Keynotes & Posters

CIMCAR

DR. S. JONES CENTENARY COLLOQUIUM ON

'CHALLENGES IN MARINE MAMMAL CONSERVATION & RESEARCH IN THE INDIAN OCEAN'

26-27 August 2011
Kochi

Marine Biological Association of India

MBAI

CIMCAR

Jones Colloquium on Marine Mammals

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FOREWORD

The Marine Biological Association of India (MBAI), the first of its kind in Asia was founded in 1959 by the eminent marine biologist Dr Santhappan Jones. As the founder President, Dr Jones made clear the objectives of the Association on the occasion of the inauguration of the Association on 3rd January, 1959 by stating that "Marine Biology is an infant science in this country. India has a long coastline and our marine resources remain inadequately explored and under-exploited. The object of the Association is to create a dynamic interest in the pursuit of marine sciences and raise the status, of this country in the study of this discipline. The Association is looking forward with courage and hope towards the achievement of this goal ....."

Immediately after the Association was formed, within 6 months, a scientific Journal was initiated and the Noble laureate, Sir C,V,Raman, the then President of Indian Academy of Sciences, Bangalore messaged on the occasion that 'It is most fitting that the men of science in India who are actively interested in marine biology should band themselves into an Association and promote a journal which would be a forum for the publication of the results of their studies'. Dr Jones, a great visionary of science dedicated his entire life to administer and implement research programs on marine ecology and fisheries. Under his stewardship, and, by the concerted efforts of several researchers, this branch of science progressed from its infancy to a multidisciplinary modern day science.

Later, Dr Jones and subsequent Presidents of MBAI organized several National and International Symposia of diverse themes under the aegis of the Association, bringing together contemporary researchers for exchange of ideas and sharing of knowledge which fostered the growth and development of Marine Biology in the country.

Now, on 26th and 27th August 2011, on the occasion of the birth centenary year of Dr.Jones, the MBAI is paying a tribute to this remarkable marine biologist who was well known for his thirst for knowledge, tireless pursuit of research and indomitable spirit, by organizing an International Colloquium on Marine Mammals, a subject which was a passion to him. Details on the life history of most of these fascinating marine mega fauna whose existence is under grave threat due to various anthropogenic factors is obscure. Several of these wonderful creatures are migratory and have specific habitats in the coastal and oceanic realms. The international colloquium on 'Challenges in Marine Mammal Conservation and Research in the Indian Ocean the (CIMCAR)' has triple objectives of assessing the status of research on marine mammals in the Indian and contiguous seas, identify research gaps and suggest advanced research for proper understanding and conservation of this endangered resource.

In this publication we have compiled the seven keynote addresses and eight poster presentations of the CIMCAR. I am confident that these will be informative and form a sound database on which further planning can be done by the neighbouring countries to protect, conserve and to provide an ecosystem which is congenial for the life of marine mammals.

On this occasion, I gratefully acknowledge the encouragement and support received from Dr.G.Syda Rao, Director, Central Marine Fisheries Research Institute and President of MBAI. The financial support received from CMFRI, World Wildlife Fund for Nature, Central Institute of Fisheries Technology (CIFT) and Central Institute of Freshwater Aquaculture (CIFA) is also placed on record. Dr.K.S.Mohamed, Secretary, MBAI has been the key person behind the entire programme. I place on record the tremendous and untiring effort put in by Dr. Mohamed to coordinate with international experts and to organize the event. All members of various committees constituted for the conduct of CIMCAR have put in their effort and spared their valuable time to organize this event successfully. I also thanks all international experts in mammalogy in region who have contributed their article and presentations in the CIMCAR.

I hope the dream of our founder President Dr. Jones, to create a dynamic interest among researchers in Marine Biology will be fulfilled over the years and in this 21st century, which is an era of international collaborations, all of us will join hands to understand the biological needs of resources, to protect them from extinction and strive to preserve the biodiversity in the vast and dynamic marine realm.

Dr. N,G.K.Pillai

Vice President, MBAI and Convener, CIMCAR, Kochi, Kerala, India

26.8.2011

DR. S. JONES - A BIOGRAPHICAL SKETCH

Santhappan Jones was born on 27th August 1910 at Kovalam in Kerala. He is the fifth and last child in the family. He had his early education at Venganoor near Kovalam and at Trivandrum. Soon after graduating with distinction from the Maharaja's College of Science (now University College), Trivandrum in 1933, he started his research as a honorary research scholar in the same college for a year. Later, the award of a university scholarship enabled him to proceed to the Zoology Laboratory of the Madras University for further studies and he received the M.Sc. degree in 1937 for his investigations on the breeding and development of brackishwater fishes. From then on, this line of work has been dearest to his heart. His ability and enthusiasm for studies on fishes captured the attention of Dr. Baini Prashad. Dr. Sunder Lal Hora and Dr. B. Sundara Raj. the giants in the field in those days.

After brief studies on the growth of marine invertebrates of the Colombo Harbour and the development of certain fresh-water fishes at the Marine Biologist's Laboratory of the Colombo Museum, and a short stint as the faculty of the Madras Christian College, he joined the erstwhile Travancore State Service as an entomologist in 1937. He continued the entomology work for the next ten years. On transfer to the Central Research Institute of the University of Kerala in 1939, he underwent training in agricultural entomology in 1943 at the Agricultural Research Institute. Coimbatore. In spite of the administrative responsibilities as entomologist he did concerted work on the control of the coconut leaf roller. the rice swarming caterpillar etc. He established the first research station on cardamom at Pampadampara and worked on cardamom pests like thrips, hairy caterpillar and weevil, and published the results in reputed journals.

He had taken as his ideal Dr. Nelson Annandale, the Founder Director of the Zoological Survey of India, who by his leadership and wide spectrum of work on 'animals, laid the foundation for zoological research in the Indian subcontinent. An incident in 1945 contributed to a great extent to change the entire life and career of Dr. Jones. The erstwhile University of Travancore (now Kerala University), withheld the Ph.D. degree that Dr. Jones was entitled to receive as per the recommendation of the board of examiners. This was done to eliminate him from becoming a potential competitor for higher posts subsequently. The examiners on coming to know of the injustice done, returned in protest the remuneration received by them, and the University authorities smarting under the ignominy and guilt tried to cover up the entire episode by passing on the tainted money to the Vanchi Poor Fund! The above prompted Dr. Jones to accept an offer of appointment under the then British Government and to go in for a higher degree than Ph.D. from elsewhere, without yielding to the pressure and persuasion to resubmit the thesis. In June 1947, he was called upon to serve as the Head of Estuarine Fisheries Division of the newly started Central Inland Fisheries Research Institute at Barrackpore, Calcutta. During this period he carried out extensive studies on the life histories and fisheries of Indian fishes, which earned him the D.Sc. degree of the University of Madras in 1952. In 1951-'52, he held charge as the Chief Research Officer (Director) of this research station. In January 1954, Dr. Jones as he puts it, was "confronted with the unexpected transfer" to what is now known as the Central Marine Fisheries Research Institute, and was posted at Calicut as the Head of the Fishery Biology Division. Despite these vagaries of service, by dint of his unremitting hard work, Dr. Jones secured the highest office of Chief Research Officer (later redesignated as Director) in the Institute in April, 1957 at a relatively young age of 46 years, and moved to the headquarters of the Institute at Mandapam Camp.

The polio affliction that he sustained at an advanced age of 53 years would have taken its toll on a lesser mortal but not on Dr. Jones. If anything, it made him more tenacious, more determined, and the tempo of his activity increased tremendously, like the Phoenix rising from its ashes, to the surprise of his contemporaries. To those of his "well wishers" who wanted him to take "complete rest" in view of his disability he used to aver for their satisfaction that this would certainly be done in his grave! He challenges any unwary sympathizer of his handicap by jocularly remarking that he is "more active above his hips" than most of his countrymen!

He held this post for nearly 13 years without allowing himself to be detracted by the lure of more remunerative assignments that were open to him at national and international levels, to develop the Institute and to foster research on marine fish and fisheries till he laid down the office in February, 1970. After retirement also Dr. Jones has been continuing his scientific studies as Emeritus Scientist at the University College, Trivandrum. Simultaneously, Dr. Jones began to plan and organize a residential home for the rehabilitation of children handicapped by polio at Trivandrum, under the aegis of the Church of South India. This he continued till his death in 1997. From April 1957 till February 1970 it goes without saying that the history of Dr. Jones' service assumed a major part of the history of the Central Marine Fisheries Research Institute. To blaze new trails and to be second to none which are parts of his personality-these traits began to unfold and take firm hold on him.

In recognition of his varied researches, Dr. Jones was elected a Fellow of the Indian Academy of Sciences, a Fellow of the Zoological Society of India, a Fellow of the National Geographic Society, etc. The "most "outstanding and perhaps permanent contribution of Dr. Jones for which the marine fishery science in India and particularly in Kerala will have to be ever grateful is with regard to the initiative he took and the dominant and decisive role he played in shifting the headquarters of the Central Marine Fisheries Research Institute from Mandapam Camp to Cochin. He passed away in 1997.

Extracted and modified from James P. S. B. R. (1986), Dr. S. Jones – A Biographical sketch. In: Recent advances in marine biology (Dr. S. Jones' 70th birthday Commemoration Volume) Ed. James P. S. B. R. Today and Tomorrow's Publishers, New Delhi

UNEP/CMS Office - Abu Dhabi: Initiatives on Dugong Conservation in the Indian Ocean Region

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Introduction

Convention on the Conservation of Migratory Species of Wild Animals (CMS) is an international treaty managed by the United Nations Environment Programme (UNEP). Its Secretariat is based in Bonn, Germany, and it has two outposted offices – one in Abu Dhabi and one in Bangkok. The principal objective of CMS is the conservation of migratory species of wild animals. To date, 116 countries are Party to CMS. CMS has two main legal tools: species listings and regional agreements. These are Appendix I "Threatened Migratory Species in Need of Strict Conservation Action" and Appendix II "International Instruments for Species Conservation via (Sub-)Regional Agreements" which include (a) legally-binding Agreements/Action Plans and (b) Memoranda of Understanding /Action Plans.

With regards to marine mammals, CMS hosts the following Agreements:

★ ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area)

★ ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas)

★ Wadden Sea Seals (Agreement on the Conservation on Seals in the Wadden Sea).

The marine mammal Memoranda of Understanding hosted by CMS are MOUs on:

★ Cetaceans in the Pacific Islands Region

★ Mediterranean Monk Seal

★ Western African Aquatic Mammals

★ Dugongs.

More information on each MOU and Agreement can be found via www.cms.int > Species Activities. This paper concentrates on dugongs, as the UNEP/CMS Office - Abu Dhabi serves as the Secretariat to the Dugong MOU.

Dugongs, Habitats and their Threats

The dugong is a conservation-dependant marine mammal inhabiting tropical and subtropical coastal waters. The Dugongidae shares the Order Sirenia with just three species of manatee. It is the sole member of the genus Dugong, which is the only extant species of the Family Dugongidae. These large marine seagrass specialists can be found in the warm tropical waters of the Indo-Pacific region that spans 37 countries and territories. The distribution range of dugongs is believed to have been broadly coincident with the tropical Indo–Pacific distribution of its food plants, the phanerogamous seagrasses of the families Potamogetonaceae and Hydrocharitaceae.

Due to their life history of being long-lived and slow breeding, extensive range and their dependence on seagrasses around coastal habitats, the dugong is particularly vulnerable to both a broad spectrum of direct human-related influences (ranging from unsustainable fishing practices and vessel strikes), as well as indirect anthropogenic threats to their habitats (including trawling, dredging, inland and coastal clearing, land reclamation and nutrient loading). Most of the world's remaining dugong populations outside of Australia and the United Arab Emirates are at serious risk of disappearing without effective and timely conservation action.

The major causes of dugong mortality are poaching, unsustainable hunting, entanglement in fishing gear, vessel strikes and habitat degradation. Gillnets are being used in almost 90% of the dugong's habitat, which threatens their survival. Reducing dugong mortality in fisheries remains the greatest challenge to the conservation of the world's only herbivorous marine mammal. Population change is quite sensitive to variances in adult survivorship and even a slight reduction in adult survivorship as a result of habitat loss, disease, hunting, or incidental drowning in nets, can cause a chronic decline in the overall viability of the dugong population. As such, it is critical to safeguard remaining major populations occurring in throughout their range.

Similarly, the seagrass habitats on which these species depend are equally important not only for the survival of the dugong but a plethora of other marine life and significantly enhance the biodiversity of coastal waters. Seagrass ecosystems provide important habitat and breeding grounds for many marine species, including important fishery species that millions around the globe depend on daily for their livelihoods. These same ecosystems provide a suite of environmental services to humanity, including coastal protection from extreme weather events, seabed stabilization, the provision of shelter to myriad species and astounding carbon sequestration sink capacity. Unfortunately, it is estimated that at least one third of the world's seagrass habitat has already been lost, and the remaining habitat is currently disappearing at a rate of 7% per year.

Dugongs are particularly vulnerable to anthropogenic influences due to a combination of their life history, their extensive range, and overlapping distribution along rapidly developing coastal habitats. This puts them in the front lines of many insidious and compounding threats. Given the dugong's capacity to move across jurisdictional boundaries, coordinating management initiatives across these boundaries will be crucial to its long-term survival. Without cooperative decision-making and the necessary critical mass for collective action, the future of the dugong is uncertain.

Summary of information regarding current threats to dugongs. (Source: Modified from UNEP 2002).

	Threatening Process						
Subregion	Habitat Loss and Degradation	Fishing Pressure	Indigenous Hunting and Use	Vessel Strikes	Acoustic Pollution	Eco-tourism	Diseases
Western Range[1]	‖	‖	‖	‖	‖	‖	‖
India & Sri Lanka[2]	‖	‖	‖	‖	‖	‖	‖
East & Southeast Asia[3]	‖	‖		‖	‖	‖	‖
Pacific Islands[4]	‖	‖	‖	‖	‖	‖	‖
Australia[5]	‖	‖	‖	‖	‖	‖	‖

1. East Africa, Red Sea and the Gulf.
2. India including the Andaman and Nicobar Islands.
3. Japan, China, Philippines, Thailand, Cambodia, Vietnam, Malaysia, Singapore, Timor Leste and Indonesia.
4. Palau, Papua New Guinea, Solomon Islands, New Caledonia and Vanuatu.
5. Western Australia, Northern Territory and the Queensland Coast of the Gulf of Carpentaria, Torres Strait and Northern Great Barrier Reef, Urban Coast of Queensland.

Currently dugongs are classified as vulnerable to extinction under the 2009 World Conservation Union (IUCN) Red List of Threatened Species, which indicates that they face a high-risk of extinction in the wild in the medium-term future. The CMS lists the dugong in its Appendix II, meaning that the conservation of the species would benefit from international cooperative activities organized across dugong's migratory range.

Mitigation and Conservation and Management Plan Priorities

Managing adverse impacts on dugongs throughout their vast and often remote range presents a challenge, which will require a pro-active and comprehensive approach. Ultimately conservation initiatives would seek to conserve dugongs across both their historic and current range. Such a systematic and co-coordinated approach will benefit not only dugong populations but also the ecological integrity of the marine environment.

The Dugong MOU is designed to facilitate national level and transboundary actions that will lead to the conservation of dugong populations and their habitats. The associated Conservation and Management Plan (CMP) provides the basis for focused species and habitat-specific activities, coordinated across the dugong's migratory range. The CMP has nine objectives:

- ★ Reduce direct and indirect causes of dugong mortality
- ★ Improve our understanding of dugongs through research and monitoring
- ★ Protect, conserve and manage habitats for dugongs
- ★ Improve our understanding of dugong habitats through research and monitoring
- ★ Raise awareness of dugong conservation
- ★ Enhance national, regional and international cooperation
- ★ Improve legal protection of dugongs and their habitats
- ★ Enhance national, regional and international cooperation on capacity building

Together, the MOU and CMP are intended to be the primary platform for conservation actions on behalf of the species in all of the waters of coastal and archipelagic States of the Indian Ocean, East Asia and western Pacific Ocean, as well as their adjacent seas.

The UNEP/CMS Dugong MOU covers dugong *(Dugong dugon)* throughout its

The UNEP/CMS Dugong MOU covers dugong (Dugong dugon) throughout its range from East Africa to the Pacific Islands. The Dugong MOU, which has 20 signatories and over 40 range states, is serviced by the Secretariat based at the UNEP/CMS Office - Abu Dhabi. The Dugong MOU is a non-binding intergovernmental agreement and its principal objective is to restore, or where appropriate maintain, a favourable conservation status for dugongs and their habitats on which they depend – taking into account, where appropriate, subsistence and customary use of dugongs in those states where is it permitted. The Dugong MOU Secretariat is funded by the Government of Abu Dhabi and cohosted by the Environment Agency - Abu Dhabi.

Dugong conservation and management activities

Conventional conservation measures for dugongs and their habitat include establishing spatial closures as marine reserves and temporal constraints to fishing operations. To date, incentives, such as loans for buying dugong-friendly fishing gear, educational campaigns and measures to improve the livelihood of local communities have not yet been applied to complement other traditional conservation tools. The Dugong MOU Secretariat has begun development of pilot projects to apply these new incentive based tools to dugong conservation which can also have social and economic benefits for local communities. Co-benefits to other marine species may occur as well.

The recent Dugong MOU activities include sub-regional dugong meetings in India and Malaysia, development of an advisory and conservation and management toolbox, and pilot projects to trial innovative financial and social incentives in dugong conservation.

(i) Sub-regional meetings

In a major step towards enhanced regional cooperation for the conservation of dugong, India hosted the First South Asia Sub-Regional Workshop on the Conservation and Management of Dugongs on 6-7 June 2011, in Tuticorin, Tamil Nadu. Policy and conservation management experts from Bangladesh, India, Pakistan and Sri Lanka came together to discuss the status of dugong conservation in their respective countries, shared information, undertook training to help develop their capacity to conduct the standardised surveys on dugongs, and worked towards preparing a coordinated CMP in South Asia. The workshop was organized jointly by the Ministry of Environment and Forests, and the UNEP/CMS Office - Abu Dhabi, in collaboration with the Wildlife Institute of India.

The high commitment from each of the range states was reflected in the unanimous support of the recommendations: (1) encourage the Governments of South Asia range states to sign the UNEP/CMS Dugong MOU; (2) develop and deliver a practical and resource-efficient strategy to collaborate in, and implement regional dugong conservation and management initiatives; (3) enhance communication among participating countries and organization; and (4) identify the financial and technological resources to support implementation of these recommendations.

A South East Asia sub-regional dugong meeting was held on 27-29 July 2011 in Lawas, Sarawak, Malaysia. Similarly, a dugong meeting for South West Indian Ocean sub-region will be held in association with the 7th WIOMSA Scientific Symposium on 28 October 2011 in Mombasa, Kenya.

(ii) Standardised Surveys

The Dugong MOU Secretariat has developed standardised methodology and protocols for fisher surveys and related work (e.g. habitat monitoring) with the involvement of key technical experts from e.g. James Cook University, San Francisco State University, and Marine Research Foundation (which has been undertaking a global study on bycatch in artisanal fisheries). The Standardised Dugong Catch/Incidental Catch Survey Tool was published on May 2010 on the Secretariat's website. It is a low-cost methodology for the rapid assessment of abundance and spatial distribution of dugongs and their habitats and on impacts on dugong populations including incidental by-catch in artisanal fisheries, habitat degradation and direct harvests. While the survey tool focuses on dugongs, it can also be used for collection of data for sea turtles and dolphins, and adapted to other marine wildlife such as manatees, small cetaceans and sharks.

A Dugong Catch/Incidental Catch Survey Tool has produced some quality data from 20 countries in the Pacific Islands, South Asia and the United Arab Emirates. The data will be combined into a geographical information system to identify the trouble spots, provide crucial information on existing populations and map important habitat areas. During 2011, the survey is extended to Range States in East Africa and the Western Indian Ocean littorals, North West Indian Ocean, South Asia as well as South East Asian regions. A workshop to this effect took place in India in June 2011 and in Malaysia in July 2011.

Standardized surveys are part of the financial, advisory and conservation toolkit to provide incentives for changes in fishing gear and practices to reduce the accidental bycatch of dugongs. The Dugong MOU Secretariat has sought to address critical lack of dugong data concerns at a regional level, to build capacity amongst dugong range states to better understand the issues between bycatch and dugong population status through the development of research and management tools, and for the development of an exciting new conservation approach as a pilot project.

(iii) Pilot Projects to trial financial incentives

Providing financial incentives to encourage the fishing community to replace harmful gillnets with alternative equipment such as line-fishing gear to reduce bycatch is one option being considered in the pilot projects. The pilot projects aim to trial innovative finance and gear exchange measures to protect dugongs and other marine species. Financial incentives will be promoted to make sure that conservation needs and sustainable development are reconciled at the community level to reduce hunting and bycatch by providing some form of incentive to drive behavioural change – this might be in the form of loans, or payments for ecosystem services, for lessening their catches or for changes to more dugong-friendly fishing gear.

Dugong conservation efforts will have other benefits as the protection of dugongs can have positive impacts across a wide range of habitats, in turn protecting other coastal marine species such as turtles, whales, dolphins and sharks. In addition to biodiversity conservation and promoting sustainable fisheries practices, changing gear-types to reduce bycatch would also make a significant contribution to the Green Economy of small-scale and subsistence fisheries. Under conservation agreements with the communities, the ecological and economic value of seagrass habitats would be protected and livelihood incentives for coastal communities would be guaranteed, many of whom rely on these sustainable small-scale fisheries.

In January 2011 the Dugong MOU Secretariat sought Expressions of Interest for pilot projects to trial financial incentives, and decided that in the first instance, will fund pilot projects in Mozambique and Papua New Guinea. Five other projects were assessed as having the potential to meet the criteria and become viable financial incentives pilot projects – subject to available capacity, resources and funding. These potential projects have been invited to work closely with the Secretariat to further develop their proposals. Recently the Secretariat has developed a transboundary pilot project proposal with India and Sri Lanka.

The overall objectives of the project are to conserve dugongs and seagrass habitats through incentives which drive conservation activities and environmental stewardship across the dugong's range using innovative financial, educational and knowledge transfer tools that encourage development and assist in accessing wider markets. The waters of the Gulf of Mannar between India and Sri Lanka are home to the largest remaining dugong population in South Asia, and funding is needed to work with local partners to develop the first incentives-based dugong and seagrass ecosystem project that crosses national boundaries. Through this project we aim to provide concrete, sustainable development incentives to fishing communities to change fishing gear and practices to reduce dugong bycatch.

In addition to biodiversity conservation and promoting sustainable fisheries practices through certified marine products, we envision the project will also make a significant contribution to greening the economy of small-scale and subsistence fisheries. Under conservation agreements with the communities, and the ecological and economic value of dugongs and their habitats will be protected while livelihood incentives for coastal communities will be guaranteed.

From a governance perspective, this project is our most ambitious. It embodies UNEP's mission by working across international boundaries with organisations including the Ministry of Environment and Forests, Gulf of Mannar Biosphere Reserve Trust (GOMBRT), Wildlife Trust of India, Reefwatch Marine Organization, Wildlife SOS, GEER Foundation, and the Government of Sri Lanka.

The Secretariat is also looking for external funding for the pilot projects to cover actions for the next three years and to secure long-lasting effects. A Strategic Support Team of selected advisors assists the Secretariat in the process.

(iv) Other Initiatives

2011 Pacific Year of the Dugong

The Secretariat has been supporting the 2011 Pacific Year of the Dugong, an initiative of the Secretariat of the Pacific Regional Environment Programme (SPREP. Also, in March 2011 the Dugong MOU Secretariat travelled to Palau for the regional launch of the campaign, and to Papua New Guinea for a national launch. The regional launch was news an internationally recognised event.

Fund-Raising

The Secretariat is also actively seeking substantial external funding from private, business and philanthropic as well the Global Environment Facility for a range of research, conservation and management projects coordinated over the global range of the dugongs which will secure sustainable funding streams in the long term. A Strategic Support Team of selected advisors assists the Secretariat in this process.

Conclusion

It is clear that dugongs are vulnerable to anthropogenic influences due to their life history, extensive range and distribution along rapidly developing coastal habitats. Given the dugong's ability to move across jurisdictional boundaries, coordinating management initiatives across these boundaries will be crucial to its long-term survival. Without cooperative decision-making and action the future of the dugong looks uncertain. The UNEP/CMS Dugong MOU presents an opportunity for States to develop and implement conservation actions to restore the dugong to a favourable conservation status and represents significant progress towards the international cooperation that will be essential for the conservation of the species.

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Marine Mammal Research and Conservation in Sri Lanka

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Historical background

The occurrence of marine mammals in the waters around Sri Lanka was known only by fishermen and a few seafarers in historical times. Travelers and historians such as Ibn Batuta mention whales in the waters around "Serendib" as far back as the 14th century. Later historians documenting the islands natural history, who wrote of whales, dolphins and the dugong include Sir James Emerson Tennent (1859 and 1861), E. W. Holdsworth (1872), A. Haley (1884 and 1887), H. Neville (1887) and W. T. Blandford (1888-1891).

Most of the early documentation on marine mammals in Sri Lanka was in relation to whale strandings. Being small in size the island had the advantage of strandings on her shores being reported and documented from as far back as 1889 (Deraniyagala, 1960; Fernando, 1912) when a sperm whale stranding was first reported in the scientific literature. Both literature and skeletal museum specimens from stranded whales are available from this period onwards.

As an island nation, Sri Lanka has a long tradition of fisheries around her shores but interactions between cetaceans and fisheries are mentioned in the literature for the first time in the mid-20th century (Lantz and Gunasekera, 1955). However the targeted dugong fishery that existed till the mid-20th century was documented in administrative reports from the early 1900's.

Despite documentation on strandings there were very few scientifically documented references to live sightings of marine mammals in Sri Lanka's waters before the 1980's. Sighting records from dedicated surveys and even opportunistic observations only began to be systematically documented in the early 1980's. Present knowledge about this diverse segment of mammalian fauna is therefore limited due to a lack of dedicated research on the subject.

Research and results

After the declaration of the Indian Ocean Whale Sanctuary by the International Whaling Commission (IWC) in 1979, the need for research on marine mammals in the northern Indian Ocean region became evident and was encouraged. In response to this international focus the National Aquatic Resources Agency (NARA) in Sri Lanka convened the first Symposium on Marine Mammals in the Indian Ocean which was held in Colombo in 1983. This helped bring the ocean around Sri Lanka to the attention of marine mammal researchers from around the world and led the way for some early research efforts including:

★ The World Wildlife Fund sponsored Tulip Expedition to study sperm whales off the east coast of Sri Lanka from 1982-1984.

★ The Centre for Research on Indian Ocean Marine Mammals (CRIOMM) was initiated in Trincomalee in 1983.

★ The National Aquatic Resources Agency (NARA) of Sri Lanka initiated its National Marine Mammal Programme in 1985. It was financially supported by the United Nations Environment Programme (UNEP) and continued till 1989. This programme focused on capacity building and initiating national studies on all aspects of marine mammals including sighting surveys, strandings and studies on fisheries catches.

The early impetus centred around Trincomalee on the east coast was unfortunately not sustained due to the escalating ethnic conflict in the north and east of Sri Lanka and even NARA's research programme moved away from the east coast in the late 1980's. Subsequently other studies continued on the south and west coasts on a more sporadic basis (as and when resources became available), from the 1990's to the present. Some of the aspects studied during this period and the more important references resulting from such studies in the form of reports and published papers are summarized below:

Type of Study	Related References
Cetacean bycatch	Prematunga, et al., 1985; Leatherwood and Reeves, 1989; Ilangakoon 1989, 1997, 2002, 2003, 2007; Ilangakoon et al., 1992, 2000b; Chantrapornsyl et al, 1991; Leatherwood et al., 1991; Kruse et al.,1991; Dayaratne and Joseph, 1993;
Cetacean sightings	Whitehead et al., 1983; Leatherwood et al., 1984; Alling, 1986; Alling et al., 1991; Gordon, 1991; Leatherwood et al., 1991; Ilangakoon, 2002, 2005, 2006b, 2007, 2008, 2009; Ocean Alliance, 2003; Branch et al., 2007; Ilangakoon and Parera, 2009, Ilangakoon et al., 2000a, 2010, 2011; Broker and Ilangakoon, 2008;
Cetacean strandings	Leatherwood and Reeves, 1989; Ilangakoon, 2006c; Branch et al., 2007; Herath, 2007.
Dugong studies	Leatherwood and Reeves, 1989; Ilangakoon et al, 2004, 2005, 2008; Ilangakoon, 2010, 2011.

Stranding network

While there was no formal stranding network till the mid-1980's such a network was initiated in 1985 by NARA, involving informants from coastal communities and local authorities. Once this network became operational it became possible to respond to strandings quickly and assist and re-float live animals, identify species not previously known to occur in the waters around the country, conduct necropsies on dead animals, collect samples for further analyses and retrieve skeletal material and complete skeletons from dead animals for study, education and display purposes. Despite a stranding network being in place there have also been some failures due to re-floated animals stranding again in another location, dead carcasses being moved around by tides, inefficient local authorities being unable to manage the situation till the response team arrives, stranding sites being difficult to reach in a timely manner because of remoteness, lack of access and security reasons.

Diversity and relative abundance

To-date 28 species of marine mammals have been recorded as occurring in the waters around Sri Lanka based on data from sightings, stranding and fisheries mortality. Bycatch studies have yielded valuable information in this respect as some species were first identified by examining specimens landed as bycatch. Taxonomically, of the 28 species recorded, 27 belong to the Order Cetacea and are placed within the two Suborders Mysticeti and Odontoceti. They belong to the six families of Balaenopteridae, Physeteridae, Kogiidae, Ziphiidae, Delphinidae and Phocoenidae. All the Mysticetes are in the Family Balaenopteridae distinguished by the presence of expanding throat grooves. The Odontoceti recorded range in size from the 18-metre sperm whale to the small finless porpoise and feed on a variety of food including fishes, cephalopods and crustaceans. The dugong *(Dugong dugon)* meanwhile is the single species in the Order Sirenia and it is confined to the waters of the northwest (Gulf of Mannar, Adam's Bridge, Kalpitiya) where its favoured seagrass habitat still occurs.

With regard to species richness and relative abundance of marine mammals around Sri Lanka, the blue whale (Balaenoptera musculus) is by far the most common Balaenopterid all around the island. Another common species is the smaller Bryde's whale *(Balaenoptera edeni/brydei)* which frequents coastal waters although the exact species is as yet inconclusive due the taxonomy of this species being presently unclear. Other baleen whales recorded include the fin whale *(Balaenoptera physalus)*, minke whale *(Balaenoptera acutorostrata)* and humpback whale *(Megaptera novaeangliae)*. Of these the fin whale however is recorded only from older strandings with no recent sightings to support its occurrence in these tropical waters.

The largest of the recorded Odontocetes is the sperm whale *(Physeter macroephalus)* that is seen in large numbers throughout Sri Lanka's deeper waters. Of the small whales and dolphins the most common species throughout both coastal and pelagic waters off Sri Lanka is the long-snouted spinner dolphin (Stenella longirostris). It is found in large acrobatic schools that often bow-ride with boats despite large numbers being killed as bycatch and directed takes. Other common species include the Risso's dolphin *(Grampus griseus)* and common bottlenose dolphin *(Tursiops truncatus)* which frequent both coastal and pelagic waters off Sri Lanka. False killer whales *(Pseudorca crassidens)* are another common species that is usually pelagic but occur in large schools in coastal waters, even very close to shore in Sri Lanka. Meanwhile the pan-tropical spotted dolphin *(Stenella attenuata)* and the striped dolphin *(Stenella* *coeruleoalba*) are common in pelagic waters.

Among the other species recorded around Sri Lanka is the Indo-Pacific humpback dolphin *(Sousa chinensis)*, the only delphinid confined to shallow coastal water of the north western region of Sri Lanka with concentration in the vicinity of the Puttalam lagoon. Other species in the family Delphinidae include the Fraser's dolphin *(Lagenodelphis hosei)*, common dolphin *(Delphinus capensis)*, rough-toothed dolphin *(Steno bredanensis)*, killer whale (Orcinus orca), pygmy killer whale *(Feresa attenuata)*, melon-headed whale *(Peponocephala electra)*, short-finned pilot whale *(Globicephala macrorhynchus)*. Both species of the family Kogiidae, the dwarf sperm whale *(Kogia sima)* and pygmy sperm whale (Kogia breviceps) occur in Sri Lanka. Four species of the rare and secretive beaked whales of the family Ziphiidae have also been identified from the waters around Sri Lanka. These include the Cuvier's beaked *(Ziphius cavirostris)* whale, Blainville's beaked whale *(Mesoplodon densirostris)*, ginkgo-toothed beaked whale *(Mesoplodon ginkgodens)* and Longman's beaked whale *(Indopacetus pacificus)*. The only species of the family Phocoenidae recorded in Sri Lanka is the finless porpoise (Neophocaena phocaenoides) which appears to be rare and has thus far only been recorded as accidental bycatch.

The single Sirenian the dugong, now appears to be extremely rare in Sri Lankan waters. Based on the minimal recent work that has been done on this species it appears to be declining rapidly in its last known habitat in the northwest.

Threats

The past three decades of research have also made it possible to identify threats to marine mammals around Sri Lanka and as a result the need to manage the resource has become evident.

Large whales have never been commercially hunted in Sri Lanka's waters but increased shipping is becoming a cause for concern with accidental ship strikes being recorded more often. Although it is known that marine pollution, both chemical and acoustic, has an adverse effect on large whales these threats have not as yet been studied. Additionally a new and rapidly growing threat to large whales around Sri Lanka is unregulated commercial whale watching tourism. This is leading to harassment of animals and a change in their natural behavior including movement away from their favoured feeding habitats. If unchecked this could have adverse long-term impacts on the animals and also lead to the loss of a valuable resource with high tourism potential.

Small cetaceans including small whales and dolphins are under increasing pressure due to both accidental entrapment in fishing gear all around the island and direct hunting using hand-held harpoons in some parts of the island. Animals that are killed are taken to inland markets away from the coast, chopped up and sold for human consumption under the false pretext of being dugong meat. Some species which are tied to coastal habitats due to their ecological needs are doubly vulnerable as habitat destruction and degradation due to land-based pollution can also have adverse impacts on them and their prey-base. Unregulated dolphin watching tourism is already impacting small cetaceans in some areas like Kalpitiya in the northwest. This area is earmarked for further tourism development in the future.

The dugong which is endangered throughout its worldwide range is still deliberately hunted in Sri Lanka for its flesh which has always been considered a delicacy among local people. The present habitat of the dugong in Sri Lanka is limited to nearshore waters off the north-west coast where it has been decimated by hunting over the years. Dugongs are also prone to accidental bycatch in fishing gear. They are also affected by habitat destruction and degradation caused by destructive fishing practices like the use of explosives and pushnets in seagrass beds. Due to a paucity of recent research on the species it is not known if the present depleted population is viable in the long-term even if given heightened protection.

Legal framework:

★ The need for protection of marine mammals has been recognized in Sri Lanka since the early 20th century as can be seen from the legislation that relates to them. The relevant legislative enactments are:

  The Whaling Ordinance of 1936, amended in 1938 to specifically list dugongs as protected and amended again in 1956 covering sperm and baleen whales and also prohibiting the killing of females with calves and immature animals.

★ The Fauna and Flora Protection Ordinance amendment of 1970 gives total protection to the dugong.

- ★ Fauna and Flora Protection Ordinance amendment of 1993 gave blanket protection to all species of marine mammals through a negative listing schedule for mammals. Unfortunately a recent amendment adopted in 2009 has gone back to a positive listing system and very few marine mammals are now listed as a very outdated list has been used.
- ★ The Fisheries Act of 1996 which replaced the Fisheries Ordinance gives specific protection for marine mammals and provides for prosecution and fines for offenses under it for the first time.

Although legal protection for marine mammals exists on paper implementation and actual law enforcement is almost completely lacking. Even the dugong, which is in danger of extinction throughout its global range and is listed as such in the IUCN Red List of threatened species, is still being illegally hunted in Sri Lanka. There is also some confusion with overlapping legislation because the Fauna and Flora Protection Ordinance and the Fisheries Act have different punishments and penalties for the same offense.

Conservation, management and the future

The most significant result of the last 30 years of systematic research is that marine mammals have now come into national focus within Sri Lanka. The majority of Sri Lankans did not even know that marine mammals inhabited the waters around the country a few decades ago, but now they have been recognized as an important marine living resource that has non-consumptive economic potential. However, due to the multiple threats that they face there is an urgent need to manage this resource in an appropriate manner in order to ensure their continued survival.

- ★ While the need for management of marine mammals as a resource in Sri Lanka is evident achieving such management goals would need an integrated but multi-pronged approach that includes:
- ★ Streamlining legislation and strengthening law enforcement in relation to the mortality of dugongs and small cetaceans due to anthropogenic factors.
- ★ Development of new legislation and implementation mechanisms applicable to tourism in marine environments, especially whale and dolphin watching.
- ★ Initiating more management-oriented research on marine mammals, that takes into consideration their ecological needs and habitat requirements.
- ★ Taking marine mammals and their spatial needs into consideration when declaring and managing Marine Protected Areas.
- ★ Initiating regional collaboration for both research and management of transient and shared marine mammal populations in order to maximize resources and develop effective management strategies.

  Creating awareness within Sri Lanka on marine mammals in general, threats faced by them and the need for conservation and management.

Because research on marine mammals is still very basic in Sri Lanka due to a lack of resources knowledge about the rich and diverse marine mammal fauna in the waters of the island is limited. Even some of the research results that are available are still not being used adequately for management purposes. For example it is crucially important and urgent that the remaining seagrass habitat off the northwest coast is mapped and protected if the highly endangered dugong population is to have any chance of survival in the long-term. Although Sri Lanka has an extensive protected area network in terrestrial habitats there are very few marine protected areas. Marine mammals and their conservation needs have not been taken into consideration when declaring even the few MPA's that exist and occurrence of marine mammals has only been studied in one MPA and this too long after its boundaries were demarcated. Likewise, it is important that economic activities like whale and dolphin watching are regulated quickly and efficiently in order to take advantage of the non-consumptive tourism potential of this living resource and utilize it in a responsible manner while minimizing adverse impacts.

Integrating research results into management planning and creating an interface between researchers and managers involved in activities related to the marine environment in Sri Lanka is extremely important. It is only through such collaboration that conservation goals will be achieved while carefully developing the economic potential of this resource. Recognizing marine mammals as a resource with non-consumptive economic potential is a first step in the right direction but a lot more work needs to be done in the future in order to utilize it in a responsible manner that ensures long-term sustainability.

Status of Marine Mammal Research and Conservation in India

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Introduction

In India, earlier research on marine mammals was restricted mostly to opportunistic collection of information on strandings and beach-cast specimens. Organised research by government and non-government organisations on these charismatic and vulnerable/endangered animals was initiated approximately 15 years ago. In the last 15 years, data on sightings, species inventory, abundance estimates, DNA sequences and fisheries interaction have been collected. These researches have indicated the need for future enhanced research on these sentinel megafauna of the oceans. At present, all species of marine mammals in the Indian seas are placed under Wildlife (Protection) Act, 1972. Capture, use and trade of marine mammals are punishable under the Act. However, marine mammal - fisheries interaction is a major cause for concern.

Status of research

In India, 25 species of cetaceans and one species of sirenian have been recorded. The Central Marine Fisheries Research Institute (CMFRI) initiated the study of marine mammals in India in the 1950s (Jones, 1959) and has collected and published information on the occasional stranding, sighting and accidental gear entanglement for the last 60 years. Dedicated seminar conducted on endangered marine animals played a pivotal role in creating awareness (Silas, 1985). For an understanding on the cetacean species diversity, distribution and abundance the CMFRI initiated a research project "Studies on Marine Mammals of Indian EEZ and the Contiguous seas" funded by Center for marine Living resources and ecology (CMLRE), Ministry of Earth Sciences in the year 2003. A Marine Mammal Stranding workshop was conducted by CMFRI in collaboration with NOAA, USA in 2010.

Distribution

Sighting cruises

In the last eight years, 48 opportunistic marine mammal cruises were conducted on board FORV Sagar Sampada in the coastal and oceanic waters of Arabian Sea, Bay of Bengal and southern part of Sri Lanka. More than 809 days of survey extending for 6798 hours of observation effort and covering a distance from 1 km to > 1000 km from the shore with a depth range of 20 m to 5000 m have been made. Nearly 600 sighting events consisting of 9912 individuals were recorded. During the surveys, seven species of whales and ten species of were recorded. Ten species, which were recorded in strandings, could not be encountered in the sighting surveys.

The major conclusions of the sighting surveys are as follows (Afsal et al., 2008):

1. Marine mammals are widely distributed.
2. Abundance and species richness are high in South Sri Lanka coast followed by Southeastern Arabian Sea (off Kerala - Karnataka).
3. In spite of absence of ten species in the surveys, the general distribution pattern agrees with historical records based on incidental capture.
4. The spinner dolphin *Stenella longirostris* is the most dominant, distributed abundantly in space and time.
5. There is an indication of habitat preference of other species; Sousa chinensis and *Tursiops aduncus* are restricted essentially to coastal waters (so also is the finless porpoise) whereas *Tursiops truncatus* inhabits oceanic waters.
6. *Stenella longirostris*, *Sousa chinensis, Tursiops aduncus and Neophocaena phocaenoides* appear to be the residents or regular visitors to the region.
7. Being residents/regular visitors to the coastal areas, the four species mentioned above are more vulnerable to fishery interactions.
8. Whereas all species were found at SST 26.0 - 30.0°C, Tursiops aduncus and *Delphinus capensis* were found at SST as high as 32.0 - 32.9°C.

In spite of valuable information generated from the sighting surveys, there were several limitations:

1. FORV Sagar Sampada is too big for sighting cruises; not easily maneuverable; observation deck (17m from sea level) is very high.
2. All cruises were "opportunistic"; not dedicated to mammal surveys.
3. Effort not uniformly distributed; oceanic waters were not well covered and Gulf of Mannar was not covered.
4. Only about 50% of the sightings was identified as 'confirmed' or as "possible".
5. Abundance estimates could not be made.

Strandings

Kumaran (2002) compiled the available reports on the stranding of Indian marine mammals, published by more than 200 authors of 180 papers from the years 1800 to 2000. He found 1452 records all along the maritime states and two island groups. He concluded that the species diversity of marine mammals in India is one among the richest in the Indian Ocean. Large number of records are available on the spinner dolphin *Stella longirostris* (260), common dolphin *Delphinus delphis* (possibly many were *Delphinus capensis*; 256), Indo-Pacific humpbacked dolphin *Sousa chinensis* (221), short-finned pilot whale *Globicephala macrorhynchus* (166) and dugong (165). Most of information pertains to occassional stranding or accidental entanglements in fishing gear, especially gillnets. In many instances, the information is limited to mere morphometric measurements and photographs. Many publications suffer from mis-identification of species.

Incidental catches of marine mammals in the gillnet fishery were used for studying the anatomy (10 species) and stomach contents (11 species). Most of the small cetaceans are opportunistic feeders and the stomach contents of the same species vary with space and time (Kumaran, 2002). Commercially important fish and shellfish were found in the stomach of dolphins.

Marine mammal - fisheries interaction

The marine mammal - fisheries interaction is a major cause for concern. Mechanized fishing was introduced on a commercial scale in India in the mid 1960s. Since then, the fisheries sector has grown rapidly. Marine fisheries census carried out by CMFRI in 2005 shows that there are 58,911 mechanized fishing craft along the Indian coast operating trawlnet, gillnet, lines, dolnet and purseseines. The efficiency of fishing vessels has increased, resulting in longer sea endurance, extension of fishing to oceanic waters and introduction of larger and efficient gear. The growing number and efficiency of mechanized boats have increased the chances of fishing gear - marine mammal encounters. Unfortunately the incidental kills of marine mammals have not been regularly monitored in India. However, it is natural to expect that the incidental kills of marine mammals, especially those of small cetaceans, would have increased with the proliferation of mechanized fishing fleet.

About 9000 to 10,000 dolphins are estimated to be caught by gillnet annually along the Indian coasts (Yousuf et al., 2008). Gillnet accounted for 68.9% of the catch. The two species commonly involved in the gillnet fishery are the spinner dolphin *Stenella longirostris* and the bottlenose dolphin *Tursiops aduncus*. In addition, other species such as Risso's dolphin *Grampus griseus*, long-beaked common dolphin *Delphinus capensis* and Indo-pacific humpbacked dolphin *Sousa chinensis* were also reported.

Maximum number of dolphin entanglements in gillnet was encountered in the fishery for large pelagics such as tuna (Visakhapatnam and Chennai) and seerfish (Kakinada). The length of gillnet ranged from 0.5 to 6 km. At Periyapatnam (near Mandapam), the mesh size ranged up to 18 cm for catching rays. Off Mangalore, a large number of finless porpoise *Neophocaena phocaenoides* was incidentally caught in purseseines. In the surveyed areas, the overall length of mechanized boats that incidentally caught dolphins and porpoise ranged from 9 to 15m with 20 to 108 hp engine. The fishing operations were carried out 4 to 70 km from the shore.

Molecular taxonomy of marine mammals

From the samples collected from the carcass of incidentally caught specimens, 63 sequences of cytochrome b gene and control region of mtDNA from 40 individuals of 11 species were deposited in the GenBank (www.ncbi.nl.nih.gov/). A PCR-based sex determination technique has been developed based on the amplification of genomic DNA extracted from skin samples (Jayasankar et al., 2008).

Bioaccumulation of trace metals

Marine mammals, as top predators, accumulate trace elements in their tissues from their environment, chiefly via their food. Trace metal accumulation depends mainly on the feeding habits, size, length and habitat. Muscle, liver and kidney samples from 33 incidentally caught and stranded marine mammals at six sampling locations showed that the concentrations in the samples were low compared to those from other parts of world.

Bioaccumulation of pesticides

The cetaceans are unique in terms of the great organochlorine 'storage capacity' of their blubber, which act as a reserve for ingested lipophilic (fat-loving) chemical contaminants (such as DDT and PCBs, Dixon). Blubber samples from 37 individuals belonging to eight species were analysed for organochlorine pesticides. The concentrations of ΣHCHs (BHCs), ΣDDTs and Σchlordanes were generally lower than the values reported from other parts of the world.

Conservation status

The research findings of CMFRI on distribution and abundance of marine mammals from sighting cruises and incidental capture in fishing gear, and the earlier published records, makes it possible to revise the status of different species of marine mammals in the Indian seas. Table 1 provides only an indicative conservation status based on the available information and is subjected to changes when more data become available. Table 1 also provides IUCN status report for the species occurring in the Indian seas.

Table 1. Conservation status of marine mammals in India

No	Common Name	Species name	IUCN Status	India Status*
1.	Blue whale	*Balaenoptera musculus* (Linnaeus, 1758)	Endangered	Endangered
2.	Fin whale	*Balaenoptera physalus* (Linnaeus, 1758)	Endangered	Endangered
3.	Bryde's whale	*Balaenoptera edeni* (Anderson, 1878)	Data Deficient	Data Deficient
4.	Common Minke whale	*Balaenoptera acutorostrata* (Lacépède, 1804)	Least Concern	Data Deficient
5.	Humpback whale	*Megaptera novaeangliae* (Borowski, 1781)	Least Concern	Data Deficient
6.	Sperm whale	*Physeter macrocephalus* (Linnaeus, 1758)	Vulnerable	Vulnerable
7.	Pygmy sperm whale	*Kogia breviceps* (de Blainville, 1838)	Data Deficient	Data Deficient
8.	Dwarf sperm whale	*Kogia sima* (Owen, 1866)	Data Deficient	Data Deficient
9.	Cuvier's beaked whale	*Ziphius cavirostris* Cuvier, 1823	Least Concern	Data Deficient
10.	Indo-Pacific beaked whale	*Indopacetus pacificus* (Longman, 1926)	Data Deficient	Data Deficient
11.	Short-finned pilot whale	*Globicephala macrorhynchus* (Gray, 1846)	Data Deficient	Data Deficient
12.	Killer whale	*Orcinus orca* (Linnaeus, 1758)	Data Deficient	Data Deficient
13.	False killer whale	*Pseudorca crassidens* (Owen, 1846)	Data Deficient	Data Deficient
14.	Pygmy killer whale	*Feresa attenuate* (Gray, 1874)	Data Deficient	Data Deficient
15.	Melon-headed whale	*Peponocephala electra* (Gray, 1846)	Least Concern	Data Deficient
16.	Irrawady dolphin	*Orcaella brevirostris* (Gray, 1866)	Vulnerable	Vulnerable
17.	Indo-Pacific humpbacked dolphin	*Sousa chinensis* (Osbeck, 1765)	Near Threatened	Near Threatened?
18.	Rough-toothed dolphin	*Steno bredanensis* (Lesson, 1828)	Least Concern	Data Deficient
19.	Risso's dolphin	*Grampus griseus* (Cuvier, 1812)	Least Concern	Least Concern
20.	Bottlenose dolphin	*Tursiops aduncus* (Ehrenberg, 1833)	Data Deficient	Least Concern
21.	Pan tropical spotted dolphin	*Stenella attenuata* (Gray, 1846)	Least Concern	Data Deficient
22.	Spinner dolphin	*Stenella longirostris* (Gray, 1828)	Data Deficient	Least Concern
23.	Striped dolphin	*Stenella coeruleoalba* (Meyen, 1833)	Least Concern	Data Deficient
24.	Long beaked common dolphin	*Delphinus capensis* Gray, 1828	Data Deficient	Least Concern
25.	Finless porpoise	*Neophocaena phocaenoides* (Cuvier, 1829)	Vulnerable	Near Threatened?
27.	South Asian River dolphin	*Platanista gangetica* (Roxburgh, 1801)	Endangered	Endangered
26.	Sea cow	*Dugong dugon* (Müller, 1776)	Vulnerable	Endangered

* Status assigned based on sighting surveys conducted by the CMFRI during the years 2003-2009 under the project "Studies on marine mammals of Indian EEZ and the contiguous seas" funded by CMLRE, Ministry of Earth Sciences, Government of India

Besides Wildlife (Protection) Act 1972 of India, the seasonal ban on fishing under the Marine Fisheries Regulation Act indirectly protects the marine mammals. Recently, a Task Force for Conservation of Dugong has been constituted by Ministry of Environment & Forests, Government of India.

Need for developing National Action Plan on Marine Mammals

Conservation management action plans are important for maintaining and restore the distribution, abundance and diversity of marine mammals in the Indian EEZ. Developing a National Action Plan on Marine Mammals by constituting a Task Force is keenly felt for India (Vivekanandan et al., 2010). The Task Force for developing NPOA-Marine Mammals may address the following:

1. Reducing incidental kills by fishing gear
2. Bycatch management
3. Establishing marine mammal stranding network
4. Necropsy of beach-cast samples
5. Research needs
6. Non-invasive ecotourism
7. Awareness building

Conclusion

As information on marine mammals is imperative to design and implement meaningful conservation measures, marine mammal research in India should be given priority and should gain a more professional approach.

References

Afsal, V.V., K.S.S.M. Yousuf, B.Anoop, A,K,Anoop, P.Kannan, M.Rajagopalan and E. Vivekanandan. 2008. A note on cetacean distribution in the Indian EEZ and the contiguous seas during 2003-2007. Journal of Cetacean Research and Management, 10 (3): 209-215.

IUCN 2009. IUCN Red List of Threatened species Version 2009.2 (www.iucnredlist.org)

Jayasankar, P., B. Anoop and M.Rajagopalan. 2008. PCR-based sex determination of cetaceans and dugong from Indian seas. Current Science, 94 (11): 1513-1516.

Jones, S. 1959. On a pair of captive dugongs [*Dugong dugon* (Erxleben)]. Journal of Marine Biological Association of India, 1: 198-202.

Kumaran, PL. 2002. Marine mammal research in India – a review and critique of the methods. Current Science, 83: 1210-1220.

Silas, E.G. 1985. Presidential address. Proceedings of the symposium on Endangered Marine Animals and Marine Parks. Marine Biological Association of India, 1: x-xii.

Vivekanandan, E., R.Jeyabaskaran, K.S.S.M. Yousuf, B.Anoop, K.S.Abilash and M.Rajagopalan. 2010. Marine mammal research and conservation in India. CMFRI Pamphlet 13/2010, 20 pp.

Yousuf, K.S.S.M., A.K. Anoop, B.Anoop, V.V.Afsal,E.Vivekanandan, R.P.Kumarran, M.Rajagopalan,P.K.Krishnakumar and P.Jayasankar. 2008. Observations on incidental catch of cetaceans in three landing centres along the Indian coast. JMBAUK onlines.

Marine Mammal Sightings in Southern Ocean

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Introduction

The Southern Ocean (SO) comprises more than 10% of the world's oceans and plays a substantial role in the Earth System. In total, it covers an area of 34.8 million km2. The shelves around Antarctica are on average 450 – 500 m deep, but exceed 1000 m in places. Of the total SO area, the continental shelf (<1000 m in depth) covers 4. 59 million km2, the continental slope (1000 – 3000 m in depth) covers 2.35 million km2 and the deep sea (>3000 m in depth) covers approximately 27.9 million km2 (Clarke and Johnston, 2003). Sea ice covers roughly half of the Southern Ocean during winter and approximately 10% during the summer. The Southern Ocean represents a complex suite of habitats for its unique biota, defined by light, temperature, water chemistry, depth, and geomorphology, as well as winds, currents, and sea ice. The diversity of Antarctic continental shelves exceeds that of Arctic, and is comparable with temperate and even non reef tropical shelves (Clarke, 2008). The SCAR-MarBIN (Register of Antarctic Marine Species) reported the presence of 6651 species of marine animals in the Southern Ocean. More than 26 major taxonomic groups are recognized among the megafauna of the Southern Ocean deep sea. The Southern Ocean's ability to store carbon dioxide (more than 40% of the total human-generated carbon dioxide stored by the world's oceans) has reduced the rate of global warming. The Southern Ocean is in many respects an ideal region to study marine animal populations in the context of global climate change. If the Antarctic ice were to melt, scientists predict global sea level would rise by an average of 200 ft. There are two main reasons why the Southern Ocean is so full of life. The first is the existence of a large amount of nutrients in the water, which act as a fertilizer, allowing for vigorous growth of tiny photosynthetic or algae, which form the basis of the food chain. These nutrients are brought to the Southern Ocean by the southerly flow of deep, nutrient-rich water known as 'Circumpolar Deep Water' which rises to the surface (upwells) near the continent of Antarctica and makes nutrients available to photosynthetic organisms in the sunlit waters near the surface, which then grow into large 'phytoplankton blooms'. The second reason the Southern Ocean is so productive is that over the six summer months the sun never sets, meaning that photosynthesis, and growth of the phytoplankton blooms, can occur 24 hours a day. Taking advantage of this abundant production are the Southern Ocean's most plentiful residents - the small shrimp-like Antarctic krill, Euphausia superba, which feed on the tiny photosynthetic diatoms which make up the phytoplankton blooms (WWF, 2010).

Baleen whales eat 30-50 million tonnes of krill in the Antarctic each year. The Southern Ocean is the feeding and breeding grounds for the marine mammals. The marine mammals are the top predators in the Southern Ocean ecosystem. Marine mammals typically mature late, live longer than 15 years and have only one or two offspring each year after maturation. Some species do not reproduce every year and individuals will not reproduce if their body condition is poor. Furthermore marine mammals are of significant conservation concern, with 23% of species currently threatened by extinction (Schipper et al., 2008). Marine mammals also influence the availability of micronutrients such as iron (Nicol et al., 2010). Baleen whales are important contributor to the Southern Ocean iron cycle, they need to be able to convert large quantities of iron from a particulate form (in krill) into a diffuse form (faeces) containing a soluble fraction, which may then be available again for phytoplankton growth. Baleen whale faecal iron content (145.9 ± 133.7 mg kg) is approximately ten million times that of Antarctic seawater, suggesting that it could act as a fertilizer (Nicol et al., 2010).

Whaling in Southern Ocean

The first of the Southern Ocean's resources to be exploited by humans were the Pinnipeds. Upon returning to England in 1775, Captain Cook told of the Island of South Georgia with its beaches teeming with Antarctic fur seals (Arctocephalus gazella). Sealing voyages thus ensued, and in 1822, James Weddell, a Scottish sealer, estimated that over 1.2 million skins had been taken from the area and that the species was nearly extirpated (Knox, 1994). Sealing in the late 1700s and early 1800s, along with whaling in the first half of the 1900s and fishing in the mid-1900s drastically reduced the abundance of many groups of organisms. The first to be removed as the seas and continent were being explored were the Antarctic fur seals (Arctocephalus gazella), which were taken for their valuable skins. This was followed by the export of meat and blubber from large whales in the early 1900s (Best, 1993). While the fur seals were being harvested for their pelts, southern elephant seals (Mirounga leonina) were being taken for their oil, although not in such large numbers (Berkman, 2002).

By 1960's when Blue Whale hunting was banned by the IWC it is estimated that over 330,000 Blue Whales had been killed. Pre-whaling population estimates were over 350,000 blue whales, but up to 99% of blue whales were killed during whaling efforts (Sears, 2002). Presently, there are estimated 5-10,000 blue whales in the Southern Hemisphere, and only around 3-4,000 in the Northern Hemisphere (Branch et al., 2007).

Similar to the Blue whales fate, Fin whales were heavily hunted beginning in the mid-1900's. It is estimated that 7,25,000 were killed until the IWC granted them protection in 1966, with full protection awarded in 1976. Since that time their numbers have begun to recover. There were about 2,00,000 Humpback whales heavily exploited by commercial whaling primarily from the 1920s-1950s in both their Southern Ocean feeding grounds and in their tropical breeding grounds. IWC banned hunting of Southern Ocean in 1963. Southern Right whales are slow swimmers, moving at 3-4 miles per hour. Because of their slow speed and high oil content blubber these whales were obvious targets for early whalers. It is estimated that in the 18th century 12,000 whales were killed in a 30 year period. This slaughter continued in the 19th century with estimations of up to 100,000 right whales killed. Sei whale populations in the SO were heavily exploited by industrial whaling after the decline in numbers of blue and fin whales, primarily from the mid-1960s to early 1970s. There were about 2,00,000 Sei Whale killed during the 20th Century (IUCN, 2011). Antarctic Minke whales were not then regularly hunted by the large-scale whaling operations in the Southern Ocean because of their relatively small size. However, by the early 1970s, following the overhunting of larger whales such as the Sei, Fin, and Blue whales, Minkes attracted their attention. By 1979, about 3,29,212 Minke whales caught by Southern Ocean fleets. Hunting continued apace until the general moratorium on whaling began in 1986 (IUCN, 2011). After rampant commercial whaling in the twentieth century brought most great whale species in the Southern Ocean close to extinction, the International Whaling Commission (IWC) established the Southern Ocean Whale Sanctuary in 1994, recognising the critical importance of protecting whales in this special place. In 1979, The International Whaling Commission (IWC) declared the Indian Ocean (north of 55°S) a Whale Sanctuary.

Marine Mammal Sightings in Southern Ocean

The studies on marine mammals of Southern Ocean were initiated after the establishment of International Whaling Commission in Washington, USA in 1946. Its aim was to achieve the maximum sustainable utilisation of whale stocks, and protect the future of stocks as a resource. Whales and seals are the two groups of marine mammals found in the Southern Ocean where they are an important part of the marine ecosystem. Whales and seals of the Southern Ocean have been severely exploited by man in the past, but are now mostly protected. Some seals and whales have had dramatic population increases in recent decades, though others remain greatly reduced compared to pre-hunting levels. There are about 30 marine mammals reported so far in the Southern Ocean. The present status of the marine mammals of Southern Ocean is shown in Table 1.

Marine Mammal Sightings by India

Information on marine mammal population of Indian sector of Southern Ocean is unknown except few surveys undertaken by the Indian Scientists. The distribution of marine mammals and migration along the different oceanic realm in the Southern Ocean is unknown. The first comprehensive marine mammal survey was initiated during the First Indian Antarctic Expedition conducted by the Department of Ocean Development, Government of India in the year 1981. So far five opportunistic surveys on marine mammals were conducted. The details of the surveys are given in Table 2. The Central Marine Fisheries Research Institute (CMFRI) initiated the study of marine mammals in India in the 1950s. CMFRI had also participated in the Pilot Expedition (PESO) organized by the NCAOR on January – March, 2004 and investigated the distribution and abundance of cetaceans in the Southern Ocean. About 22 individuals of marine mammals were observed in the 13 sighting records. Recently, the first author participated in the 5th Indian Southern Ocean Expedition for marine mammal studies. A pod of Minke whales (Fig. 1) and pod of Killer whales (Fig. 2) were sighted during the expedition. The Killer whales were in different form and identified as type 'D' described by Jefferson et al., (2008). It has been reported for the first time from Indian sector of Southern Ocean. Killer whales attacks have been observed on 20 species of cetaceans, 14 species of pinnipeds, the Sea Otter, and the Dugong (Jefferson et al., 2008). Southern Hemisphere Killer Whales prefer to feed on tongue and lips of Baleen Whales (Wellings, 1944). Three readily field-identifiable killer whale ecotypes have been described from Antarctic waters (types A, B, and C; Pitman and Ensor, 2003). A fourth and markedly different looking killer whale from the southern hemisphere was described by Jefferson et al., (2008); it was referred to as 'type D' and was easily recognizable by its extremely small white post-ocular eye patch. Pitman et al., (2011) suggest that type D likely represents yet another ecotype or possibly even species of killer whale in the Southern Ocean.

Conclusion

Marine mammal richness was predicted to be highest in temperate waters of both hemispheres with distinct hotspots around New Zealand, Japan, Baja California, the Galapagos Islands, the Southeast Pacific, and the Southern Ocean (Kaschner et al., 2011). In the Southern Ocean, seabirds and marine mammals are threatened by incidental mortality from interactions with fishing gear such as long lines and trawls. Marine mammals of Southern Ocean play a important role in reduction of global carbon level. Recent studies showed that populations of large baleen whales now store 9.1 x 106 tons less carbon than before whaling. Pershing et al (2010) estimated that rebuilding whale populations would remove 1.6 x 105 tons of carbon each year through sinking whale carcasses. For example, rebuilding the southern hemisphere blue whale population would sequester 3.6 x 106 tons C in living biomass. Assuming 82 tons C ha^{-1} of forest (FAO, 2006), the new blue whales would be equivalent to preserving 43,000 hectares of temperate forest, an area comparable in size to the City of Los Angeles. Rebuilding all of the whale populations would store 8.7 x 106 tons C, equivalent to 110,000 hectares of forest or an area the size of the Rocky Mountain National Park. Therefore, dedicated continuous monitoring and management of marine mammals are required in Southern Ocean.

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References

Bhatnagar, Y.V. and Sathyakumar, 1999. Developing a long term monitoring programme for birds and mammals in the Indian Ocean and Antarctica. Fifteenth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication No. 13, pp 131-164.

Berkman, P. A. 2002. Science Into Policy: Global lessons from Antarctica. Academic Press, London.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES Journal of Marine Science 50: 169-186.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner,M.,Matsuoka, K., Mikhalev, Y., Miyashita, T., Morrice, M., Nishiwaki, S., Sturrock, V.J., Tormosov, D.,Anderson, R.C., Baker,A.N., Best, P.B., Borsa, P., Brownell, R.L., Childerhouse, S., Findlay, K., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, D.K., Ljungblad, B., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., OmanWhale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and northern Indian Ocean. Mammal Rev. 37(2): 116-75.

Clarke, A. 2008. Antarctic Marine Biodiversity: Patterns and processes. Journal of Experimental Marine Biology and Ecology, 366: 48 – 55.

Clarke, A. and Johnston, N.M. 2003. Antarctic marine benthic diversity. Oceanography. Mar. Biol. Ann. Rev. 41: 47 – 114.

IUCN. 2011. The 2010.4 version of the IUCN red list of threatened species. IUCN, Gland, Switzerland (2011). <http://www.iucnredlist.org/>

Jayasankar, P., A.K. Anoop., M. Rajagopalan and P.K. Krishnakumar. 2007. A note on observations on cetaceans in the western Indian sector of the Southern Ocean (20-56°S and 45-57°30'E), January to March 2004. J. Cetacean Res. Manage. 9(3):263–267.

Jefferson T.A., Webber M.A., Pitman R.L. 2008. Marine mammals of the world. A comprehensive guide to their identification. Academic Press, San Diego.

Kaschner K., Tittensor D.P., Ready J., Gerrodette T., Worm B. 2010. Current and Future Patterns of Global Marine Mammal Biodiversity. PLoS ONE 6(5): e19653. doi:10.1371/journal.pone.0019653

Knox, G. A. 1994. The Biology of the Southern Ocean. Cambridge University Press, Cambridge.

Nicol S., Bowie A, Jarman S., Lannuzel D., Meiners K.M., et al. 2010. Southern Ocean iron fertilization by baleen whales and Antarctic krill. Fish and Fisheries 11: 203–209.

Parulekar, A.H. 1983. Sea birds and marine mammals of the First Indian Antarctic Expedition. First Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication No. 1, pp 224-231.

Pitman R.L., Ensor P. 2003. Three different forms of killer whales in Antarctic waters. J Cetacean Res Manag 5:131–139.

Pitman, R.L., Durban, J.W., Greenfelder, M., Guinet, C., Jorgensen, M., Olson, P.A., Plana, J., Tixier, P., Jared R.T. 2011. Observations of a distinctive morphotype of killer whale (Orcinus orca), type D., from subantarctic waters. Polar Biol 34:303–306.

Sathyakumar, S. 1998. Developing A Long-term Monitoring Programme for Birds and Mammals in the Indian Ocean and Antarctica Using GPS and GIS Technologies. Fourteenth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication No. 12, pp 207-219.

Schipper J.., Chanson J.S., Chiozza F., Cox N.A., Hoffmann M., et al. 2008. The status of the world's land and marine mammals: Diversity, threat, and knowledge. Science. pp 225–230.

Sears, R. 2002. Blue Whale, Balaenoptera musculus. - In: Encyclopedia of marine mammals (W.F. Perrin, B. Wursig, and J.G. M. Thewissen, eds). Academic Press, San Diego, CA. pp.112-116.

Wellings, C.E. 1944. The Killer Whales of Twofold Bay, N.S.W., Australia, Grampus orca. Australian Zoologist 10: 291-293.

WWF, 2010. Report on 'Save the whale and save the Southern Ocean'. WWF International Species Programme and the WWF Antarctic and Southern Ocean Initiative. The report is available at www.panda.org/iwc.

Table 1. Status of Marine Mammals of Southern Ocean

No	Common Name	Scientific Name	Recent Population	IUCN Status
1.	Blue Whale	*Balaenoptera musculus* (Linnaeus, 1758)	2,300	Criticall Endangered
2.	Fin Whale	*Balaenoptera physalus* (Linnaeus, 1758)	38,185	Endangered
3.	Sei Whale	*Balaenoptera borealis* (Lesson, 1828)	11,000	Endangered
4.	Antarctic Minke Whale	*Balaenoptera bonaerensis* (Burmeister, 1867)	3,39,000	Data Deficient
5.	Humpback Whale	*Megaptera novaeangliae* (Borowski, 1781)	42,000	Least Concern
6.	Southern Right Whale	*Eubalaena australis* (Desmoulines, 1822)	7,500	Least Concern
7.	Pygmy Right Whale	*Caperea marginata* (Gray,1846)	Few sightings	Data Deficient
8.	Sperm Whale	*Physeter macrocephalus* (Linnaeus, 1758)	9,500	Vulnerable
9.	Arnoux's Beaked Whale	*Berardius arnuxii* (Duvernoy, 1851)	30,000	Data Deficient
10.	Cuvier's Beaked Whale	*Ziphius cavirostris* (G. Cuvier, 1823)	80,000	Least Concern
11.	Southern Bottlenose Whale	*Hyperoodon planifrons* (Flower, 1882)	5,99,300	Least Concern
12.	Shepherd's Beaked Whale	*Tasmacetus shepherdi* (Oliver, 1937)	Few Sightings	Data Deficient
13.	Gray's Beaked Whale	*Mesoplodon grayi* (von Hasst, 1876)		Data Deficient
14.	Hector's Beaked Whale	*Mesoplodon hectori* (Gray, 1871)	No Estimates	Data Deficient
15.	True's Beaked Whale	*Mesoplodon mirus* (True, 1913)	No Estimates	Data Deficient
16.	Strap toothed Beaked Whale	*Mesoplodon layardii* (Gray, 1865)	153	Data Deficient
17.	Spade toothed Beaked Whale	*Mesoplodon traversii* (Gray, 1874)	No Estimates	Data Deficient
18.	Killer Whale	*Orcinus orca* (Linnaeus, 1758)	25,000	Data Deficient
19.	Long finned Pilot Whale	*Globicephala melas* (Traill, 1809)	2,00,000	Data Deficient
20.	Dusky Dolphin	*Lagenorhynchus obscurus* (Gray, 1828)	7,252	Data Deficient
21.	Hourglass Dolphin	*Lagenorhynchus cruciger* (Quoy and Gaimard, 1824)	1,44,300	Least Concern
22.	Southern Right Whale Dolphin	*Lissodelphis peronii* (Lacepede, 1804)	No Estimates	Data Deficient
23.	Spectacled Porpoise	*Phocoena dioptrica* (Lahille, 1912)	No Estimates	Data Deficient
24.	Sub Antarctic Fur Seal	*Arctocephalus tropicalis* (Gray, 1872)	3,10,000	Least Concern
25.	Antarctic Fur Seal	*Arctocephalus gazella* (Peters, 1875)	60,20,000	Least Concern
26.	Southern Elephant Seal	*Mirounga leonina* (Linnaeus, 1758)	6,50,000	Least Concern
27.	Crabeater Seal	*Lobodon carcinophaga* (Hombron and Jacquinot, 1842)	1,20,00,000	Least Concern
28.	Ross Seal	*Ommatophoca rossii* (Gray, 1844)	1,30,000	Least Concern
29.	Leopard Seal	*Hydrurga leptonyx* (Blainville, 1820)	3,00,000	Least Concern
30.	Weddell Seal	*Leptonychotes weddellii* (Lesson, 1826)	5,00,000	Least Concern

Table 2. Indian's Marine Mammals Sightings

Species	Parulekar 1983	Sathya kumar, 1998	Bhatnagar & Sathyakumar, 1999	Jayasankar, 2004	Jeyabaskaran, 2011
Blue Whale, *Balaenoptera musculus* (Linnaeus, 1758)	2	-	3	3	-
Fin Whale, *Balaenoptera physalus* (Linnaeus, 1758)	-	-		4	-
Sei Whale, *Balaenoptera borealis* (Lesson, 1828)	–	-	-	5	6
Antarctic Minke Whale, *Balaenoptera bonaerensis* (Burmeister, 1867)	-	-	5	3	-
Humpback Whale, *Megaptera novaeangliae* (Borowski, 1781)	5	9	-	-	-
Southern Bottlenose Whale, *Hyperoodon planifrons* (Flower, 1882)	2	-	32	-	-
Killer Whale, *Orcinus orca* (Linnaeus, 1758)	-	4	3	-	7
Crabeater Seal, *Lobodon carcinophaga* (Hombron and Jacquinot, 1842)	8	363	30	-	-
Leopard Seal, *Hydrurga leptonyx* (Blainville, 1820)	4	2	-	-	-
Unidentified Baleen Whale	-	-	-	4	3

Fig. 1. Photo taken onboard ORV Sagar Nidhi on 16.02.2011 by R. Jeyabaskaran at 60°00'S & 52°18'E

Fig. 2. Killer Whale *Orcinus orca* sighted at Southern Ocean

Marine Mammal Research in India: A Step Forward

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My talk will provide an overview of global threats to marine mammals and some major conservation issues; in the Indian context the talk will cover diversity and ongoing research, both opportunities and limitations and finally a request for a step forward to build upon the currently empty ocean of knowledge regarding marine mammals of India. The IUCN Red List has assessed 25% of marine mammal species as threatened. Records from carcasses washed ashore, by - caught animals and recent livesightings suggest that the waters around India probably have at least 30 species many of which are listed as globally Data Deficient while a few are listed as 'Endangered' by the IUCN (Table 1). 'Data Deficient' as a category in itself is misleading and much like a Catch 22 situation, as most funds and research interests stay focused on the threatened species, but those species of which we know close tonothing, remain unknown and unstudied.

Table 1. Marine mammals recorded from Indian subcontinent along with the IUCN status of these species. (DD: Data Deficient; LC: Least Concern; V: Vulnerable; E: Endangered; NT: Near Threatened)

Species	Common name	IUCN status
1) *Balaenoptera physalus*	Fin Whale	E
2) *Balaenoptera acutorostrata*	Common Minke Whale	LC
3) *Balaenoptera edeni/brydei*	Bryde's Whale	DD
4) *Balaenoptera omurai*	Omura's Whale	DD
5) *Megatera novaeangliae*	Humpback Whale	E
6) *Physeter macrocephalus*	Sperm Whale	V
7) *Kogia breviceps*	Pygmy Sperm Whale	DD
8) *Kogia sima*	Dwarf Sperm Whale	DD
9) *Mesoplodon ginkgodens*	Ginko-?toothed Beaked Whale	DD
10) *Mesoplodon densirostris*	Blainville's beaked Whale	DD
11) *Mesoplodon sp*		DD
10) *Ziphius cavirostris*	Cuvier's Beaked Whale	LC
11) *Orcinus orca*	Killer Whale	DD
12) *Pseudorca crassidens*	False Killer Whale	DD
13) *Feresa attenuata*	Pygmy Killer Whale	DD
14) *Globicephala macrorhynchus*	Short-finned Pilot Whale	DD
15) *Peponocephala electra*	Melon-headed Whale	LC
16) *Sousa chinensis*	Indo-Pacific Humpback Dolphin	NT
17) *Tursiops aduncus/truncatus*	Indo-Pacific/Common Bottlenose Dolphin	DD
18) *Steno bredanensis*	Rough-toothed Dolphin	LC
19) *Delphinus capensis*	Long-Beaked Common Dolphin	DD
20) *Stenella longirostris roseiventris*	Spinner Dolphin	DD
21) *Stenella coeruleoalba*	Striped Dolphin	LC
22) *Stenella attenuata*	Pantropical Spotted Dolphin	LC
23) *Lagenodelphis hosei*	Fraser's Dolphin	LC
24) *Grampus griseus*	Risso's Dolphin	LC
25) *Orcaella brevirostris*	Irrawaddy Dolphin	V
26) *Neophocaena phocaenoides*	Finless Porpoise	V
27) *Dugong dugon*	Dugong	V
28) *Indopacetus pacificus*	Longman's Beaked Whale	DD
29) *Baleanoptera borealis*	Sei Whale	E
30) *Balaenoptra musculus*	Blue Whale	E

Major threats to marine mammals include targeted hunting and directed harvesting, and indirect threats like entanglement in fishing gear, noise pollution from naval exercises and seismic sonar, shipping and fishing vessels, coastal and deep-sea development e.g ports and dams, and boat strikes. Bycatch is the cause for the highest mortality of cetaceans world-wide. In India, bycatch has been reported from all along the coastline. In USA, annual bycatch was estimated to be at 6125 between 1990 and

1999, with small cetceans and seals making up most of the bycatch. This data along with FAO fishing fleet data, gives an estimate of 653,365 marine mammals by-caught globally between 1990-1999.

As we are aware information regarding the marine mammals of Indian coastal waters is limited to stranding or incidental catch records with approximately twenty-five species of cetaceans recorded (Kumaran 2002),with the exceptions of dedicated work ongoing in Chilika Lagoon and in the Ganges and Brahmaputra rivers. The study of marine systems, marine conservation and marine mammals is thus limited and often intimidating to many a young ecologist. This can be appropriated to a range of causes, from logistical and financial limitations, to limited expertise to bureaucratic procedures and discouraging seniors. Even though we have recorded carcasses from all along the coast, no data collection or analysis have been carried out to specifically assess life-history parameters or feeding ecology of most of the species. Sadly therefore, while most of South Asia and South-east Asia have moved far ahead in terms of quantifying, monitoring, researching and simply studying marine mammals, we in India have many hurdles to cross before we can meet the benchmarks.

The diverse habitat types - coral reefs, sea grass beds, rocky shores, sandy shores, mangrove creeks, deep-water canyons and trenches, in Indian waters and those shared with neighboring countries offer a vast unexplored and data deficient biodiversity landscape. The study of species diversity amongst such diverse habitats and landscapes would make a very informative study for the region and for marine mammals in general. Information on the overlap in geographic range and genetic stock is vital for the conservation of marine mammals that cross international boundaries. A huge research gap in what is known about faunal biodiversity of the Indian ocean, Bay of Bengal and the Arabian sea is thus still at an exciting and exploratory stage. Very few systematic vessel-based surveys have been carried out to document the status of cetaceans and their distribution in relation to environmental parameters, hydrology, coastal development and physiographical features in India. Oceanic surveys have recently been carried out from platforms of opportunity to document cetacean diversity in waters deeper than 20m (Jayashankar et al. 2007, Afsal et al 2008 unpublished). CMFRI as we all know has also been doing pioneering work in publication of marine mammal information, education material and carrying out workshops such as this to fill this gap in formation as we all see it. Other than CMFRI, Chilika Development authority and James Cook University along with Nature Conservation Foundation have been studying and conserving the Irrawaddy dolphins in Chilika lagoon for a decade now. Coastal surveys in India have been carried out systematically in the Gulf of Kachchh in Gujarat, along the coast of Goa (Sutaria & Jefferson 2004), and along the coast of Orissa (Sutaria 2009) and opportunistically at the mouth of the Godavari river in Andra Pradesh (Tripathy & Choudhury 2004). Most of these surveys though are single surveys, they also lack standard methodology across surveys, and are thus very difficult to compare. Some standard line transect methods, both vessel based and aerial can be followed to make data-sets comparable. Based on the species or the habitat type and size, Mark-Recapture methods can also be sued to estimate population size. Sophisticated acoustic methods using hydrophone arrays can also be used to assess species diversity, encounter rates, population estimation, and habitat use. These methods produce robust estimates with a measure of uncertainty that allows for comparisons and help in assessing the likely impact of human activities or climate change led changes on marine mammal populations. This is a critical issue for coastal dolphins, which are among the most threatened and vulnerable species of cetaceans because of their close proximity to anthropogenic activities (DeMaster, 2001; Thompson, 2000). A creative and robust field of scientific research with researchers and government institutions work hand-in-hand, to study marine mammals and their habitats and better inform their conservation in Indian waters is thus most urgently required in India.

Marine Mammal Conservation and Research in South Asia: Approaches to International Cooperation

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Of the world's approximately 120 species of marine mammals, India has a quarter of it and most of these are shared with the rest of the coastal countries of south Asia. However, inventories and studies on the population dynamics, distribution and seasonal migration patterns of this important component of marine diversity remain markedly inadequate. The Indian Ocean basin shows an increase in fish catch while it is declining in other major ocean basins, indicating the health of the marine ecosystem of the region to host viable populations of marine mammals. There is, however, growing threat to this marine group as indicated by increasing beaching and bycatches.

Effective regional cooperation among the coastal countries of south Asia is imperative to the successful conservation of the marine mammals and to address the critical issue of data deficiency. Article 65 of the UN Convention on the Law of Seas commits States to cooperation for the conservation, management and study of marine mammals, and this is further affirmed in the case of high seas in Article 120. The Convention on Migratory Species (CMS or Bonn Convention) is an important framework for international cooperation for marine mammal studies and conservation. It has already developed two legally binding Agreements among regional range States for cetacean conservation- one for the Mediterranean and adjoining seas and another for the Baltic and North seas. CMS has also developed four Memoranda of Understanding among range States in different regions on conservation and studies on marine mammals. The Convention on Biological Diversity's (CBD) Program of Work on Marine Biodiversity emphasizes the need for cooperation among Parties on marine biodiversity conservation and sustainable use, and sets the basis for the establishment of protected areas covering transboundary marine areas and in areas beyond the limit of national jurisdiction.

The presentation will explore the options available for forging international cooperation in south Asia and discuss capacity building issues for strengthening the conservation and research systems for marine mammals in the region.

Marine Mammals: Recent Developments in the Taxonomy and Sex Determination of Whales, Dolphins and Porpoises

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Introduction

There has been increasing awareness of the integral importance of marine mammals to healthy aquatic ecosystems, and of the growing threats that a variety of anthropogenic activities, such as destruction of habitats, fishery interactions (e.g. gill net fishery), illegal fishing methods and pollution challenge to these animals and their environments. Research and education programmes should try to properly understand and more clearly communicate these threats and recommend appropriate steps to reduce or eliminate their impacts.

Accurate taxonomy is fundamental to the conservation efforts of living resources; the units on which conservation is based are determined partly by population structure and ultimately by species designation. Imperfect taxonomy may result, at least as much as a lack of understanding of the population structure, in the loss of genetic variability, e.g. unwitting extinction of a species. In cetaceans, morphological features are often subtle and difficult to compare because of the rarity of specimens or widespread distributions (Baker et al., 2004). A series of adult animals are required for the documentation of geographic morphological variation and such series may take decades to accumulate in museums and research institutions, unless large-scale fishery mortality accelerates the process. Thus identification of the geographical variants of recognized species of delphinids and phocoenids is difficult using the conventional approaches. There are yawning gaps in our present understanding of species status and geographic variation of cetaceans, which means that the list of currently recognized species of cetaceans will probably undergo serious revisions.

The order Cetacea comprises two extant sub-orders Mysticeti (filter feeding or baleen whales) and Odontoceti (toothed whales) The number of extant species of cetaceans remains debated. A recent list of IUCN consists of 84 species of which 16, including "stocks", "populations", or sub-species were assigned threatened status in 1996 (Reeves et al., 2004). However, with the recent consensus that recognizes three rather than one species of right whale, the total number of species comes to 85 (Perrin, 2002), and the number of subspecies is reduced to 41.

Approaches for identification of cetaceans

Cetacean systematics is rapidly changing for a variety of reasons, including advances in analytical techniques, application of molecular markers, and increase in the amount of material available and revisions are expected to continue at all levels (Milinkovitch et al., 2002).

Morphology based approach

Cetacean specimens "in hand" can be identified by using the dichotomous keys to external features. Characters, such as ratio of the outer margin of the flipper to the total body length, colouration pattern, teeth count, comparative osteology, etc. are used conventionally to identify the cetaceans (Rice, 1998). Skulls of many species are sufficiently similar that it will be necessary to examine a full series of each to define reliable diagnostic features. It is important to study the available material in various museums and private collections before expanding the already reported number of species to a final inventory. Studying the archive materials, thus eliminating the possible repetition, can bring out unknown details of a species.

More of the world's cetacean collections in museums and other institutions should be catalogued and made accessible through the internet (Reeves et al., 2004). This effort is already underway by many major museums, but the contents of some smaller collections remain relatively unknown. To facilitate access and comparisons, catalogues should ultimately be linked, managed and the information standardized through a single centralized location with the following data: collection locality and date, age/sex class, material collected (including soft tissue samples), total length and photographs of external appearance and skull morphology.

Great variability in morphological characters of cetaceans is not uncommon.

Sometimes it may only be possible to label an animals or group as "unidentified long-snouted dolphin" or "unidentified beaked whale", etc.

Photo identification

Photographs of dorsal fins and flukes help in identification of individual cetaceans. This technique, known as photo-identification, is useful for studying the school structure and species composition. A repeated photo-session from the same geographical location for a protracted period of time will help in monitoring resident and migrant populations as well as the reproductive success.

Identification of the species at sea is quite different from that of a dead animal at disposal on land. Even under ideal conditions, an observer often gets little more than a brief view of a splash, blow, dorsal fin, head, flipper, or back, and this is often at a great distance. Rough weather, glare, fog, or other bad sighting conditions compound the problem. Many species appear similar to another, especially in the brief glimpses typical at sea. It needs fair amount of experience and expertise to master the technique of identifying free ranging marine mammals at sea.

Generally, sightings are initially identified as "possible" or "confirmed" or, usually for the animals far away from the vessel, "unidentified". Photo and video documentation of sightings would later help to confirm the identification with the assistance of experts. Sixty eight percent of individual cetaceans sighted during one southern ocean cruise could be identified to the species level (Jayasankar et al., 2007c).

Molecular taxonomy

Molecular taxonomy is not meant to be a critique of morphology-based taxonomy, but must be firmly anchored within the knowledge, concepts, techniques and infrastructure of traditional taxonomy (Tautz et al., 2003). DNA-based taxonomy is especially relevant for cetaceans, because (i) they are very mobile and inaccessible organisms for which morphological, physiological and behavioural characters can be exceedingly difficult to score for population studies and (ii) their highly derived and specialized morphology reduces the utility of phenotypic data for assessing their phylogenetic position within mammals.

DNA sequence analysis has become a powerful tool for conservation - identifying the source of samples thought to be derived from threatened or endangered species. Only minute amounts of DNA are required, allowing for remote sampling. It is possible to use hair, blood, feces, skin biopsies and sloughed skin as a DNA source. PCR-based techniques technically are simple and rapid, making them practical for conservation and population studies. In cetaceans and dugong, the technique could be effectively used in the forensic identification of commercial products and verification of trade records and for identifying ambiguous beach-cast specimens. Illegal trade in animal/plant products is commonly practiced in some of the Asian countries, where they market some of the endangered species in the guise of ones approved by authorized bodies such as, the International Whaling Commission (IWC). Through a series of reports, the International Whaling Commission has brought out techniques and incidences of identification of market samples of cetaceans illegally traded by Japan and Korea. The DNA-based approach would help the conservationist to identify the species even from a small piece of tissue sample, such as skin from the marketed product.

The rapid advances in molecular techniques of the past few decades have led to significant contributions towards improving cetacean taxonomy. At higher taxonomic levels, the increasing case of generating useful molecular genetic data, notably DNA sequences, paralleled by theoretical advances and the development of computer programs, has stimulated reinvestigation of phylogenetic issues involving cetaceans. In some cases, results of these investigations have led to revisions of taxonomic relationships. Molecular genetics can also provide significant contributions to taxonomic understanding of inter and intra-specific variations for conservation and management purposes.

Mitochondrial DNA is often used in studies of marine mammals for a number of reasons including its high rate of evolution, maternal inheritance, low effective population size and lack of recombination (Hoelzel et al., 1998). Understanding population structuring is important for the effective management of the exploitation of any species. Analysis of mitochondrial DNA (mtDNA) has become a standard method for investigating population structure because of the rapid rate of evolution and simpler interpretation of the haploid nature of this molecule relative to nuclear DNA, and has helped define management units of many exploited species of marine mammals.

Two regions of the mitochondrial genome most commonly used for studies on marine mammals are the mitochondrial control region and the cytochrome b gene. The mitochondrial control region is a non-coding segment of the mitochondrial genome that regulates the replication of this genome. The control region is commonly used due to its high level of variabilityto study intraspecific evolution.

The cytochrome b gene has been used in numerous studies of phylogenetic relationships within mammals, and it is the gene for which the most sequence information from different mammalian species is available. The sequence variability of cytochrome b makes it most useful for the comparison of species in the same genus or the same family. The results obtained in many of the phylogenetic studies in which this gene has been used led to the proposition of new classification schemes that better reflected the phylogenetic relationships among the species studied.

Molecular identification of marine mammals can be done in two steps: (1) sequence similarity search under BLAST (Basic Local Alignment Search Tool) as implemented in GenBank (www.ncbi.nlm.nih.gov). (2) Once it was confirmed that the tissue sample was from a cetacean, the species identity was searched within DNA Surveillance (www.cebl.auckland.ac.nz:9000/). Most sequences in DNA Surveillance were included only if the specimen had been expertly identified and diagnostic skeletal material or photographic records were collected (Dizon et al., 2000). The purpose of checking the higher taxa of the unknown sample with BLAST search is important because if it does not belong to the order Cetacea, results of the phylogenetic identification could be misleading. Details of these web-based sequence databases are given elsewhere (Jayasankar and Anoop, 2010).

Sex identification

Sex identification is of fundamental importance in the studies of population structure, social organization, distribution, behaviour or heavy metal accumulation in marine mammals. For example, in heavy metal accumulation studies, males are preferred since lactating females would invariably pass the heavy metal contents to the baby, thus giving an erroneous level of concentration during testing. However, distinguishing the males and females among these animals is difficult due to the poor sexual dimorphism, especially during their free-ranging state (Gowans et al., 2000). Direct anatomical evidence of an individual's sex comes only from a full-ventral inspection of its genital region and such opportunities are limited during field observations; unless the animal rolls and remains inverted at the surface its genital region is visible only to an underwater observer, that too only at a very close range.

Non-molecular methods of gender identification have proved difficult and often unreliable. By examining the carcass remains of stranded/beach-cast cetaceans, which are often at decomposition levels, accurate assessment of reproductive organs is not possible. Though the individual may be inferred to be female if it is observed near calf, such inferences are troublesome for some species, like the sperm whale, in which "babysitting" males are possible (Whitehead, 1996).

More recently, PCR amplification of sex-specific DNA fragments has been widely available for sex identification. Molecular gender determination is essential in situations when the animal is not present but tissues are available or when sex-specific characters are either absent or difficult to observe.

A widely practiced method has been amplification of Y-chromosome specific SRY locus amplified simultaneously with the homologous ZFX/ZFY genes on the X chromosome of females (ZFX) and XY chromosomes of males (ZFX/ZFY) as positive control for the absolute confirmation of sex. Females lack Y chromosome and the test is based on the absence of a SRY product in females. This method was successful in identifying sex of several mammalian groups (Aasen and Medrano, 1990).

Indian scenario

In the Indian seas, marine mammals are represented by two groups of marine mammals, cetaceans and sirenians. Latter is represented by a single species, dugong (Dugong dugon). Research on marine mammals in India has been restricted to reporting on their incidental catches in fishing nets or beach-cast samples. Spinner dolphin (Stenella longirostris), bottlenose dolphin (Tursiops aduncus), Indo pacific humpbacked dolphin (Sousa chinensis) and common dolphin (Delphinus capensis) are the commonly encountered delphinids and finless porpoise, the only known representative of phocoenids in India along with dugong. These species seem to be residents or regular visitors to the coastal areas, thereby facing higher risks of either entanglement in fishing nets other than the other offshore species. The annual mortality of cetaceans in gillnet fishery is about 1000-1500 (Yousuf et al., 2008). Entanglement of cetaceans in other fishing gears such as trawls, purse seines, shore seines and long-lines has also been reported. While the Indian Wildlife Protection Act of 1972 puts all marine mammals in Schedule I of the Act, very little has been done in ways to mitigate mortality. Dugong has a very narrow distribution and is considered endangered.

It is still unclear as to how many species of cetaceans exist in the Indian seas. In the absence of any dedicated survey to assess the abundance of cetaceans in Indian waters, we have no indication of their numbers; leave alone their population trends. Though the extant cetacean species number in Indian seas is suggested to be 25 (Kumaran, 2002), it could probably be more. Lack of adequate field keys and reliable inventory has resulted in several cases of misidentification. About 50% of the stranded baleen whales have not even been identified to the species.

At the Central Marine Fisheries Research Institute, under a research project sanctioned by the Ministry of Earth Sciences, the first major concerted attempt was made to study biology, trophodynamics, fisheries interaction, contaminant accumulation, biomarkers, molecular taxonomy and PCR-based sex identification of marine mammals from Indian coasts (Yousuf et al., 2008; Jayasankar et al., 2006, 2007a, b, c, 2008a, b, c; Anoop et al., 2008; Jayasankar and Anoop, 2010). The work on molecular taxonomy carried out under this project was an attempt to develop a database of genetic sequences for future cetacean research in addition to confirming the identity of delphinids and finless porpoise collected around India using standard genetic techniques and to make a comparison of Indian haplotypes with those of the corresponding species from other geographical seas. Unique haplotypes were detected in Indo pacific humpbacked dolphin *(Sousa chinensis*; n = 2) and finless porpoise *(Neophocaena phocaenoides*; n = 12) from Indian coast. On the other hand, some haplotypes were shared with other regional populations in spinner dolphin *(Stenella longirostris*; n = 16) and bottlenose dolphin *(Tursiops aduncus*; n = 3). Common dolphins *(Delphinus capensis*; n = 2) had both unique and shared haplotypes including one highly divergent sequence. The smaller numbers analyzed in most of the cases would not probably resolve the species identity crisis; but could contribute for a comparison of the species from India with those of global occurrence.

Orcaella brevirostris, the Irrawaddy dolphin, has been recorded from a wide range of coastal and riverine habitats from the north-western Bay of Bengal to the east coast of Australia. In India, the Irrawaddy dolphin has been recorded from Visakhapatnam to the deltas of the Brahmaputra and Ganga rivers. Globally there are less than 1000 animals of Orcaella distributed among six countries of Asia and in Australia. Of the only known two lagoon populations of this dolphin in the world, one is residing in Chilika in Orissa state, India. In addition to accidental deaths in gill net fishery and mechanized boat operations, there has been exploitation of the species for their oil (hence their local name Bashiyya Magar – oil yielding dolphin). Although *O. brevirostris* is listed by IUCN as Data Deficient, extreme vulnerability of this species owing to its narrow ecological niche, patchy distribution and become entangled in fishing gear has made it a focus of conservation concern. Establishment of a genetic diversity database within this species will help conservation efforts with regard to translocation of individuals and population viability assessments, which ultimately will help managers to make critical decisions to lessen the species' risk for extinction. Against this background, a study was carried out with a broad objective of generating baseline genetic information on the Irrawaddy dolphin population of Chilka lagoon and to provide inputs for formulating protection strategy of this endangered species (Jayasankar et al., 2001). Phylogenetic analysis indicated distinct clades within the Asian samples, with the Indian population showing closest genetic proximity to the haplotypes from Thailand. It is recommended to continue to examine the population discreteness and genetic variation of Irrawaddy dolphin in Chilika Lagoon vis-à-vis its global geographic distribution for formulating the conservation plans of the species.

Remarks on the results of molecular taxonomy study

Of the eleven species of cetaceans identified using molecular taxonomy by the present author, ten were recorded by earlier workers from Indian seas, except Delphinus capensis, which was reported previously as D. delphis (Kumaran, 2002). Marine mammals in terms of number of species and individuals are abundant in the southwest coast of India, Gulf of Mannar and southern Sri Lanka. For addressing all issues impacting the cetaceans around India, their unambiguous identification, inventory and cataloguing are essential. Several cases of misidentification of cetaceans committed by earlier Indian workers who solely depended on conventional tool of taxonomy has been brought to the notice – molecular approach can help address the species identity through standardized comparisons (Kumaran, 2002).

The specimen of *S. attenuata* collected during the Indian study was apparently a juvenile, measuring 93 cm in total length. Initially it was misidentified as bottlenose dolphin in the field. Whale and Dolphin Conservation Society (WDCS) in its website have suggested that the Pantropical spotted dolphins are born without spots and that it could easily get muddled up with other species such as bottlenose dolphin. The specimens of this species from far west Pacific, the Hawaiian form, are least spotted, nearly unspotted as adults (Dizon et al., 1994). From its photograph and few body measurements, the species was confirmed as *S. attenuata* (William Perrin, personal communication). According to them the shape of the species was not that of bottlenose dolphin and the colour patterns around the head were consistent with *S. attenuata*. Molecular approach has strongly ratified its species status.

As many as 11 haplotypes were observed in *S. longirostris* of Indian seas, indicating high genetic variability in the species. The taxonomy of Stenella is a matter of ongoing debate and presence of multiple subspecies of *S. longirostris* (Perrin et al., 1999) could further complicate the scenario. DNA Surveillance itself recommends caution on phylogeny-based molecular identification.

The earlier published studies from India have mentioned the bottlenose dolphin species as Tursiops truncates (Sathasivam, 2004). However, it is now evident that the species of bottlenose dolphin which is often killed accidentally in the coastal gillnet fisheries is likely to be *T. aduncus*. *T. truncatus* is known to be larger than *T. aduncus* and has a shorter beak. All the three specimens collected in the study conducted by present author showed closest genetic proximity to T. aduncus.

Taxonomic status of common dolphin appears to be far from fully resolved, particularly that of its representatives in the Indian Ocean and Southeast Asia (Jefferson and Waerebeek, 2002). All the earlier workers have mentioned the species of common dolphin from Indian seas as *Delphinus delphis* (Sathasivam, 2004). But the species encountered in the Indian study had a fairly long beak and based on the morphological features as well as mtDNA sequencing, is identified here as either *Delphinus capensis* or *D. tropicalis*. On the basis of morphological comparisons, the tropicalis form should be appeared to be a subspecies of *D. capensis* (Jefferson and Waerebeek, 2002). The Indian Ocean species is most likely to be *Delphinus capensis tropicalis* (T. A. Jefferson, personal communication). While one of the haplotypes identified by the present author had absolute genetic similarity with the one reported earlier (LeDuc et al., 1999), the other one was extremely divergent and in DNA Surveillance was placed in a cluster grouping two short-beaked common dolphins as well as one tropicalis form. It was decided to name this specimen as *Delphinus capensis* with an interrogation mark. Although the possibility of contamination of this sample is unlikely, sequencing of a nuclear pseudogene, which came about as a replication of cytochrome b cannot be ruled out (Mirol et al., 2000).

Preliminary results of genetic analysis have indicated that strong population structuring occurs in Sousa, both within and across ocean basins (IWC, 2003a). In the Indian study study, all the samples of Indopacific humpbacked dolphins were from the West coast of India; hence the possible genetic differences between the West and East coastal forms of this species could not be verified. Populations along the two coasts are reported to differ markedly in their body color and size of the dorsal hump (Sutaria and Jefferson, 2004).

MtDNA sequence analysis of Irrawaddy dolphin (Orcaella brevirostris) from Chilika Lake showed closest genetic proximity of Indian haplotypes with those from Thailand. The haplotypes from Cambodia were next closer and ones from Indonesia were farthest from the Indian haplotypes. Present results are in conformity with the observations of Beasley et al. (2005) on the possible occurrence of more than one genetic population of Irrawaddy dolphin in the Asian region.

Remarks on the results of PCR-based sex identification

The sex determination method used by the present author for cetaceans and dugong is technically simple, requiring only PCR amplification and agarose gel electrophoresis, and has advantage over the sex determination based on probe hybridization.

The method was also reliable and yielded 82% success in 44 individuals of 11 species tested (Jayasankar et al., 2008a). Every sample should produce at least one band and the absence of any amplification implies a failed PCR reaction. Testing the technique using samples of known sexes (determined by physical examination of stranded/ accidentally caught individuals) from ten cetaceans and dugong indicated that this sexing method was effective across a broad taxonomic range. The method can provide the secondary confirmation necessary for positive sex identification in marine mammal specimens, or a primary method where accurate field observation of gender is not possible.

In three cases, one each of spinner dolphin, sperm whale and Bryde's whale specimens, where external sex determination was not possible, molecular sexing could be possible. In two cases, one each spinner dolphin and finless porpoise, PCR based method revealed erroneous sexing by external examination. However, in 8 individuals molecular sexing failed probably due to the highly deteriorated condition or non-availability of gDNA of the particular specimens.

In Chilika Lake the females of *O. brevirostris* with calves were observed to remain in shallower regions of the lake and were relatively less mobile compared to males. In the study by Jayasankar et al. (2001) female to male ratio was skewed towards male among the dead specimens, which might indicate relatively higher risk of males to accidental death in the lagoon from gill net fishing and boat operations, owing to their more active free ranging behaviour.

It is expected that the PCR-based gender identification method standardized by the present author (Jayasankar et al., 2008a) would help in the studies of conservation, population structure and forensic issues of marine cetaceans and dugong.

Conclusions

The identity of many cetaceans, especially the delphinid species from Indian seas is as confusing as it is elsewhere. The Indian attempt mentioned here was restricted to only coastal collections, taken as fisheries by-catch. Some of the Indian haplotypes were comparable to those segregated far apart geographically; but not comparable to those in the same locality. This is perhaps because they are highly migratory and the segregation/aggregations are coupled with generations of migrations across the oceans. The first attempt on the molecular identification of cetaceans of Indian seas has clearly indicated the need for studying more number of species and individuals; phylogenetic relationships to understand the evolution of different species; and genetic variation vis-à-vis global geographic distribution of different species for the biodiversity conservation plans of these vulnerable/endangered animals. Given the fact that even from a small piece of skin tissue of the animal, the species and sex can be identified will certainly have far reaching implications in the conservation and management of marine mammals.

References

Aasen E., Medrano J.F. Amplification of the ZFY and ZFX genes for sex identification in humans, cattle, sheep and goats. Biotechnology, 1990; 8:1279–1281.

Anoop A.K., Yousuf K.S., Kumaran P.L., Harish N., Anoop B., Afsal V.V., Rajagopalan M., Vivekanandan E., Krishnakumar P.K., Jayasankar P. Stomach contents of cetaceans incidentally caught along Mangalore and Chennai coasts of India. Estuarine, Coastal and Shelf Science, 2008; 76:909-913.

Baker C.S., Ross H., Lavery S., Rodrigo A., Dalebout M.L. Progress on an applied molecular taxonomy of cetacean species. In: Reeves R.R., Perrin W.F., Taylor B.L., Baker C.S., Mesnick S.L., editors. Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management, La Jolla, California, 2004. pp. 91.

Beasley I., Robertson K.M., Arnold P. Description of a new dolphin, the Australian Snubfin Dolphin *Orcaella Heinsohni* sp. n. (Cetacea, Delphinidae). Marine Mammal Science, 2005; 21:365–400.

Dizon A., Baker S., Cipriano F., Lento G., Palsboll P., Reeves R. Molecular genetic identification of whales, dolphins, and porpoises. In: Leatherwood S, Reeves R.R., editors. Proceedings of a workshop on the forensic use of molecular techniques to identify wildlife products in the market place. NOAA- TM-NMFS-SWFSC-286, 1-51: Academic Press, San Diego. 2000. pp. 129–139.

Dizon A., Perrin W.F., Akin P.A. Stocks of dolphins (*Stenella* spp. and *Delphinus delphis*) in the Eastern Tropical Pacific: A phylogeographic classification. NOAA Technical Report NMFS 1994; 119: 1-20.

Gowans S., Dalebout M.L., Hooker S.K., Whitehead H. Reliability of photographic and molecular techniques for sexing northern bottlenose whales *(Hyperoodon ampullatus)*. Canadian Journal of Zoology, 2000; 78:1224–1229.

Hoelzel A. R., Potter C.W., Best P.B. Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of the bottlenose dolphin. Proceedings of the Royal Society of London Series B-Biological Sciences, 1998; 265:1177-1183.

International Whaling Commission (IWC). Annex K. Report of the Standing Sub-committee on Small Cetaceans. Journal of Cetacean Research and Management, 2003a; 5 (Suppl.):362-381.

Jayasankar P., Anoop A.K., Rajagopalan M., Krishnakumar P.K. A note on observations on cetaceans in the western Indian sector of the Southern Ocean (20-56°S and 45-57°30'E), January to March 2004. Journal of Cetacean Research and Management, 2007c; 9:263-267.

Jayasankar P., Anoop A.K., Rajagopalan M., Krishnakumar P.K. A note on observations on cetaceans in the western Indian sector of the Southern Ocean (20-56°S and 45-57°30'E), January to March 2004. Journal of Cetacean Research and Management, 2007c; 9:263-267.

Jayasankar P., Anoop A.K., Rajagopalan M., Krishnakumar P.K. Cetaceans in the Southern Indian Ocean 2004. OBIS-SEAMAP web site: http://seamap.env.duke.edu/datasets/detail/468. 2008c.

Jayasankar P., Anoop B., Afsal V.V., Rajagopalan M. Species and sex of two baleen whales identified from their skin tissues using molecular approach. Marine Fisheries Information Service Technical & Extension Series, 2006; 190:16-17.

Jayasankar P., Anoop B., Rajagopalan M., Vivekanandan E., Krishnakumar P.K., Kumaran, P.L., Reynold P., Anoop A.K., Yousuf K.M.M.., Afsal V.V.

Mitochondrial DNA sequencing of cetaceans and dugong from the Indian seas for their conservation and management. Marine Fisheries Information Service Technical & Extension Series, 2007b; 192:1-6.

Jayasankar P., Anoop B., Rajagopalan M. PCR-based sex determination of cetaceans and dugong from the Indian seas. Current Science, 2008a; 94:1513-1516.

Jayasankar P., Anoop B., Reynold P., Afsal V.V., Rajagopalan M. Species of a whale and an unknown fish sample identified using molecular taxonomy. Indian Journal of Fisheries, 2007a; 54:339-343.

Jayasankar P., Anoop B., Vivekanandan E., Rajagopalan M., Yousuf K.M.M., Reynold P., Krishnakumar P.K., Kumarran R.P., Afsal V.V., Anoop A.K. Molecular Identification of Delphinids and Finless Porpoise (Cetacea) from the Arabian Sea and Bay of Bengal. Zootaxa, 2008b; 1853: 57–67.

Jayasankar P., Anoop B. Identification of Marine Mammals of India. First Edition, Narendra Publishing House, Delhi, 2010.

Jayasankar P., Patel A., Khan M., Das P., Panda S. Mitochondrial DNA diversity and PCR-based sex determination of Irrawaddy dolphin (*Orcaella brevirostris*) from Chilika Lagoon, India. Molecular Biology Reports, 2011; 38:1661–1668.

Jefferson T.A., Waerebeek K.V. The taxonomic status of the nominal dolphin species Delphinus Tropicalis Van Bree, 1971. Marine Mammal Science, 2002; 18:787-818.

Kumaran P.L. Marine mammal research in India – a review and critique of the methods. Current Science, 2002; 83:1210-1220.

LeDuc R.G., Perrin W.F., Dizon A.E. Phylogenetic relationships among the delphinid cetaceans based on full cytochrome b sequences. Marine Mammal Science, 1999; 15:619-648.

Milinkovitch M.C., LeDuc R., Tiedemann R., Dizon A. Marine Mammals: Biology and Conservation. In: Evans PGH, Raga JA, editors. Applications of molecular data in cetacean taxonomy and population genetics with special emphasis on defining species boundaries: Kluwer Academic/Plenum, 2002: pp.325-359.

Mirol P.M., Mascheretti S., Searle J.B. Multiple nuclear pseudogenes of mitochondrial cytochrome b in *Ctenomys* (Caviomorpha, Rodentia) with either great similarity to or high divergence from the true mitochondrial sequence. Heredity, 2000; 84:538-547.

Perrin W.F., Dolar M.L.L., Robineau D. Spinner dolphins *(Stenella longirostris)* of the western Pacific and Southeast Asia: pelagic and shallow water forms. Marine Mammal Science, 1999; 15:1029-1053.

Perrin W.F. Species. In: Perrin W.F., Wursig B., Thewissen J.G.M., editors. Encyclopedia of Marine Mammals: Academic Press, San Diego, CA, 2002 a. pp.1155-1158.

Reeves R.R., Perrin W.F., Taylor B.L., Baker C.S., Mesnick S.L. Report of the Workshop on Shortcomings of Cetacean Taxonomy in Relation to Needs of Conservation and Management. La Jolla, California, 2004; pp.91.

Rice D.W. Marine mammals of the world: Systematics and distribution: Society for Marine Mammalogy, Special Publication, Lawrence, Kansas, USA, 1998; 4:1-230.

Sathasivam K. Marine Mammals of India, University Press, Hyderabad, 2004.

Sutaria D., Jefferson T.A. Records of Indo-Pacific Humpback dolphins (*Sousa chinensis*, Osbeck, 1765) Along the Coasts of India and Sri Lanka: An Overview. Aquatic mammals, 2004; 30:125-136.

Tautz D., Arctander P., Minelli A., Thomas R.H., Vogler A.P., A plea for DNA taxonomy. TRENDS in Ecology and Evolution, 2003; 18:70–74.

Whitehead, H. Babysitting, dive synchrony, and indications of alloparental care in sperm whales. Behavioral Ecology and Sociobiology, 1996; 38:237–244.

Yousuf K.S.S.M., Anoop A.K., Anoop B., Afsal V.V., Vivekanandan E., Kumarran R.P., Rajagopalan M., Krishnakumar P.K., Jayasankar P. Observations on incidental catch of cetaceans in three landing centres along the Indian coast. Journal of Marine Biological Association UK 2 Biodiversity records, online publication, 2008; (Ref no. 6254):

CETACEAN DISTRIBUTION IN THE INDIAN EEZ AND CONTIGUOUS SEAS DURING 2008-10

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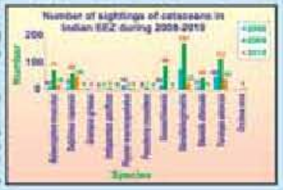
Introduction

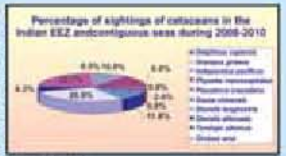
- During 2003-2007, 35 extensive marine mammal sighting surveys were made in the Indian EEZ and contiguous seas on board FORV *Sagar Sampada*. The results were published by Afsal *et al* (2008).
- In the earlier surveys the total number of days of observation was 657 and cetaceans were sighted on 299 days. The total number of sightings was 473, which comprised of 5865 individuals. 14 species identified, 6 were whales and 8 were dolphins. The six whales include 5 species of baleen whales and one species of toothed whale. *Tursiops aduncus and Stenella longirostris* were the most dominant species, distributed abundantly in space and time followed by *Delphinus capensis* and *Sousa chinensis*.
- In continuation of the earlier surveys, 12 opportunistic surveys were made onboard FORV *Sagar Sampada* between September 2008 and December 2010.

Methodology

- Cetacean sightings surveys were carried out by single trained observer in every cruise by scanning with naked eye and interspersed with a Nikon 10 x 50 mm CFWP handheld binocular with visual range of 4km. Sighting plat forms were situated 16m above surface of sea level.



- A Nikon F80 camera fitted with Nikor 70-300 mm lens was employed to capture appearances of cetaceans in the form of spouts, dorsal fin, flipper, upper body, fluke.
- Data on the distribution of cetaceans were collected along with related environmental variables.
- Simrad GN33 GPS navigator was used to record geographical position of animal sighted area.
- Cetaceans were identified to the lowest taxonomic level possible based on descriptions in FAO field guide (Jefferson, 1993, 1998).
- Environmental data four variables, namely two physiographic variables (depth and distance from the shore) and two oceanographic variables (sea surface temperature and surface salinity) were considered.



- EMCON SBE 9plus underwater shipboard sensors unit provided SST and salinity data.
- For recording the maximum depth at which the animal was sighted, Simrad EK 60 Echo-sounder of frequency 38 kHz was employed.
- Distance between the sighting and nearest shore was calculated using Garmin Map source software version 6.15.6.
- The cruises were not dedicated to marine mammal sightings and the cruise tracks were determined by the needs of other project. Hence the marine mammal surveys can be termed as opportunistic. The study area included the coastal, continental shelf and oceanic waters of the Indian EEZ and the Sri Lankan Sea.

Important Highlights

Distribution

- A total of 93 cetacean sightings were recorded in 1307 hours of observation effort in 191 days in the Northeastern Arabian Sea, Southeastern Arabian Sea, Northern Bay of Bengal, Southern Bay of Bengal, Andaman Sea and southern Sri Lankan Sea (Indian Ocean).
- The sightings included the following species: *Stenella longirostris* (spinner dolphin), *Delphinus capensis* (long-beaked common dolphin), *Sousa chinensis* (Indo-Pacific hump-backed) dolphin, *Grampus griseus* (Risso's dolphin), *Tursiops aduncus* (bottlenose dolphin), *Stenella attenuata* (Pantropical spotted dolphin), *Balaenoptera musculus* (blue whale), *Physeter macrocephalus* (sperm whale), *Pseudorca crassidens* (false killer whale) and *Orcinus orca* (killer whale).

MAP SHOWING THE LOCATIONS OF CETACEAN SIGHTINGS DURING 2008-2010

- Among the areas surveyed, the Sri Lankan Sea was the richest in diversity and abundance of whales, namely, *Balaenoptera musculus* (blue whale; 29 individual sightings), *Balaenoptera* sp
- The southeastern Arabian Sea was the second most diverse area, from where four species of cetaceans, namely *Stenella longirostris*, *Tursiops aduncus*, *Delphinus capensis* and *Sousa chinensis* were recorded.

Conclusion

- The 'delphinids' were the most diverse group with eight species. (*Tursiops aduncus and Stenella longirostris* were the most abundant and widespread species. Among delphinids, the spinner dolphin was dominant in terms of abundance, whereas Indo-Pacific bottlenose dolphin was the most dominant species in terms of number of records.
- Among large whales *Balaenoptera musculus* was the most abundant species with wide distribution. The sperm whales *Physeter macrocephalus* are found more in the Sri Lankan Sea.
- Cetaceans are found to have a very wide geographical distribution in the Indian EEZ and the contiguous seas. Abundance and species richness are greater in the southeastern Arabian Sea and southern Sri-Lankan waters whereas and relatively sparse in other surveyed area, in particular, in the northern parts of Indian coast. This confirms the earlier report by Afsal *et al* (2008).
- An important observation made during this survey was the first sighting of Longman's beaked whale (*Indopacetus pacificus*) (southern Bay of Bengal), Killer whale (*Orcinus orca*) from Andaman sea and Blue whale (*Balaenoptera musculus*) from Arabian sea.

SIGHTINGS OF CETACEANS IN THE INDIAN SEAS DURING THE SURVEY

Blue Whale
Balaenoptera musculus
(Off Mangalore 16-10-10)

Long-Beaked Common Dolphin
Delphinus capensis
(Off Kollam 21-09-09)

Risso's Dolphin
Grampus griseus
(Off Kannur 11-10-08)

Longman's Beaked Whale
Indopacetus pacificus
(Southern Bay of Bengal 26-01-09)

Killer Whale
Orcinus orca
(Near shore South Nicobar Island 21-10-10)

Sperm Whale
Physeter macrocephalus
(South East Coast of Srilanka 14-11-08)

False Killer Whale
Pseudorca Crassidens
(Off Vengurla Maharashtra 30-3-09)

Indo-Pacific Humpback Dolphin
Sousa chinensis
(Off Kochi 21-09-08)

Pantropical Spotted Dolphin
Stenella attenuata
(Off Kakinada 31-8-09)

Spinner Dolphin
Stenella longirostris
(West off Cape Comorin 15-11-08)

Indo-Pacific Bottlenose Dolphin
Tursiops aduncus
(Off Kasargod 2-10-08)

References

Afsal, V.V., K.S.S.M. Yusuf, B. Anoop, A.K. Anoop, P. Kannan, M. Rajagopalan and E. Vivekanandan A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003-07. *Journal of Cetacean research Management*. 10 (3):209-215, online publication 2008.

Jefferson, T.A., Leatherwood, S. and Webber, M.A. 1993. *FAO Species Identification Guide. Marine Mammals of the World*. FAO, Rome. 320pp.

Jefferson, T.A., Webber, M. and Pitman, R.L. 2008. *Marine Mammals of the World: a Comprehensive Guide to their Identification*. Academic Press, London. 573pp.

STATUS OF *DUGONG DUGON* (MULLER, 1776) IN ANDAMAN AND NICOBAR ISLANDS

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Introduction

- The sea cow *Dugong dugon* (Muller, 1776) is a large herbivorous marine mammal which, together with the manatees, is one of four living species of the order Sirenia. It is the only living representative of the once-diverse family Dugongidae.
- All extant members of Order Sirenia (including the Dugong) are listed as vulnerable to extinction and also listed on Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- In India Dugongs occur along the coast of Gulf of Kutch, Gulf of Mannar and Palk Bay and in the Andaman and Nicobar Islands.
- Considering the declining population of this mammal, Dugongs are protected under schedule-I category of Wildlife (Protection) Act, 1972. It is also declared as state animal of the Union Territory of Andaman and Nicobar Islands.
- However, legal hunting by aboriginal tribes and illegal poaching mostly by neighboring countries are continued to be unabated and posing a threat to insular population of this mammal in A & N Islands.
- The aim of the present investigation is to understand the current status of Dugong in A & N waters and to suggest possible threats for population depletion as well as to draft effective managerial measures to conserve these endangered animals.

Material and Methods

Undersea surveys were conducted along the waters of A & N Archipelago during the year 2008-10 to investigate the present status of Dugong, while monitoring the health of coral reefs (Fig. 1). Dinghy boats were engaged to conduct the intensive surveys in promising areas inhabited by the Dugongs. Apart from that, secondary data on the reports of Dugongs in these islands were collected through published literatures. Consultations and interaction were made with scientific departments as well as fisher-folk communities and local inhabitants to collect the information on sightings of Dugong in recent past.

Fig 1 Area surveyed

Dugong dugon in Neil island

Courtesy: Reef Watch

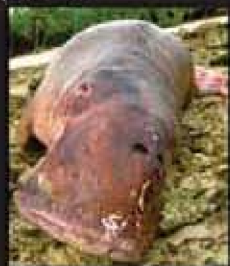
Results

- The data on the earlier records of dugong in A & N Islands collected through the published literature, reports from government departments, personal communications and observations made during 2008-10 are depicted in table.
- Based on the existing data on Dugong in A & N Islands, it is observed that over the period of 51 years since 1959, a total of 77 Dugongs were recorded either in the form of live or dead.
- Among them 48 Dugongs were from Andaman Islands, whereas 29 encountered from Nicobar Islands.
- Only 44 Dugongs were reported live from these islands while 26 and 7 Dugongs found dead in Andaman Islands and Nicobar Islands respectively.
- The distribution of these mammals is comparatively high in north Andaman region, Ritchie's Archipelago in Andaman group and Great Nicobar Island in Nicobar group.
- Main causative factor for the mortality of Dugong is fishing nets especially gillnet and shore seine net.

Table: Records of dugong sighted in A & N Islands

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Stranded Dugong in Neil Island



Courtesy: DoEAF, A&N Is.

Discussion

- In India, Dugongs were common in the 1950s, but the population has dropped drastically in the recent past, as evidenced by sporadic sightings and rare records of poaching. Due to over exploitation, the Dugong completely disappeared in many areas, while its residual populations still existed at other places (Rao, 1990).
- Impact of tsunami coupled with scarcity of seagrasses in the coastal waters might be a cause for the reduction in Dugong population in these islands.
- Hunting and fishing in seagrass bed region are also a potential threat and stranding of Dugong reported in the past by the entanglement of this mammal in gillnets.
- Habitat loss is one the prime reasons for the decrease in the Dugong population in these islands due to anthropogenic activities such as boat traffic and natural calamities like cyclone, tidal waves, high energy tidal storms, and frequent tremors and earthquakes.
- The present study opined that the Dugongs are less abundant than in recent past.

Recommendations

1. High priority should be given to monitor Dugong distribution and relative abundance using regular aerial surveys.
2. Regular seagrass surveys are also required to assess temporal changes in seagrass meadows, and the impacts of extreme climatic events on Dugong habitats in the region.
3. Satellite tracking of dugongs in key areas will provide detailed information on Dugong habitat use. Such information would be very useful for assessing the local impacts of proposed developments on Dugongs and for other local scale planning.
4. All vessels/boats operating Andaman and Nicobar Islands should have a Dugong sighting log which will enable to understand the distribution of Dugong in all over these islands as well as effective management.
5. Development of a chart detailing the distribution of seagrass beds in A & N Islands to allow fishermen to identify potential Dugong areas and to avoid fishing in those zones.

BEHAVIOUR OF INDO-PACIFIC HUMPBACK DOLPHIN, *SOUSA CHINENSIS* (OSBECK) IN THE ASHTAMUDI ESTUARY, SOUTHWEST COAST OF INDIA

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Introduction

Though very common in Indian coastal waters, the behaviour of Indo-Pacific humpback dolphin, Sousa chinensis (Osbeck) is not well documented.

This dolphin enjoys near-shore distribution throughout its range, often entering estuaries and sometimes rivers.

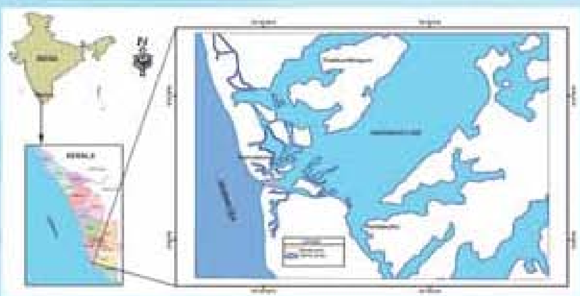
Listed as 'Near Threatened' by the IUCN Red Data Book, in Appendix I of the CITES and in Appendix I of the CMS.

First report on the behaviour of Sousa chinensis from the estuarine ecosystem of India.

Methodology

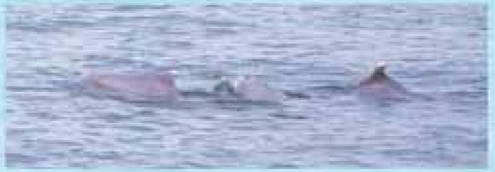
The behaviour of *S. chinensis* (Osbeck) found in the Ashtamudi estuary (8045'- 9028' N and 76028'-77017'E) situated along the southwest coast of India was documented during the June 2010 – May 2011.

Dolphins were observed at a distance of 5 to 50 metres from them, with binoculars from the artificial sea wall of the Sakthikulangara fishing harbour, close to the mouth of the estuary and photographed with a digital camera (Nikon D90).



Major Observations

- Maximum record of 20 dolphins at a time in the estuary; pod size varied from 1 to 5 (mean 3).



- Entry depends primarily based on tidal inflow into the Ashtamudi lake.
- The dolphins displayed a fairly stereotyped surfacing–breathing pattern, with the rostrum rising steeply above the water before the forehead breaks the surface.
- While travelling, moving in the same direction, the group members dive and surface synchronously for a longer time.
- No significant seasonal and monthly variations in occurrence; calves observed throughout the year.
- The feeding-related behaviours noted were sudden bout towards the prey with shuttling or speedy zigzagging backwards and forwards and fish-stunning by tossing them into the air.

- The surface feeding was primarily on mullets (first photographic documentation in India).

- The resting activity was primarily floatation in water.

- As part of socializing behaviour, they exhibited vertical leaps, side leaps, quasi leaps and somersaults.

The principal threat to dolphins in the Ashtamudi estuary is the heavy traffic of trawlers and other motorised vessels.

STUDIES ON THE STRANDED AND INCIDENTAL CATCH OF SPERM WHALES (PHYSETER MACROCEPHALUS LINNAEUS) ALONG THE INDIAN COAST - STRATEGIES FOR CONSERVATION AND MANAGEMENT

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INTRODUCTION

- The whales, dolphins and porpoises are collectively grouped in the order Cetaceae. There are two distinct branches of Cetaceans – those mouths contain baleen plates and who have two blow holes on the top of their heads (Mysticeti) and those who have teeth and a single blow hole (Odontoceti).
- The sperm whale family *Physeteridae* has three species, all of which occur in Indian waters. The sperm whale, *Physeter macrocephalus* Linnaeus growing to more than 18m in length is much larger than the Pygmy and Dwarf sperm whale, *Kogia brevicephs* and *Kogia sinus* which attains a length of only 3m or so.
- These whales in deep waters, feed mainly on giant squids, cuttle fish and occasionally fishes.
- There are probably a few hundred thousands existing today but because of the extensive killing of large reproductive males by developed countries, the future status of this species remains doubt and so awareness for conservation of sperm whales are to be created.
- Sperm whales were subjected to intensive whaling for valuable substances like spermacetti oil and ambergris during 19th and 20th centuries.

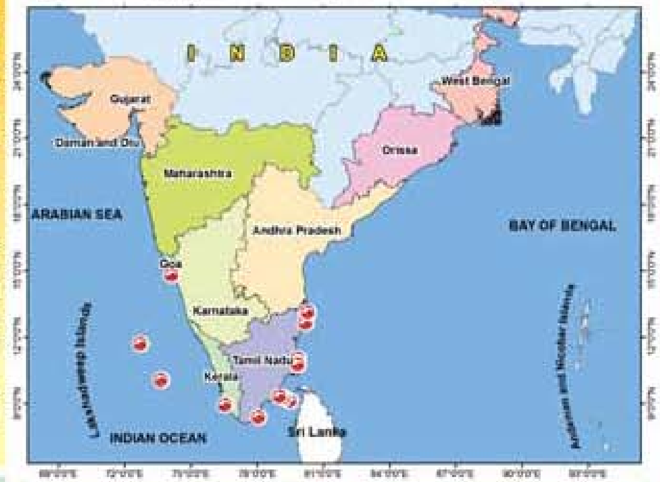
METHODOLOGY

- Normally most of the stranding of sperm whales along the Indian coast is caused due to the rough weather conditions. The sperm whales while moving to their feeding grounds in the shallow waters are also get stranded.
- Various morphometric measurements of the stranded/incicentally caught sperm whales were recorded. The carcass was cut open and the food remains in the stomach was ascertained.

RESULTS

- The beaks of cephalopods and skeletal parts of fishes were identified

Sperm Whale (*Physeter macrocephalus Linnaeus*)



MAP SHOWING LOCATIONS OF STRANDED AND INCIDENTAL CATCH OF SPERM WHALES (1890 - 2002)

IMPORTANT HIGHLIGHTS

- The standed and incidental catch of sperm whales along the Indian coasts were not reported after 2002 to July 2011.
- The knowledge together with education and increased public awareness will help to conserve wild populations of sperm whales.
- Remote sensing data are necessary to study distribution, migration and their behavioral patterns of sperm whales. The IKONOS and QUICKBIRD offer multispectral imagery at resolutions of 4m and 2.4-2.8m respectively and panchromatic imagery at 1m and 0.6-0.8m respectively. At these resolutions, direct identification of certain species and species assemblages is becoming feasible.

THE STRANDED AND INCIDENTAL CATCH OF SPERM WHALES ALONG THE INDIAN COAST

No	Date	Place	Length (cm)	Sex	Reference	Remarks
1	Jan 1890	Madras	731	Male	Blanford (1891)	Killed by an pirates
2	23.2.1971	Kalpeni Island (Lakshadweep)	530	Male	James and Panicker (1980)	Entangled / caught in drift gill net
3	23.06.1972	Karwar	837	Female	Antony Raja and Pai (1973)	Dead/washed ashore
4	30.04.1980	Krusadai Island (Gulf of Mannar)	810	Male	James and Soundararajan (1980)	Dead stranded
5	12.04.1980	Mahabalipuram (near Chennai)	670	Male	James and Manivasagam (1980)	Live specimen struggling in water, was
6	25.11.1980	Puthenthurath Island (Ashtamudi lake, Near Quilon)	555	Male	Bande et.al. (1983)	Stranded
7	01.11.1982	Cheriyan Shore, Kalpeni (Lakshadweep)	530	Male	James and Panicker (1994)	Dead/Stranded
8	22.12.1982	Chetlat Island (Lakshadweep)	500	Male	James and Panicker (1994)	Decomposed/washed ashore
9	06.06.1982	Pudhupattinam (Thampattar)	906	Male	Nammalwar and Thanapathi (1982)	Stranded/washed ashore
10	15.12.1983	Peddagarjapalli palem (Prakasam Dt., AP)	1180	-	Chandrasekara rao (1983)	Dead/washed ashore
11	07.05.1984	Chetlat Island (Lakshadweep)	500	Male	James and Panicker (1990)	Stranded
12	03.11.1986	Hare Island (Gulf of Mannar)	930	Female	Sivadas et.al. (1987)	Stranded
13	03.12.1986	Pommiyarpalayam (Pondicherry)	555	Female	Nammalwar et.al (1989)	Stranded
14	19.11.1986	Chetlat Island (Lakshadweep)	1030	Male	James and Panicker (1990)	Hit by the propeller of a sailing vessel
15	25.01.1986	Manapad - Near Thiruchendur, TN	1010	-	Venkataramanujam et.al., 1987	Stranded
16	18.12.1988	Samanthanpettai (Nagapattinam)	371	Female	Nammalwar et.al., (1992)	Stranded
17	26.03.1988	Kasimedu (Chennai)	380	Female	Nammalwar et.al., (1989)	Stranded / washed ashore
18	01.02.1989	Neelankaraikuppam (Chennai)	1060	Female	Nammalwar et.al., (1989)	Stranded/washed ashore
19	18.01.1991	Vizhunthamavadi (Nagapattinam)	970	Female	Nammalwar et.al., (1992)	Stranded
20	10.11.2000	Irumeni (Near Mandapam - Palk Bay)	400	-	Kasinathan and Gandhi (2002)	Stranded/washed ashore
21	21.01.2002	Marina Beach - Chennai	440	Female	Nammalwar et.al., (2002)	Entangled in trawl net

STRATEGIES FOR CONSERVATION AND MANAGEMENT OF SPERM WHALES

- Action plans needs to be taken to create public awareness and interest in sperm whales and a detailed study of the distributions, habits and behavior needs to be carried out.
- Scientific data such as length, weight, food contents of the stomach and other biological data should be updated.
- Effective steps are required towards declaration of National Protected Areas (NPA) for conservation and management of sperm whales in Gulf of Mannar, Palk Bay, Lakshadweep and Andaman & Nicobar Islands and other regions along the Indian coast.

FISHERMEN KNOWLEDGE AND PERCEPTION ON MARINE MAMMALS IN KERALA AND MAHARASTRA

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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, P.BOX 1603, KOCHI -18.

Introduction

- Marine mammals aggregate in areas of fish abundance for food
- They are incidentally caught in fishing gears, thus making them vulnerable. A large number of cetaceans are being caught continuously (Yousuf *et al.*, 2008), which is causing concern.
- Wildlife (Protection) Act is the existing instrument to prevent incidental killing of marine mammals, but the extent of awareness of this act and the perception of fishermen on marine mammals is not fully understood.
- It is imperative to document fishermen perception and technical knowledge on marine mammals
- A interview survey was carried out in fishing villages of Kerala and Maharastra to collect fishermen perception and knowledge on marine mammals.

Methodology

- In August and September, 2009, fishermen interview surveys were conducted in few fishing villages in Maharashtra and Kerala states on west coast.
- A questionnaire was developed to obtain information on fishermen knowledge and perception on marine mammals. A total of 370 fishermen of different age groups, comprising 200 fishermen from nine districts of Maharashtra and 170 fishermen from three districts of Kerala were interviewed.

Important Highlights

- Most of the fishermen in both the states have the ability to distinguish dolphin species but not whale species. However, their ability to differentiate the species varied depending on their age and experience.
- Fishermen within 35years of age and 10 years of fishing experience have less ability to distinguish. Similarly, fishermen who are involved in oceanic and deep sea fishing are aware of more cetacean species than fishermen involved only in coastal fishing.
- About 94% of the respondents did not agree that there is a relationship between weather and marine mammal distribution. About 74.6 % of fishermen stated that marine mammals are sighted in all the seasons while 18.8% of fishermen opined that cetacean sightings are more in post-monsoon season.
- In Maharashtra, 88.8% denied relationship between fish and marine mammal distribution. In Kerala, 98% of fishermen told that marine mammal occurrence is related to the abundance of pelagic fishes such as sardines, mackerel, tuna and seer fish.
- A vast majority of fishermen (>98%) in Kerala told that marine mammal populations have increased in recent years. In Maharashtra 52% of fishermen agreed on this.
- In Kerala, fishermen complained that dolphins forage on fish caught in their nets. About 90% of fishermen who use monofilament gillnet for sardine fishing complained of heavy economic loss due to net damage by dolphin forage behaviour.
- About 2% of fishermen informed that they are using additional net, which is specially designed to surround the purse seine as a measure to protect fish caught in the net and to avoid net damage. As this operation needs another boat and net, this method is practiced by only a few fishermen.
- About 83.3% of fishermen in the two states agreed that the there are incidental catches of dolphins in the fishing nets. However, they denied intentional killing or targeting marine mammals.
- A vast majority of respondents attributed cetacean entanglement to multifilament gillnet fishing, but not in monofilament gillnets. Fishermen in Maharashtra said that incidental catch is a rare occurrence in dol net (10%) and trawl net (1%) and purseseine (1%) (Fig. 1).

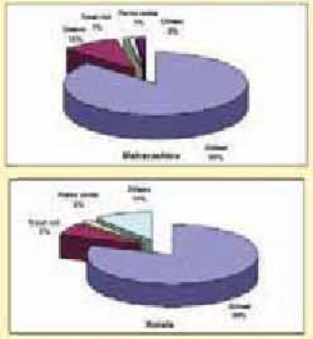

Fig. 1. Contribution of different gears to incidental catches of marine mammals in two states (as stated by fishermen)

- Consumption and illegal sale of incidental catch was admitted by the fishermen in Kerala, whereas in Maharashtra, 98.5% of fishermen denied dolphin consumption or use for other purposes.
- Most of fishermen of all age groups in both the states were aware of Wildlife (Protection) Act. Many elders (>65%) were not aware of the act because of their poor literacy.
- In Maharashtra, about 99% of the fishermen responded in favor of the Wildlife Act because of their sentimental approach to marine mammals. Most of the fishermen in this state told that they worship of marine mammals, particularly whales, because of their belief that whales bring fishes from deep sea to their fishing range.
- The response was different in Kerala. Majority of fishermen (77.5%) urged removal of Wildlife Act and wanted legal consent to kill dolphins whenever fishing is disturbed by dolphins.

Reference

Yousuf, K.S.S.M., A.K. Anoop, B. Anoop, V.V. Afsal, E. Vivekanandan, R.P. Kumarran, M. Rajagopalan, P.K. Krishnakumar and P. Jayasankar.2008. Observations on incidental catch of cetaceans in three landing centres along the Indian coast. *Biodiversity Records JMBA UK Online publication*

CIMCAR - 2011

OCCURRENCE OF KILLER WHALE *ORCINUS ORCA* IN ANDAMAN WATERS

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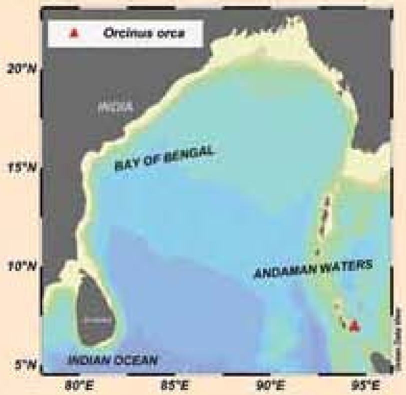
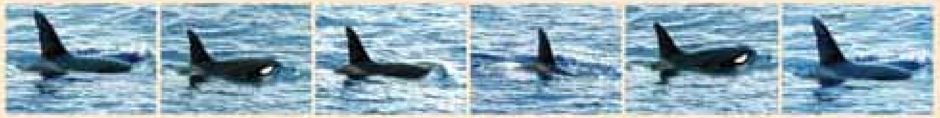
INTRODUCTION

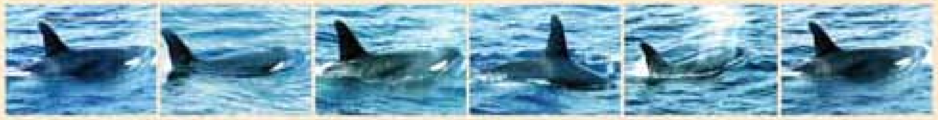
- The Killer Whale *Orcinus orca* is the only recognized species in the genus *Orcinus*, one of many animal species originally described by Linnaeus in 1758 in *systema Naturae*. Konrad Gessner wrote the first scientific description of a killer whale in his "Fish book" of 1558, based on examination of a dead stranded animal in the Bay of Greifswald that had attracted a great deal of local interest.
- Records of killer whale *Orcinus orca* in the Indian Ocean and adjacent seas are very rare. They have been reported as bycatches from longlines targeting tuna in the Indian Ocean (Sivasubramanian 1965).
- In 2003, CMFRI with funding from MoES commenced the first systematic project to generate knowledge on Marine mammals in the Indian EEZ and the contiguous seas.
- The study area included the coastal, continental shelf and oceanic waters and the Sri Lankan waters. The surveyed area extended between 5° - 23° N Latitude and 69° - 95° E Longitude with depth range of 20 to 5000 meter.
- So far no killer whale has been sighted during the 2003-2010 survey period.
- The killer whales (four numbers) were sighted for the first time during this survey from southern Nicobar Island (Lat: 6°59- Long: 93°58) on 23.9.2010 reported here.
- In India, a single sighting was recorded north- east of the Andaman Islands in the Bay of Bengal in 1983 (Leatherwood *et al.* 1984); two unconfirmed sightings have been reported in 1976 (off Madras) and in 2000 (Lakshadweep Islands); and a single stranding was reported from Armadas in Baroda State in 1943 (Sathasivam 2004).
- In opportunistic oceanographic surveys off Sri Lanka and India in the past three decades, there was no record of killer whale (Illangakoon, 2002; Afsal *et al.*, 2008).
- During the year 2009 a dedicated cetacean survey was conducted by Ilangakoon (2009) to study the abundance in Sri Lankan waters and three killer whales were recorded.



MALE KILLER WHALE



FEMALE KILLER WHALE



Methodology

- Ship based visual survey is a conventional and widely practiced method for the study on marine mammals.
- The sighting surveys were onboard FORV *Sagar Sampada* (overall length: 71.4m).
- Cruises were not dedicated to marine mammal sightings and the cruise tracks were determined by the needs of other projects.
- A single observer positioned on the flying bridge and equipped with a Nikon handheld binocular and a Nikon D80 camera fitted with Nikon 70-300mm lens, collected data during daylight hours.
- The species identifications was validated later with the photographs taken onboard. 'Marine Mammals of the World' (Jefferson et al. 1993) and 'Sea Guide to Whales of the World' (Watson, 1981) aided identification.

Result

In November 2010, along with other projects, cetacean sighting survey was carried out in Andaman waters onboard FORV *Sagar Sampada* (Cruise No. 280) and the salient observations were recorded.

- During this cruise the killer whale *Orcinus orca* was sighted nearshore on 23.9.2010 of southern Nicobar island (Lat: 6°59 Long: 93°58). Four numbers were sighted, but only two animals were sighted close to the vessel, enabling identification of clear features.
- The identification features are the rounded tip to the dorsal fin and a closed saddle patch which does not extend further forward than the midpoint of the dorsal fin.
- The eye patch was medium-sized oval oriented parallel to the body axis.
- The individuals were identified as Type 'A' killer whale
- Type A killer whales are the largest of all three types and have pointed dorsal fin tip than residents, always possessing a closed saddle patch.
- The saddle patch typically extends quite far forward sometimes nearly to the anterior insertion of the dorsal fin. There is no obvious dorsal cape and the eye patch is a medium sized oval oriented parallel to the body axis.
- Presence of male and a female was observed.
- Sex identification was done on the basis of dorsal fin characteristics (Jefferson et al. 2008).
- The dorsal fin of female whale is falcate, and are generally pointed or slightly rounded at the tip.
- Adult male tend to have dorsal fin that are triangular or that may even forward to varying degrees.

Conclusion

- There has been no earlier records of the presence of the killer whale in Andaman waters for the past three decades. It is not clear whether the presence of killer whale in Anadaman waters is a new occurrence or was not recorded earlier.

References

Afsal,V.V., K.S.S.M. Yousuf, B. Anoop, A. K. Anoop, P. Kannan, M. Rajagopalan and E. Vivekanandan. 2008. A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003-07. *Journal of Cetacean Research Management*, 10(3): 209-215.

Illangakoon, A. D. 2002. Whales and dolphins of Sri Lanka. WHT Publications, Colombo.

Illangakoon, A. D., R. Jayewardene and L. D. Perera. 2008. First confirmed sightings of the killer whale (*Orcinus orca*) in Sri Lanka's waters. *Marine Biodiversity Records*, 3: 1-4.

Jefferson, T. A., M. Webber and R. L. Pitman. 2008. *Marine Mammals of the World: a Comprehensive Guide to their Identification*. Academic Press, London. 158-159.

Leatherwood, S., A. E. Bowles, E. Krygier, J. D. Hall and S. Ignell. 1984. Killer whales (*Orcinus orca*) in Southeast Alaska, Prince William Sound and Shelikof Strait: a review of available information. *Report of the International Whaling Commission*, 34: 521-530.

Sathasivam, K. 2004. Marine Mammals of India. University Press, Hyderabad.

Sivasubramanian, K. 1965. Predation of tuna longline catches in the Indian Ocean, by killer whales and sharks. *Bulletin of the Fisheries Research Station, Ceylon*, 17: 221-236.

Watson, L. 1981. Whales of the world. Hutchinson, London. 302 pp.

CETACEAN DISTRIBUTION IN RELATION TO ENVIRONMENTAL PARAMETERS IN THE INDIAN EEZ

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Introduction

- Cetacean distribution is largely influenced by different oceanographic and physiographic variables (Macleod *et al*., 2007) and prey availability (Lindstrom *et al*., 2002).
- These variables vary between regions and hence there is a need to study their role in habitat preference by cetaceans.
- Understanding habitat characteristics of cetaceans is crucial to understand the ecology and community structure of cetacean species and serves as key component for cetacean conservation.
- Historical stranding, bycatch and sighting records document occurrence of 26 species of marine mammals in the Indian seas (Kumaran, 2002), but our understanding of ecology of these cetaceans in Indian waters remains poor.
- The present study is the first effort to correlate the distribution of five cetacean species with oceanographic parameters in the Indian EEZ and contiguous seas.

Methodology

- Shipboard opportunistic visual surveys (passing mode) were conducted from 35 cruises of FORV *Sagar Sampada* (over all length: 71.5m), for three years and four months from October 2003 to February 2007.
- Cetacean sightings surveys were carried out by single trained observer in every cruise by scanning with naked eye and interspersed with a Nikon 10 x 50 mm CFWP handheld binocular with visual range of 4km. Sighting platforms were situated 16m above surface of sea level.
- A Nikon F80 camera fitted with Nikor 70-300mm lens was employed to capture appearances of cetaceans in the form of spouts, dorsal fin, flipper, upper body and fluke.
- Data on the distribution of cetaceans were collected along with related environmental variables.
- Simrad GN33 GPS navigator was used to record geographical position of animal sighted area.
- Cetaceans were identified to the lowest taxonomic level possible based on descriptions in FAO field guide (Jefferson *et al*., 1993).
- Four variables, namely two physiographic variables (depth and distance from the shore) and two oceanographic variables (sea surface temperature and surface salinity) were considered.
- EMCON SBE 9plus underwater shipboard sensors unit provided SST and salinity data.
- For recording the maximum depth at which the animal was sighted, Simrad EK 60 Echo-sounder of frequency 38kHz was employed.
- Distance between the sighting and nearest shore was calculated using Garmin Map source software version 6.15.6.
- Inter-quartile deviation was performed for five species *Physeter macrocephalus, Stenella longirostris, Tursiops aduncus, Delphinus capensis* and *Sousa chinensis* for which adequate sightings along with data of oceanographic parameters were available

Important Highlights

- The cetaceans were widely distributed from 0.05 km to 964 km from the nearest shore. In eastern Arabian Sea, distribution of cetaceans from the nearest shore ranged from 0.5 to 783.5km range, whereas it ranged from 2km to 964km in Bay of Bengal.
- Most of the sightings of *Balaenoptera* sp were in oceanic water on continental slope of > 500m depth, but considerable sightings were found in nearshore deeper water.
- *Physeter macrocephalus* occurred commonly in deep oceanic continental slope water at depth varied from 340m to 3693m. Their occurrence ranged up to 579 km from the shore but predominant occurrence was <200km.
- *Pseudorca crassidens, Globicephala macrorhynchus* and *Grampus griseus* were found on slopes. The occurrence of *Pseudoraca crassidens* was <300km, closer than that of *Globicephala macrorhynchus* and *Grampus griseus*.
- Sighting of *Stenella longirostris* and *Stenella* sp ranged from 27km to 716km with average observation within 150km. Spinner dolphin and *Stenella* sp occurred both on shelf and slope but generally occurred on slope water >300m (Fig. 1).
- *Tursiops aduncus* showed coastal preference mainly in shelf water and also over slope regions <500m depth and most of the sightings occurred between 22km and 276km with mean distance of 87km.
- *Delphinus capensis* was found in coastal waters with few occurrences in deep oceanic waters and most of the sightings were within 100km distance. Occurrence of *D. capensis* ranged from shelf to outer slope with predominant sightings on shelf and shelf break. The depth range of the sightings was 28m-3701m and average depth was 907m.
- *Sousa chinensis* was commonly found in nearshore waters with average distance of 23km (SD=20). The occurrence of *S. chinensis* was confined to shallow waters, generally at depth <20m.
- The surface salinity in survey area varied from 27 ppt to 36ppt with a mean of 33.3 ppt (SD= 1.5). The SST ranged from 24.2°C to 33.0°C with the mean of 28.8°C (SD= 1.2).
- The cetacean occurred in the water with relatively narrow range of SST and SSS, similar to those reported for northern Gulf of Mexico (Fritts *et al*., 1983) and eastern tropical pacific (Au and Perryman, 1985; Perrin and Gilpatrick, 1994).
- All the cetacean species except *S. chinensis* were encountered in water with mean surface temperature of 28°C and mean surface salinity of 33ppt.
- However, oceanic species differ in their preference for SST and surface salinity. *Balaenoptera* sp, sperm whale, spinner dolphin and *Stenella* sp and three larger delphinids occurred in waters with SST <29°C.
- The coastal species such as *T. aduncus* and *D. capensis* were recorded relatively in waters with wide variation in SST and salinity. Humpback dolphins were sighted in area of low surface temperature and surface salinity.

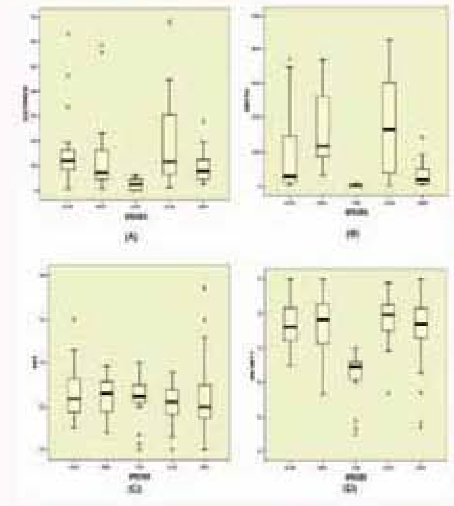

Fig.1. Cetacean distribution with respect to environmental variables observed during the cruise represented by Box and Whisker plot showing median, quartiles and extreme values (The box represents the interquartile range, the whiskers are lines that extend from the box to the highest and lowest values and the line across the box indicates the median); bal- *Balaenoptera* sp, dcap- *Delphinus capensis*, pmac- *Physeter macrocephalus*, schi- *Sousa chinensis*, slon- *Stenella longirostris* sten- *Stenella* sp, tadu- *Tursiops aduncus*

References

Au, D.W.K. and W.L. Perryman. 1985. Dolphin habitats in the eastern tropical Pacific. *Fishery Bulletin*, US. **83**: 623-643.

Fritts, T.H., A.B. Irvine, D. Jennings, L.A. Collum, W. Hoffman and M.A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. Report FWS/OBS-82/65. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC. 455 pp.

Jefferson TA, S. Leatherwood and M.A Webber. 1993. FAO Species identification guide. Marine mammals of the world. UNEP / FAO, Rome, 320 pp.

Kumaran, P.L. 2002. Marine Mammal research in India-a review and critique of the methods. *Current Science*. **83**: 1210-1220.

Lindstrom U., T. Haug and I. Rottingen. 2002. Predation on herring, Clupea harengus, by minke whales, *Balaenoptera acutorostrata*, in the Barents Sea. *ICES Journal of Marine Science*, **59**: 58-70.

Macleod, C.D., C.R. Weir, C. Pierpoint and E.J. Harland. 2007. The habitat preference of marine mammals west of Scotland (UK). *Journal of the Marine Biological Association U.K*. **87**: 157-164.

Perrin, W.F. and J.W. Gilpatrick, Jr. 1994. Spinner dolphin *Stenella longirostris* (Gray, 1828). In: S. H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol.5: The First Book of Dolphins, pp. 99-128. Academic Press, 416 pp.

CETACEAN DIVERSITY AND ABUNDANCE OFF KARWAR, SOUTHWEST COAST OF INDIA

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Introduction

- The Indian Seas are one major habitat for many marine mammal species and support 25 cetacean species and one sirenian species.
- Offshore and coastal distribution of many cetaceans in Indian waters is well documented (Afsal *et al.*, 2008). Southwest coast of India in Arabian Sea has been identified as potent area for rich cetacean diversity due to high productivity.
- However, information on cetacean diversity, abundance and their distribution in nearshore waters is sparse.
- The present study was aimed to study diversity, distribution and abundance of cetacean species in coastal waters of Karwar in southwest coast of India.
- Several boat based visual surveys were conducted off Karwar to enumerate the marine mammals off Karwar. The objectives of the survey were as follows:

1. Examine the diversity of marine mammal and abundance of each species off Karwar using visual surveys and photo identification method.
2. To understand Investigate interaction of cetaceans with local fishery and their behaviours.

Methodology

- Boat based opportunistic visual surveys were conducted in the coastal waters off Karwar continuously for seven days from 8th to 14th of March 2011.
- Photo identification method was adopted to assess abundance of each species.
- Surveys were conducted in the morning between 6hrs to evening 1hrs. Daily observation effort ranged from 5 hrs to 7hrs with average of 6 hrs. Surveys were abandoned during evening because of inclement sea condition. A trawl boat (OAL: 32m) fitted with 52hp engine was used for surveys.
- Two observers were positioned to scan the survey area and were aided by boat crew of 4 members.
- Data on Sea surface temperature (SST) and surface salinity were collected by handheld thermometer and refractometer, respectively.
- Handheld Garmin GPS was used to position the animal sighted area.
- Nikkon D80, digital SLR camera fitted with 55-70mm Nikkor lens was used for photo sampling, species identification and abundance estimation.

Important Highlights

- Daily observation effort ranged from 5 hrs to 7hrs with average of 6 hrs. The total survey effort for seven days was 42 hrs.
- The area covered every day ranged from 35 km² to 45km² with an average of 40km². Survey was carried out upto 6 km from the shore.
- Depth of survey area ranged from 2m to 12m. SST ranged from 26°C to 29°C and salinity from 30ppt to 32 ppt.

- Two species namely, *Sousa chinensis* (humpbacked dolphin) and *Neophocaena phocaenoides* (finless porpoise) were sighted during the survey.
- A total of 11 sightings consisting of 84 individuals were observed during survey period (Table 1).
- Humpbacked dolphin was dominant in terms of occurrence and abundance and was sighted on nine occasions, whereas finless porpoise was sighted on two occasions.
- Most of the sightings were in the northern part near Kurumgad and Devgad Islands which are 4 km off Karwar.
- Sightings were observed in the southern part also, near Anjadiv and Devgad Island. Humpacked dolphins were sighted throughout the survey area as scattered groups in depth range from 3 to 8m. Based on photo identification method it was found a total of 32 individuals of 9 small groups occurred and each group consisted of 3 to 6 adults and sub adults.
- The dolphins congregate in northern part near Kurumgad Island for feeding whenever there is fishing activities. Feeding and socializing were the main behaviours of the humpbacked dolphin observed in the present survey.

Sighting of *Sousa chinensis* (SCHI) and *Neophocaena phocaenoides* (NPHO) in Karwar water

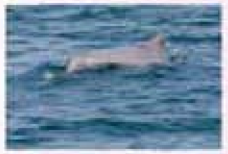
Table 1 Sighting of cetacean species off Karwar in March 2011

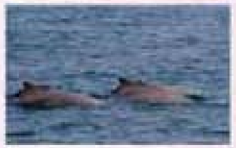
Species	GPS Position	Area of sighted	Depth (m)	SST (°C)	Salinity (ppt)	No. of animals
Sousa chinensis	[illegible]	Near Kurumgad Island	9	29	33	20
Neophocaena phocaenoides	[illegible]	Off Devbag beach	5	27	30	5
Sousa chinensis	[illegible]	Off Devbag beach	7	29	33	4
Sousa chinensis	[illegible]	Near Kurumgad Island	7	29	33	20
Neophocaena phocaenoides	[illegible]	Off Lighthouse Island	12	29	32	1
Sousa chinensis	[illegible]	Anjadiv Island	8	29	33	2
Sousa chinensis	[illegible]	Anjadiv Island	8	28	33	6
Sousa chinensis	[illegible]	[illegible] Beach	3	29	30	4
Sousa chinensis	[illegible]	Between Anjadiv and Lighthouse Islands	6	27	30	4
Sousa chinensis	[illegible]	[illegible] Beach	8	29	30	6
Sousa chinensis	[illegible]	[illegible]	3	29	30	3

- A group of finless porpoise consisting of 5 individuals was sighted near Devbagh Island at 3m water depth on one occasion. Single animal was sighted off Devgad (Lighthouse) Island at 10m depth.

- During the survey, interaction between humpbacked dolphin and local trawl and purse seine fisheries was observed regularly.
- During purse seine operation dolphins consisting of 30 animals congregate in fishing area, surround purse seine net and cause disturbance to their fishing by taking away fishes like sardine and mackerel from the net.
- In order to prevent this, some fishermen use crackers to drive away the dolphins from their fishing area.
- Some other fishermen are cautious to avoid physical injury to the dolphin groups by patrolling the fishing area on small boat which is used for deploying net.
- Trawl fishing is also more susceptible to the disturbance but no preventive method is undertaken by fishermen.

Sousa chinensis sighted in the coastal waters of Karwar





Humpbacked dolphin interacting with purse seine fishery

Fishermen use crackers

Reference

1. Afsal, V.V., K.S.S.M. Yousuf, B. Anoop, A.K. Anoop, P. Kannan, M. Rajagopalan AND E. Vivekanandan. **2008. A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003-07.** *J. Cetacean Res. Manage.* **10**(3):209-213.

The Marine Biological Association of India was established in the year1958 to serve the cause of promotion of research on marine sciences in the Asia-Pacific region. Enshrined in the articles of the association is the primary cause to create among its members an active interest in the field of marine biology and allied marine sciences. The association carries out this objective by:

- Organising lectures, symposia and seminars on specific subjects
- Offering requisite information to research workers and students Undertaking research in marine biological sciences
- Publishing the Journal of the Marine Biological Association of India (JMBAI)
- Publishing occasional Memoirs, Monographs andBibliographies on topics of current interest in marine biology
- Instituting fellowships and studentships to research workers at various recognized institutions
- Sponsoring and aiding expeditions in Indian Seas
- Institution of prizes in recognition of outstanding contributions towards advancement of marine biological sciences

From all over the world Institutional Members constitute nearly 1000. During the past 53 years, the Association has conducted a number of international symposia focusing attention on specific areas of topical interest in marine biology. These were on Scombroid fishes (1962); Crustacea (1965); Mollusca (1968); Corals and Corel Reefs (1969); Indian Ocean and Adjacent Seas (1971); Coastal Aquaculture (1980); Endangered Marin Animals and Marine Parks (1985); Tropical Marine Living Resources (1988); Eco-friendly Mariculture Technologies (2000) and Marine Ecosystems- Challenges and Opportunities (2009).

The papers presented in the symposia have been published as proceedings which have been well received in different parts of the world. The monographs, memoirs and bibliographies published by the MBAI are widely used by the scientific community.

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The Association is administered by President, two Vice-Presidents, a Secretary, an Associate Secretary, a Treasurer, an Editor with two Associate Editors and six Executive Members. The Association functions within the premises of the Central Marine Fisheries Research Institute (CMFRI) at Cochin, Kerala State, India.

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