UoE work has, through the designation of a 580km^2 MPA, increased protection for seabirds in South Africa. UoE research [**3.1–3.4**] has been integral to **ensuring the government could make evidence-based decisions** on management of marine resources [**5.2**]. UoE-led research on penguin-forage fisheries interactions [**3.1,3.3,3.4**] contributed to independent reviews of South Africa's experimental fishing closures in 2014, 2016, 2019 and 2020 [**5.6**, **5.7**]. Moreover, Sherley was one of six members of a Task Team [**5.7**] that advised the government on decisions pertaining to the continuation of the experiment [**5.2**]. These outputs, combined with UoE-led research that confirmed a link between rock lobster abundance and Bank Cormorant population dynamics [**3.2**], **guided legislative change** by providing **the evidence base** needed to include provisions for seabird conservation (prohibiting fishing for rock lobster, sardine and anchovy) in a **new 580km^2 MPA** designated around Robben Island (Figure 1) in 2019 [**5.2**]:

"*Dr Sherley's contributions have assisted the government with evidence-based decision making predicated on scientific advice of international standing [and] University of Exeter led research [has] contributed to the motivation for and design of the Robben Island Marine Protected Area" – Chief Director: Oceans and Coastal Research, DEFF, South Africa* [**5.2**]

1.b Informed policy debate, leading to evidence-based legislative change: Management of Marine Environments. UoE research has also **informed submissions to government by NGOs**, including a 2019 policy brief [**5.1**] in which our papers [**3.1,3.3,3.4**] were 3 of the 5 "key scientific publications" underpinning the argument for "declaring permanent closure of [20 km] areas around the six largest [penguin] breeding colonies" [**5.1**]. And UoE research has **stimulated decisions in regional policy documents:** the Draft 2nd Biodiversity Management Plan for the African Penguin states that UoE research on metapopulation tracking of juveniles [**3.5**] supports "suspending fishing when prey drops below critical thresholds" to safeguard seabirds' access to prey outside of existing protected areas [**5.8**]. The important role played by UoE research in these processes has been recognised both by the government [**5.2**] and external stakeholders:

"The [UoE-led] work highlights the benefits of fishing restrictions to penguins within 20 km of paired islands through the island closure experiment, one we laud the South African government for having initiated and maintained"– IUCN Penguin Specialist Group Co-Chairs [**5.9**].

"*The South African government is updating the current Biodiversity Management Plan for the African Penguin [and] Dr Sherley's work is crucial to some of the actions that have been drafted therein" – Chief Executive Officer, SANCCOB* [**5.5**].

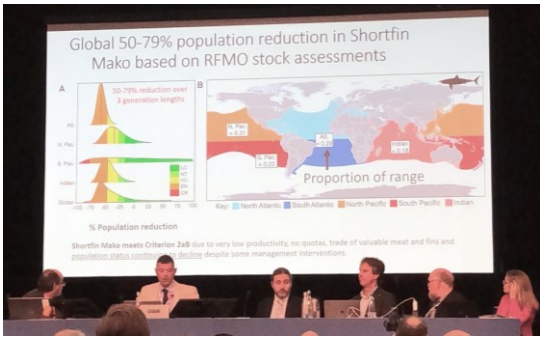

Figure 2. IUCN Shark Specialist Group Co-Chair, Professor Nick Dulvy (second from left), presenting results (weighted population declines) from the JARA-based Red List Assessment of Shortfin Mako [**3.6**] at CoP18 of CITES (August 2019). The assessment listed Shortfin Mako as globally *Endangered* and played "*a pivotal role"* in the species gaining Appendix II listing [**5.4**].

2. Supported capacity building in Southern Africa through the development decision-support tool. The development of JARA as a decision support tool [**3.6**] was directly influenced by Sherley's experience working with policy makers in Southern Africa (South Africa, Namibia, Angola). The JARA tool has subsequently been used by NGO, government and academic scientists to assess the conservation status of 112 marine predator species. The easy-to-use, open access nature of JARA has **supported institutional capacity building** in at least 5 countries (Bahamas, Canada, USA, South Africa and UK) [**5.2–5.4**]. For example, the Benguela Current Convention (BCC) Top Predator Working Group has employed JARA to assess five seabirds, three marine mammals, and two sea turtles in South Africa and Namibia [**5.2,5.3**]. An IUCN Shark Specialist Group analyst (trained by Sherley) has used JARA [**3.6**] to undertake IUCN Red List assessments of > 50 species during 4 international workshops [**5.4**].

3. Influence on international policy: UoE research has helped **change the policy of international agencies** on two of the five oceanic shark species identified as highly threatened using JARA [**5.4**] (Figure 2). The inclusion of the Oceanic Whitetip Shark on Appendix I of the Convention on Migratory Species (CMS) at the 13th Conference of the Parties (February 2020) was supported by a JARA-based Red List Assessment [**5.4**] and our assessment of Shortfin Mako as globally *Endangered* [**3.6**] contributed (Figure 2) to a successful proposal [**5.10**] to list the species under Appendix II at the 18th Conference of the Parties (CoP18) of the Convention on the International Trade in Endangered Species (CITES), a binding treaty with 183 signatory countries that regulates the global wildlife trade:

"The one single page of graphs cut through hundreds of pages of detail, complexity, and uncertainty. Without the transparent and robust analysis from JARA, it is highly likely that the [Food and Agriculture Organisation] opinion would have carried the day at CoP18. Consequently, it is no exaggeration to say that the JARA analysis played a pivotal role in Appendix II listing and international trade regulation for the Shortfin Mako" – IUCN Shark Specialist Group Co-Chair [**5.4**].

One hundred and two countries supported the proposal and Canada has subsequently banned retention of Shortfin Makos in their North Atlantic fisheries.

5. Sources to corroborate the impact

5.1 Letter from South African NGOs (SANCCOB, BirdLife South Africa, WWF South Africa) and Research Institutes (FitzPatrick Institute of African Ornithology, SA Research Chair in Marine Ecology and Fisheries, Institute for Coastal and Marine Research) to the Minister of Department of Environment, Forestry and Fisheries, South Africa, dated 1 November 2019

5.2 Letter from the Chief Director: Oceans and Coastal Research, Department of Environment, Forestry and Fisheries, South Africa (Ashley Naidoo), dated 15 May 2020.

5.3 Letter from the Benguela Current Convention Secretariat to Dr Henning Winker (co-developer of JARA with Sherley), dated 3 February 2020.

5.4 Letter from IUCN Species Survival Commission Shark Specialist Group Co-Chair (Professor Nick Dulvy), dated 20 March 2020. The full list of 112 species assessed using JARA (up to date on 20 August 2020) is available upon request.

5.5 Letter from Chief Executive Officer, Southern African Foundation for the Conservation of Coastal Birds (SANCCOB; Dr Stephen van der Spuy), dated 23 August 2018.

5.6 Anon. Documents for the MARAM/DAFF International Fisheries Stock Assessment Review Workshop, 2014. Department of Agriculture, Forestry and Fisheries Report MARAM/IWS/DEC14/ALL/3. 6 pp.

5.7 Dunn A, Haddon M, Parma AM and Punt AE. 2016. International Review Panel Report for the 2016 International Fisheries Stock Assessment Workshop, 28 November – 2 December 2016, UCT. Department of Agriculture, Forestry and Fisheries Report MARAM/IWS/DEC16/General/7. 17 pp (see pages 2, 11).

5.8 Department of Environmental Affairs. 2019. Draft 2nd Biodiversity Management Plan for the African Penguin (*Spheniscus demersus*). Department of Environmental Affairs, Republic of South Africa. 55 pp.

5.9 Letter from IUCN Species Survival Commission Penguin Specialist Group Co-Chairs (Dr Pablo García Borboroglu and Professor Dee Boersma) to the Deputy Director-General of the Department of Environment, Forestry and Fisheries, South Africa, dated 17 November 2019.

5.10 IUCN and TRAFFIC (2019). IUCN/TRAFFIC Analyses of the Proposals to Amend the CITES Appendices. Prepared by IUCN Global Species Programme and TRAFFIC for the Eighteenth Meeting of the Conference of the Parties to CITES. IUCN – International Union for Conservation of Nature, Gland, Switzerland. 343 pp. (see CoP18 Prop. 42 Inclusion of Mako Sharks Isurus oxyrinchus and Isurus paucus in Appendix II p221)