Operational interactions between marine mammals and commercial fisheries in Australian and South Pacific waters: characterisation and options for mitigation.

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For Kate, my love.

Freedom is the absence of choice.

Pol Pot

Table of Contents

Thesis abstract

Reports of interactions between marine mammals and fisheries are on the increase globally. This is mainly because fishery effort has increased to feed the burgeoning human population and because advances in technology have allowed fisheries to exploit habitats that were until recently inaccessible. Additionally, many marine mammal populations decimated by harvesting over the past few hundred years are recovering and the growing conservation community is paying unprecedented attention to their welfare and conservation generally, with growing interest in their interactions with fisheries.

Operational interactions are conspicuous and involve the close contact of marine mammals with fishing gear, either because marine mammals opportunistically or habitually target fishing activities to depredate (i.e. attempt to consume) caught fish, or because marine mammals incidentally encounter fishing gear while foraging naturally. Operational interactions often result in negative outcomes for the conservation and welfare of the marine mammals involved and for the economic viability of the fisheries involved. Marine mammals that become by-caught may receive life threatening injuries from entanglements, or may drown, thus having adverse impacts on small or recovering populations. Fisheries that are targeted by depredating marine mammals may need to replace damaged fishing gear, or may have the catch partially or completely removed, thus having adverse impacts on their economic viability.

At the time this body of work commenced, little was being done to address the known or suspected occurrence of operational interactions between marine mammals and several commercial fisheries in the Oceania region. The general aim was to make significant inroads into addressing thesis, by:

1. Reviewing a major fishing method in the two regions in which there are operational interactions with marine mammals;
2. Characterising the nature and extent of depredation and by-catch where operational interactions are known to exist; and
3. Where deemed necessary in those fisheries, developing mitigation strategies and explore their efficacy.

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Collectively, the five research chapters in this thesis address these aims. They are stand alone case studies of marine mammal depredation and by-catch in commercial fisheries, four of which have already been published in international, peer reviewed journals. The first three research chapters focus on operational interactions involving odontocetes (i.e. toothed whales) and the second two research chapters focus on the otariids (i.e. eared seals).

Chapter 2 generally defines and reviews the nature and extend of odontocete (i.e. toothed whale) depredation and by-catch in longline fisheries, which has emerged as an environmental and economic concern internationally. At least 20 odontocete species are involved across all major oceans, although depredation and by-catch rates were variable. This study also introduces fishing gear modification as a viable mitigation strategy. Chapter 3 builds on this theme in more detail by exploring depredation and by-catch, mainly by pilot whales (*Globicephala* spp.), false killer whales (*Pseudorca crassidens*) and melon headed whales (*Peponocephala electra*), in pelagic longline fisheries targeting tuna in Australia and Fiji. Two devices were developed to physically or psychologically deter depredating odontocetes. Unfortunately, the rarity of depredation and by-catch events did not enable the efficacy of the devices to be properly assessed, although both were found to be easily integrated into the normal fishing practice and to have little or no impact on target fish catch rates. Chapter 4 attempts to specifically address the efforts of a purse-seine fishery operating in South Australia (SA) in reducing by-catch of common dolphins (*Delphinus delphis*), pursuant to conditions set out under the Australian Government *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). After characterising the nature and extent of the problem, it was found that a combination of a Code of Practice (CoP) using avoidance and release strategies and of gear modifications resulted in a reduction in encirclement by-catch from an estimated 377 to eight mortalities each year.

Chapters 5 and 6 attempt to assess the impact of a demersal gill-net fishery on the *Endangered* Australian sea lion (*Neophoca cinerea*) in waters adjacent to SA. Specifically, Chapter 5 assesses the performance of the Great Australian Bight Marine Park (GABMP) in protecting animals of populations residing within it, pursuant to a management plan that aims to uphold the spirit of the EPBC Act. It was found that individuals tracked using satellite transmitters spent only 27.7% of their time inside the GABMP and could travel up to 9 times further than the location of the southern boundary. Additionally, it was found that by-catch occurred beyond the southern boundary and also within the

GABMP during the six months each year that the fishery was allowed to operate within it, with an estimated 14 to 33 individuals killed each 17.6 month breeding cycle. Based on these findings, Improvements to the GABMP were recommended. In a similar manner to chapter 4, chapter 6 directly addresses recommendations pursuant to the EPBC Act to quantify the impact of a demersal gill-netting on all Australian sea lions across SA, by quantifying the extent of geographic overlap and the level of by-catch mortality and extent of overlap between the two. It was found that the two overlapped extensively in 68.7% of 4 km^{-2} cells and that by-catch was high, at 283 to 333 killed each breeding cycle. Based on these results, it was suggested that a network of permanent and temporary closures along with more extensive monitoring of fishing activities be considered.

In summary, this thesis demonstrates that with sufficient political will, stakeholder support and the necessary funds, by-catch and depredation issues can be addressed and can lead to favourable outcomes for the marine mammal populations and commercial fisheries involved. Each case study presented provides many lessons, some being specific to the operational interaction, the marine mammal species or the fishery, and some being more generally applicable. Regarding the latter, more general lessons, it is acknowledged that depredation and by-catch are statistically rare events that may vary across time and space. As such, investigating and addressing them is likely to be costly, with the results still only providing a snapshot or a broad estimate that may not be representative of the overall problem. Additionally, marine mammals are intelligent and may quickly learn how to circumvent mitigation measures, despite their complexity and cost. Although marine protected areas (MPAs) such as the GABMP are implemented with the best intentions, they are often of insufficient size to provide adequate protection and may also allow a level of fishing that still has a quantifiable impact.

Despite these drawbacks, all stakeholders are encouraged to adopt a spirit of collaboration and of commitment to attempting to resolve operational interactions with marine mammals where possible. Acoustic deterrence devices have many problems that are yet to be resolved, including their impractically large size and limited sound propagation and battery life. Nonetheless, their amalgamation with some of the physical deterrence technologies developed in chapter 3 may provide a more generic method of deterrence across all fisheries, thus providing hope that resolving operational interactions between marine mammals and commercial fisheries may be a viable proposition in the future.

Personal acknowledgements

Following tradition, firstly I would like to sincerely thank my supervisors for assisting me along the path towards achieving this life changing goal. Peter Shaughnessy was always available to provide endless and balanced advice, and proved to be an extremely tolerant sounding board for all of my ideas, the good ones and the not so good ones. Peter reviewed and improved endless drafts, all the time allowing me to take my own direction. He cared deeply about all aspects of the work and remained concerned for my welfare, especially during the more trying periods. Peter had the skill of putting me back on track with simple, insightful statements; the quintessential 'optim-o-realist'. Tim Ward stepped in at a time when all looked lost in the early days and helped me to embrace a broader approach to the project than I had originally intended. Despite the extra work, this turned out to be a very good idea. Tim also taught me some key lessons in writing that helped me to prepare the first publication associated with the thesis. I will benefit from those lessons throughout my career. Simon Goldsworthy facilitated my first academic opportunity; to explore the operational interaction between Australian sea lions and demersal gill-netting. I learned through my operational interactions with Simon that I should stick to my principals, whatever the outcome. Without doubt, this approach helped me to (perhaps stupidly) expand the project and to carry on to the bitter end, no matter how trying the conditions; kill or be killed.

Among my friends and colleagues, I must first thank Simon Childerhouse, my first marine mammal science 'boss'. Aside from being a 'doer' and collegial king, Simon also enthusiastically adopted the unofficial role of PhD supervisor, helping me to remain focused on finishing my thesis after I had returned to work. Aside from providing endless assistance with developing ideas, organizing logistics and funding, then structuring and editing drafts, Simon provided incredible motivation in a sports coach like manner. Simon singlehandedly dragged me over the finish line; you would not be reading any of these words had it not been for him. Included among the fonder memories from my PhD days will be gaining Simon as a lifelong friend.

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*

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Statement of originality

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Derek J Hamer and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Name: Derek John Hamer

Signature:

Date: 27 May 2013

Associated publications

During my PhD candidature at the University of Adelaide, my aim was to prepare all of the case studies as chapters, to a standard worthy of journal publication. When the time came to compile the thesis, four of the five chapters had been published in international, peer reviewed journals (one being featured), while the remaining chapter was published as an Australian Government report. They are, in order of their appearance in this thesis:

Hamer, D.J., Childerhouse, S.J., Gales, N.J., 2012. Odontocete by-catch and depredation in longline fisheries: a review of the literature and of potential solutions. *Marine Mammal Science* 28, E345-E374 (Chapter 2)

Hamer, D.J., Childerhouse S.J., 2012. Physical and psychological deterrence strategies for mitigating odontocete by-catch and depredation in pelagic longline fisheries: progress report. Progress report to Pacific Island Forum Fisheries Agency (FFA), Worldwide Fund for Nature (WWF) South Pacific, and Pacific Islands Tuna Industry Association (PITIA). Australian Marine Mammal Centre (AMMC), Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 47pp. (Chapter 3)

Hamer, D.J., Ward, T.M., McGarvey, R., 2008. Measurement, management and mitigation of operational interactions between the South Australian Sardine Fishery and short-beaked common dolphins (*Delphinus delphis*). *Biological Conservation* 141, 2865-2878. (Chapter 4)

Hamer, D.J., Ward, T.M., Shaughnessy, P.D., Clark, S.R., 2011. Assessing the effectiveness of the Great Australian Bight Marine Park in protecting the endangered Australian sea lion (*Neophoca cinerea*) from by-catch mortality in shark gill-nets. *Endangered Species Research* 14, 203-216. (Chapter 5)

Hamer, D.J., Goldsworthy, S.D., Costa, D.P., Fowler, S.L., Page, B., Sumner, M.D., 2012. The endangered Australian sea lion regularly becomes by-catch in and extensively overlaps with demersal shark gill-nets in South Australia. *Biological Conservation*. DOI: 10.1016/j.biocon.2012.07.010 (Chapter 6)

Over the same period, I was also involved in the publication of several other papers. Those most relevant of those to this thesis are as follows:

Hamer, D.J., Grayson, J. (eds). 2012. Issues paper for the Australian sea lion (*Neophoca cinerea*). September 2012. Report for the Threatened Species Scientific Committee (TSSC), Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 50pp.

Izzo, C., **Hamer, D.J.**, Bertozzi, T., Donnellan, S.C., Gillanders, B.M., 2011. Telomere length and age in pinnipeds: the endangered Australian sea lion as a case study. *Marine Mammal Science* 27, 841-851.

Lowther, A.D., Harcourt, R.G., **Hamer, D.J.**, Goldsworthy, S.D., 2011. Creatures of habit: foraging habit fidelity of adult female Australian sea lions. *Marine Ecology Progress Series* 443, 249-263.

Shaughnessy, P.D., Goldsworthy, S.D., **Hamer, D.J.**, Page, B., McIntosh, R.R., 2011. Australian sea lions *Neophoca cinerea* at colonies in South Australia: distribution, abundance and trends, 2004 to 2008. *Endangered Species Research* 13, 87-98.

Baylis, A.M.M., **Hamer, D.J.**, Nichols, P., 2009. Assessing the use of milk fatty acids to infer the diet of the Australian sea lion (*Neophoca cinerea*). *Wildlife Research* 36, 169-176.

Hamer, D.J., Ward, T.M., McGarvey, R., 2009. Objective reporting of scientific results is critical for maintaining relationships with industry and achieving conservation outcomes for fisheries. *Animal Conservation* 12, 287-288.

Statement of co-authorship

All five research chapters in my PhD thesis have been published (four in international, peer reviewed scientific journals and one as an Australian Government report). The completion of each was made possible through the contribution of many others, who have been either formally acknowledged, or have been included as co-authors. Co-authorship was offered to those who ultimately assisted by providing opportunities, data, advice and expertise. Ultimately though, most of the fieldwork and analysis, and all of the writing was completed by me. Naturally, the degree and nature of the contribution made by each co-author varied considerably, although sincere gratitude is extended to all involved. Each co-author has signed below, indicating their endorsement of the work and of co-authorship. They are, in alphabetical order:

Childerhouse, Simon J.

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