Evaluation of different management approaches to reduce the bycatch of Indo-Pacific humpback dolphins (*Sousa chinensis*) and Australian snubfin dolphins (*Orcaella heinsohni*) in Queensland, Australia

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Photograph by Alvaro Berg Soto

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Alvaro Berg Soto

Date

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I once read that postgraduate research studies have the unwelcome effect of making one feel stupid. The article argued that this phenomenon was caused by the constant sense of ignorance intrinsic to the struggle of answering research questions no one else has answered before. Although in many ways I still feel rather ignorant, the invaluable help and expertise provided by my advisory team largely abated the sense of stupidity that flavoured these long years of research. I would like to thank Dr. Michael Noad from the University of Queensland for his technical assistance with respect to fieldwork techniques and the unfathomable field of acoustics. Dr. Guido J. Parra from Flinders University is undoubtedly one of the leading experts in humpback and snubfin dolphin ecology in Australia, and his guidance was crucial for the development and completion of this project. PhD projects require not only knowledge of the fields studied, but also a thorough understanding of statistical analysis applicable to natural systems and populations. Although I found statistics extremely daunting due to my initial limited knowledge of this subject, Dr. Yvette Everingham from the School of Engineering and Physical Science at James Cook University helped me understand the magic of SPPS and ‘R’ programs. It is thanks to Dr. Everingham that I overcame my fear of statistics, and achieved a level of proficiency that helped me explore my

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Abstract

Incidental bycatch in gillnets is amongst the most serious global threat to marine mammals. Bycatch in commercial fishing gear is particularly troublesome, as this industry is vital for the sustenance of coastal human populations and typically uses its significant political clout to defend its interests. Consequently many management agencies aim to implement practical and efficient bycatch mitigation systems within commercial fisheries to protect species of conservation concern. In Queensland, such species include Indo-Pacific humpback dolphins and Australian snubfin dolphins. These species occur in small fragmented populations along most of the remote coast of subtropical and tropical Australia where they are caught in shark nets set for bather protection and commercial gillnets operated from small vessels.

Three main categories of mitigation approaches have variously been adopted globally to reduce marine mammal bycatch: (1) to change the behaviour of the fishers, (2) to change the nature of the interaction, and (3) to change the behaviour of the species of conservation concern. In addition to a complex system of marine parks with extensive 'no-take' areas, the Queensland Government proposed two types of technological solutions in 2006 to further reduce the bycatch of these species: (1) the implementation of passive acoustic monitoring to enable fishers to detect the presence of animals to avoid an interaction, and (2) the deployment of acoustic alarms to deter animals from fishing gear. To assess the relative efficacy of these and other bycatch mitigation measures, a multi-disciplinary study was desirable to address the complex nature of the bycatch issue, which covers multiple species and diverse stakeholders throughout different habitats and fisheries. This thesis evaluated the effectiveness of different mitigation measures to reduce the bycatch of humpback and snubfin dolphins in Queensland waters, by analysing historical mortality, and new acoustic, behavioural and social data.

To assess the current impact of bycatch on local populations of coastal dolphins, I analysed and compared mortality and stranding data between 1991 and 2010 from two databases maintained by the Queensland Government: StrandNet and Species of Conservation of Interest (SOCI) logbooks. Values considered in this analysis included: (1) species composition, (2) causes of mortality for coastal dolphins, and (3) geographical distribution of bycatch incidents. Chi square tests showed that the recorded mortality of coastal dolphins increased in the last 20 years, mainly due to bycatch mortality of common dolphins in Southeast Queensland. Uncertainty about the

overall causes of mortality for dolphins remains high. The bycatch mortality reported in StrandNet was mainly based on records from the Queensland Shark Control Program. This program recorded over 200 dolphin entanglements in nets with acoustic alarms attached since the mid 1990s. Bycatch incidents occurred more frequently in Southeast Queensland, as opposed to the Great Barrier Reef Marine Park World Heritage Area. However, bycatch incidents in Queensland are underreported, partially due to irregularities in the bycatch reported in SOCI logbooks by the East Coast Inshore Finfish Fishery. Even so, current bycatch levels exceed the Potential Biological Removal of some known inshore dolphin populations.

To assess the feasibility of using passive acoustic monitoring to detect and discern vocalisations from humpback and snubfin dolphins, I recorded their vocalisations at two locations along the Queensland coast. Vocalisations were categorised both qualitatively and quantitatively. Each species emitted a unique burst pulse sound. Humpback dolphins had at least 16 whistle types in their repertoire, while snubfin dolphins emitted at least 11 whistle types. Nine acoustic variables were extracted from these whistles. Cross-validated discriminant function analyses performed on the variables obtained from the humpback acoustic repertoire classified 83% of whistles correctly, supporting the qualitative categorisation of the repertoire for this species. Single and multiple inter-species discriminant function analyses performed on the acoustic repertoires of both species classified more than 95% of humpback whistles correctly and more than 80% of snubfin whistles correctly. Results indicate clear acoustic differences between the vocal repertoires of these two species, particularly with respect to the frequency parameters of their sounds. The ability to discriminate vocalisations of snubfin and humpback dolphins will facilitate future monitoring of these inconspicuous species, especially for distribution and abundance studies. However, the cost of purchasing and maintaining of the equipment, together with the training required, render the use of passive acoustic monitoring impractical for commercial fishers.

To further assess the practicality of fishers using passive acoustic monitoring to avoid an interaction with humpback and snubfin dolphins, I quantified how often these dolphins vocalise under the water. I also evaluated if vocalisation types were diagnostic of dolphin behavioural budget, with a view to better inform fishers how to react in the presence of dolphins engaged in specific behavioural activites. Although some vocalisations were more frequently recorded in association with certain behavioural states, this relationship was not significant, suggesting that the sounds emitted by

these dolphins are not diagnostic of behaviour. Inter-species differences in the way in which vocalisations and behaviour of humpback and snunfin dolphins were related may be a result of their distinct social structures. In addition, neither humpback nor snubfin dolphins vocalise constantly; they remained silent about a third of the time I observed them. This result suggests that the use of passive acoustic monitoring by fishers to detect their presence under the water may be unreliable about a third of the time.

To evaluate the effectiveness of acoustic alarms in deterring humpback and snubfin dolphins from a pinger array, I experimentally investigated whether a commercially available acoustic alarm modified the behavior of each species of dolphin in the absence of a net (for ethical reasons). I compared dolphin movements around an esonofied barrier that was active or silent on random days. I also quantified changes in both acoustic and surface behaviours throughout sequential treatments in which a pinger was introduced and removed from the proximity of a school of dolphins. The movements of humpback and snubfin dolphins around an array of acoustic alarms, and the likelihood of the animals leaving the area did not change significantly when the pingers were active. In addition, the introduction of a pinger in the proximity of dolphins elicited only subtle changes in their behavior. Specifically, humpback dolphins reduced echolocation rates as a possible alertness response, while snubfin dolphins reduced the time they spent vocalising. These results suggest that deploying acoustic alarms is unlikely to deter animals from fishing gear. Nonetheless, pingers are not expected to have a negative effect on the behaviour of these species.

To investigate the human dimensions of the bycatch issue, and to identify factors affecting the compliance of different bycatch mitigation measures by fishers, I interviewed 15 key participants about (1) their perception of bycatch as a problem for the fishing industry; (2) the factors that may increase the risk of an interaction with species of conservation concern; (3) their opinions on the effectiveness and practicality of selected bycatch reduction solutions; and (4) ways in which bycatch mitigation measures can be best implemented. In general, interactions with species of conservation concern such as dolphins were not perceived as a problem, as their incidence was claimed to be very low. Nonetheless, fishers were very knowledgeable about the factors that can increase the chance of an interaction, such as seasonality, fishing in areas known to be frequently occupied by species of conservation concern and the type of net used in fishing operations. Fishers' opinions about the effectiveness and practicality of different bycatch reduction solutions were varied, with a general tendency to prefer self-managing alternatives and net gear modifications to acoustic

alarms or passive acoustic monitoring. Fishers believe that to increase the compliance of a given mitigation measure, legitimacy for that solution must be achieved, preferably through fishers' participation at a regional scale.

I synthesised this information to assess the impact of bycatch on humpback and snubfin dolphins, the effecitveness of technological solutions proposed by the Queensland Government, and the legitimacy of bycatch reduction solutions. I concluded that: (1) bycatch of humpback and snubfin dolphins in Queensland poses a real threat to the viability of their small populations; (2) the effectiveness of technological solutions such as passive acoustic monitoring and acoustic alarms to reduce this bycatch is questionable; (3) the cost of implementation would be high; and (4) if mitigation measures are regarded as legitimate by fishers, the cost of compliance should decrease. As a result, I proposed to combine different mitigation solutions into a comprehensive bycatch reduction system, consisting of a core of spatial closures to ensure that the populations of these species are secure plus the implementation of operational solutions with greater uncertainty of effectiveness, in 'non-closure' areas throughout the ranges of humpback and snubfin dolphins. Ideally, these operational measures should be regarded as legitimate by fishers and involve their participation and co-management at regional scales.

Further research is necessary for this approach to be fully effective, including: (1) improvement of existing knowledge of coastal dolphin distribution, population estimates and area of occupancy along the Queensland coast, (2) behavioural and environmental information necessary to produce a model of population "hot spots" in their area of occupancy, and (3) inclusion of fishers local knowledge into current understanding of the dolphins' area of occupancy. Other fields of possible future research include: (1) ongoing research on the effectiveness of various types of acoustic alarms and (2) future acoustic studies of temporal and regional variations on the repertoires of Queensland's populations of coastal dolphins.

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Abbreviations and Acronyms

Distance units:

Kilometers.....km

Meters.....m

Millimeters.....mm

Time units:

Seconds.....s

Milliseconds.....ms

Weight units:

Kilograms.....kg

Grams.....g

Acoustic units:

Decibels.....dB

Hertz.....Hz

Kilo Hertz.....kHz

Terms:

Geographic Information System.....GIS

Species of Conservation Interest.....SOCI