Species conservation in a complex socio-ecological system: Irrawaddy dolphins, *Orcaella brevirostris* in Chilika Lagoon, India

Thesis submitted by

Dipani N. Sutaria M.Sc.

October 2009

for the degree of

Doctor of Philosophy

School of Earth and Environmental Sciences

James Cook University

Townsville

Australia

STATEMENT OF ACCESS

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere. All users consulting this thesis will have to sign the following statement:

"In consulting this thesis I agree not to copy or closely paraphrase it in whole or in part without consent of the author to make proper written acknowledgement for any assistance which I have obtained from it"

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and I do not wish to place any further restriction on access to this work.

Signature Date: October 22, 2009

Dipani N. Sutaria

STATEMENT OF SOURCES DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Signature Date October 22, 2009

Dipani N. Sutaria

ELECTRONIC COPY DECLARATION

I, the undersigned, the author of this work, declare that the electronic copy of this thesis provided to the James Cook University Library is an accurate copy of the print thesis submitted, within the limits of the technology available.

Signature Date October 22, 2009

Dipani N. Sutaria

STATEMENT ON THE CONTRIBUTION OF OTHERS

Nature of Assistance	Contribution	Names, Titles, Affiliations
Intellectual support	Proposal writing	Prof Helene Marsh Dr Rohan Arthur
	Data Analysis	Prof Helene Marsh Prof Ken Pollack Prof Mark Burgman
	Statistical support	Prof Helene Marsh Dr Yvette Everingham
	Cartography and GIS	Adella Edwards Alana Grech
	Editorial assistance	Prof Helene Marsh Prof Allison Cotrell Dr Guido Parra Dr Ellen Hines Dr Martin Robards
Financial support	Field research	Wildlife Conservation Society, NY: $US 11,200 Ocean Park Conservation Society: $US11,200
	Stipend, Write-up grant and travel grant to conferences	IPRS, James Cook University, Townsville, QLD Society for Marine Mammal Biology
Data collection	Research assistance	Ajit Mohanty Satya Behera Jyotimay Jena Ms Loba Fakir
	Interview design and transcription	Ms Loba Fakir
	Boat drivers	Jagannath Das, Barkul Ganesh , Mahisa
Logistical support	Living arrangements	Family of Ms Loba Fakir
	Administrative help	Vasundhara & Operation Kachappa, Bhubaneswar

ACKNOWLEDGEMENTS

My father had said to me that one day I would come back home. He wanted me to explore and to do things that we had dreamed of, with the reassurance that I would come back unscathed. His personality voiced that the truth is same as the dream, and that both are faced by the same nuances of realism. It took me some time to come back home the way I left him so many years ago. I would like to thank here all those who were part of my journey back home.

My thesis has been as much a part of my family as it has been a part of my life. Thanks to my mother to give me the strength and the compassion to see it through and my grandparents to give me the tenacity to transform and adapt so that dreams always remain true, in the dimension in which they were formed. Thanks to my brother, sisters and better halves for keeping me sane, and for supporting me financially and emotionally. Thank you for letting me follow my dreams, for seeing me through the PhD, and for telling me that whatever happens; I always have a home and a family. Thank you for the kids who always make me smile-Ishaan, Vivaan, Anamika, Aarya and Tigger.

No amount of thanks for my supervisor Professor Helene Marsh will be enough. Thank you so much for the unlimited support you have shown towards the project and for the regular meetings and guidance even when I was in field far away. Those meetings with you always refreshed and rejuvenated energies that were down and out. Thank you for working endlessly towards my presentations and for never discouraging my style or personality. Thank you for all the analytical and editorial assistance with the thesis, for encouraging me to finish, for offering me a write-up scholarship and for all those nerve-wrecking hours you spent rereading the text. Thank you for all the interesting conversations on books, films, cultures and places, and thanks to both Lachie and you, for a very comfortable home to write in.

I would like to thank my funders, Ocean Park Conservation Foundation, Hong Kong and Wildlife Conservation Society, New York for funding my PhD field research and for their support and interest. I sincerely thank James Cook University for supporting me through the International Postgraduate Research Scholarship and The School of Earth and Environmental Sciences (used to be TESAG) for giving me departmental support towards stipend, tuition waiver and travel funds to international conferences. I would also like to take this chance to thank Whale and Dolphin Conservation Society who has funded follow up projects in Chilika Lagoon, India.

I would like to take this chance to sincerely thank the then Principle Chief Conservator of Forests, S.C Mohanty for giving me the necessary permissions for my project, for encouraging my project and for always listening to the progress of my work. I would also like to thank Mr Anup Nayak, Mr Ajay K Jena, and Mr Abhimanyu Behera, from the Orissa Forest Department, Wildlife wing, for supporting my work. I would like to thank the then Chief Executive of Chilika, Dr Ajit Pattnaik for supporting my work and offering his guidance and advice on many parts of my project. Sirs, thank you all for all the time you spared to meet me every time I visited your office and for encouraging me.

I would also like to thank Ranjeet Patnaik, for first taking me to Chilika on Holi day in 2002 for a pilot survey. It was a wonderful experience and the pictures of A1 from that day are still with me. I would like to thank Rohan Arthur for encouraging me to apply for a PhD at James Cook University, for all the intellectual support he offered during the proposal writing and funding application phase. I would like to thank Mr Biswajit Mohanty and Operation Kachappa in Bhubhaneswar for always encouraging my work and supporting my initiatives and thank you for providing whatever logistical help you could and for introducing me to folks like Prutyush and Dutta Sir. I would also like to thank the folks at Vasundhara for the many nights I spent in their office and homes working on reports, for helping me fix my broken computer and for the trips to Devi River mouth.

The field research of my project would never have been possible without my assistants, and I thank all of them sincerely: Satya Behera, Ajit Mohanty, Jyotimay Jena, Loba Fakir,

Raja, Jagga and Ganesh and the six crew of my coastal survey vessel. I would also like to thank Vidyadar for helping me find a place to stay when I first moved to Chilika and Rabi Jena from Alupatna for offering his boat for my research. I would also like to give many thanks to Rabi at Rushikulya, Bichi at Devi and forest staff at Gahirmatha for helping me with data collection for my coastal surveys. Many thanks to the managers of the tourism associations in the Outer Channel of Chilika for giving me their time and sharing their thoughts with me. I am thankful to the innumerable folks in the villages I visited, for smiling, talking and often giving us a room to spend the night-those were very humbling experiences. The fisher-boy (who loved playing football on the weekends) from Mahisa who sang to the dolphins as he took me across the Rajhans channel in his dug out canoe every fortnight, is just one of those many people who made my life in field enriching.

I would like to especially thank the crab dealer's son in Balbhadrapura – Bhalu, for visiting me often to talk about anything but dolphins. Thank you for those twinkling eyes and the naughty smile. For getting bored when I took him on the boat once. He said I was crazy to be doing the work I did. At his tender age of seven he knew more than I did. I think of him more often than I think of many other people I know and meet regularly. He will stay with me always.

Company is always welcome when one is in field and a couple of people visited me in field and those days were always special- many thanks to Anuradha Rao, Curtis Andrews, Sudarshan Rodrigues, Aarthi Shridhar, Amanda Hodgson, Nicola Hodgins, Chaitanya Krishna and Aditya Bhaskaran. Lastly but very importantly, I would like to thank all those books that kept me company. I read voraciously during fieldwork under starlit nights, with an oil lantern to keep the pages bright. It is not possible here to list all those irreplaceable authors and poets who lived with me day and night. They spoke to me and I learnt to listen.

I would like to thank many colleagues and friends who took out time to discuss the project in different capacities-Dr Martin Robards, Dr Guido Parra, Dr Isabel Beasley, Dr Tom Jefferson, Dr James Sheppard, Dr Mark Burgman, Dr Ken Pollack, Adella Edwards, Jillian Grayson, Alana Grech, Dr Alex Aguilar, Dr Leszek Karczmarski, Dr Ellen Hines,

Dr Rohan Arthur, Brian Smith, Gill Braulik, Anouk Ilangakoon, Rubaiyat Munsur, Elizabeth Fahrni, Dr Randall Reeves, Dr William Perrin, Dr Allison Cottrell, Dr Ivan Lawler, Dr James Maloney, Dr Nadine Marshall, and Dr Peter Valentine. Thank you all very much. I would also like to thank Clive Grant, Robert Scott, Beth Moore, Susan Midson, Barbara Pannach and all the staff at the GRS and TESAG/SEES for administrative help and support.

I would like to thank all my friends who have supported me through the years. Renu Desai, Shona Dalal, Mehzabeen Hoosein, Kalpa Shah, Jillian Grayson, Guido Parra, Maria Jedensjo, Roxana Arthur, Amanda Hodgson, James Shepherd, Rohan Arthur, Karin Galloway, Yuki Ichinawa, Rima Jabado, Christopher Bartlett, Rie Hagihara, Chaitanya Krishna, Smita Krishnan and Martin Robards. Jill, thank you so much for being there (next door) every time I needed a friend. Smita (Krishnan), my mentor, and friend from one season to next, thank you for the seasons, the lessons, the laughter and the hugs. Rohan (Arthur), thank you for your words, your thoughts and your criticism and for the lovely place on Mitchell Street. I would also like to thank Coralie D'Lima and Nachiket Kelkar. Their interest in my work and my thoughts, even though over the distance kept me connected to a world I loved but could not enjoy. I wish you both all the best for your journeys.

Martin (Robards) – Thank you for nudging me along and for showing me that there is a moving on even if it takes some time. Thank you for waiting patiently. Thank you for Tupac. Thank you for bringing me home.

PUBLICATIONS ASSOCIATED WITH THE THESIS

Pattnaik, A. K., Sutaria, D., Khan,M., and Behera,B. 2007. Review of the Status and Conservation of Irrawaddy Dolphins *Orcaella brevirostris* in Chilika Lake of India. In Status and conservation of freshwater populations of Irrawaddy dolphins pgs 41-52. Wildlife Conservation Society, Pnom Penh.

Van Waerebeek, K., A. N. Baker, F. Felix, J. Gedamke, M. Iniguez, G. P. Sanino, E. Secchi, D. Sutaria, A. Van Helden, and Y. Wang. 2007. Vessel collisions with small cetaceans worldwide and with large whales in the southern hemisphere, an initial assessment Latin American Journal of Aquatic Mammals **6**:43-69.

PUBLICATIONS PLANNED:

Sutaria, D., and H. Marsh. (Ready to be Submitted). Photo-identification based Mark-Recapture methods for precise estimates of population size of small populations-Irrawaddy dolphins (*Orcaella brevirostris*) in Chilika Lagoon-India.

Sutaria, D., H. Marsh, S. Behera, J. Jena, and A. Mohanty. (Ready to be Submitted). The value and limitations of single surveys of coastal cetaceans: an Indian case study.

Sutaria, D., and H. Marsh. (In Preparation). Space use, Behavior and Social Structure of Irrawaddy dolphins in Chilika Lagoon, India.

Sutaria, D., and H. Marsh. (In Preparation). Assessing conservation status under Uncertainty - the Irrawaddy dolphin (*Orcaella brevirostris*) in Chilika Lagoon, India.

ABSTRACT

Endangered species conservation requires many lines of inquiry to provide the evidence required for a holistic approach to conservation planning. The main aim of my research was to inform the conservation planning of endangered species found in developing countries. It is my thesis that species conservation in developing countries is a socio-ecological issue and that the role of conservation science is limited without the inquiry of human dimensions and their influence on conservation outcomes. I studied the Irrawaddy dolphin, *Orcaella brevirostris* in Chilika Lagoon, India, as a case study to exemplify this problem and to validate a solution.

The Irrawaddy dolphin has been assessed as 'Data Deficient' by the IUCN at a global scale, but five freshwater and brackish water subpopulations are Critically Endangered. The species is found in isolated, patchy populations and tends to occupy shallow, muddy coastal waters, enclosed bays and lagoons, or freshwater river systems. In the region of the Indian subcontinent, the species has been recorded from Chilika Lagoon on the east coast of India, and in the tributaries of the Sunderbans Delta, West Bengal. My thesis informs current knowledge regarding Irrawaddy dolphins and produces new results for the population in Chilika Lagoon. The absence of recent Irrawaddy dolphin carcasses along the coast of Orissa or of sightings of live Irrawaddy dolphins during a vessel based survey of the coast suggests that the population in Chilika Lagoon is isolated and should be treated as a conservation target.

Chilika Lagoon is a RAMSAR site supporting a population of more than 200,000 people. A preservationist strategy which completely excludes people from protected areas by relocation programs is neither feasible nor culturally advisable in the case of Chilika Lagoon. To incorporate dolphin conservation and sustainable use of resources into the daily lives of the people requires strategies that consider the social circumstance of the communities, and their perceptions. I interviewed fishers from 44 villages to collect local information and knowledge regarding Chilika and its dolphins. The results indicate a

significant decrease in the range of the dolphins within the Lagoon and suggest that the major causes for mortality in dolphins are fishing nets, habitat loss and motorized boats. I found that fishers' perception of dolphins differed primarily with the location of their village, suggesting that experience plays a role in developing affiliation. Local people in Chilika like to observe dolphins, like to have them in their vicinity when they go fishing and to an extent revere dolphins. These are good signs for conservation and for future dialogue in the fields of awareness building, innovative solutions and co-operation towards conservation aims. I also found that the economic well being of stakeholders is dependent on fish catch and there are conflicting perceptions towards the management of fishery resources in Chilika among local communities and between policy makers and local communities. These issues of common property management are likely to limit the success of social programs, including conservation initiatives.

I identified 80 individual dolphins using natural marks and variously estimated the abundance of the population using Mark-Recapture analysis as 109 to112 individuals at CV=0.07 (closed models); and 140 at CV=0.25 (open models), based on surveys from November 2004 to December 2006. The power analysis indicated that a rate of 5% decrease per year would take 7 years to detect; even a decline of 20% would take 3 years to detect using the same survey protocols, by which time a population of 112 animals will have become reduced to 57 animals. It is thus critical that the monitoring of the population use a robust standard protocol which includes an assessment of uncertainty. I suggest that owing to the small population size, long-lasting natural marks, enclosed nature of the study area and already present photo-identification catalogue, the Mark-Recapture methodology would be feasible and appropriate for future monitoring of the population.

The total Extent of Occurrence for Irrawaddy dolphins in Chilika was <330km^2; and the Area of Occupancy was <131km^2, both of which are less than half of the available habitat. The dolphins concentrate their use in two core areas in the Lagoon: the Outer Channel (12km^2) and the South-Central Sector (49km^2). The site fidelity of individual dolphins is high with more than 80% of the individuals remaining within 10km of their mean centre. Home range estimates vary from 1.7km^2 to 186km^2 for individuals sighted more than nine

times between 2004 and 2006 with a large overlap in home ranges. The quality and carrying capacity of the habitat thus play an important role in the long term survival and health of dolphins in Chilika.

The analysis of group size and behavior suggested that average group sizes were small (3-4 dolphins) with 25% of the observations consisting of solitary individuals. Group size did not differ significantly among the behavioral states of feeding, milling and traveling, but were significantly larger when the dolphins were socializing and resting. The dolphins were found across the entire range of water depths and salinity, and group sizes varied little with changes in measured environmental variables. The core areas appear to be the major feeding grounds for Irrawaddy dolphins in Chilika Lagoon, with feeding, milling and socializing dominating the day-time activity budget.

A preliminary analysis of social structure for Irrawaddy dolphins suggested that the associations among dolphins in Chilika Lagoon were weaker and more fluid than those observed in other populations of *Orcaella,* which live in stable societies. Out of the 48 individuals analyzed, only 14 individuals showed an association index ≥ 0.5. Few individuals did not associate with any other individuals, whereas most individuals associated loosely with all other individuals.

Based on all the data, both the conventional IUCN assessment and the RAMAS Red List assessment indicate that the population of Irrawaddy dolphins in Chilika Lagoon should be listed as Critically Endangered. This decision would be precautionary rather than evidentiary and not without uncertainty.

I investigated the locally run dolphin-watching industry, an established occupation in the Outer Channel, to assess ways in which the industry could help in conservation of dolphins. Ideally, the industry would strengthen conservation programs through local economic development and income generation. Interviews with tourists suggest that boat drivers turn their engines off in the presence of dolphins indicating that most boat drivers have gradually become aware that dolphins stay around their boats longer if the engines are

off. Results from a questionnaire survey of tourist operators show that local communities are aware of the risks faced by dolphins from the tourism operations, and could distinguish factors that cause disturbance and mortality. Respondents suggested that removal of obstructions to dolphin movements was the most effective conservation strategy, as it would increase the amount of space available to dolphins and ease their movement between the Outer Channel and South Central sectors. This strategy would also increase the free movement of roe and fish into the Lagoon. The strength of the tourism linkage is very similar to that of the fisheries with communities in the Outer Channel of Chilika but conservation outcomes from the linkage have not yet been realized and would require responsible social and ecological planning to make the industry sustainable. There are currently no set approach distance and no limits on the number of boats allowed around a group of dolphins, or on the number of boats allowed to go dolphin watching per day. Conservation practitioners need to increase awareness amongst local stakeholders to help recognize the benefits of conservation goals, and the linkage between tourism livelihood and dolphin persistence.

My research demonstrates that conservation planners require evidence from both ecological and socio-economic lines of inquiry. Biological information is necessary, but not sufficient to conserve Irrawaddy dolphins in Chilika. Dolphin conservation is inextricably linked to natural resource management and system-level management. One of the main limitations to successful conservation is the mismatch between top-down 'expert opinion' - based management decisions and the preferences of the stakeholders who actually operate at the scale of the system being managed. Given the Critically Endangered status of the Irrawaddy dolphin population of Chilika and the cultural and social importance of dolphins, a long term conservation program inclusive of social and ecological research using an action-research model should be the future goal of conservation practice in Chilika. I propose a conservation model which functions with the support of policy makers to reduce cross-scale conflict, rather than as a top-down enforcer of protection. Given the range of natural and induced ecological changes in Chilika over the past decades and the changes anticipated in this era of climate change, sustaining habitat quality remains the priority of conservation planning for the Chilika system.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES