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REDUCING THE PROBABILITY OF SHIP-STRIKE RISK TO BLUE WHALES IN SRI LANKAN WATERS

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This book is dedicated to the blue whales of Sri Lanka
and those who work for their protection

ISBN 978-955-3446-00-8

Reference for citation:
de Vos, A. (2018) Reducing the probability of ship-strike risk to blue whales in Sri Lankan waters, Oceanswell, Colombo.

Cover photograph by Asha de Vos

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EXECUTIVE SUMMARY

Coastlines all around the world are crowded with ships traveling through shipping lanes to ports, causing a negative impact on great whale populations [1, 2]. In some channels ship collisions are responsible for one-third to half of the documented whale fatalities [1].

Ship (or "vessel") collisions (or "strikes") with whales is the biggest threat to endangered blue whales (*Balaenoptera musculus*) in Sri Lankan waters as a result of the overlap between the primary Indian Ocean shipping route (located off southern Sri Lanka) and important blue whale foraging areas. The fourfold increase in global ship traffic within this region since the 1990s and predicted continued increase in traffic is therefore a cause for concern. Using data from Automatic Identification Systems (AIS) it has been shown that 90% of ship traffic using Sri Lankan waters is in transit while only 10% use local ports.

Based on this finding, two recommendations for reducing the likelihood of fatal collisions with whales are suggested:

1. Shift the existing vessel Traffic Separation Scheme (TSS)
2. Encourage ship speed restrictions in specific high-risk areas

The most effective means of reducing strikes is re-routing, i.e. removing ships from areas important to the whales. Alternatively, if this is not possible in some locations restricting speed is a good alternative.

Most significantly, these recommendations provide an opportunity for Sri Lanka to prioritise and protect natural resources vital to the growing tourism industry, increase safety for the whale watching community and fishermen who depend on these waters, enhance marine ecosystem health, reduce noise pollution and emissions, provide safer waters for the growing global shipping industry and emerge as a world leader in addressing these issues. Under these recommendations, minimal changes in ship operations are needed; thus, economic impacts to vessel operators would be negligible. Further, it allows Sri Lanka to adhere to the commitments it has made on behalf of the oceans including the proposed adoption of MARPOL 73/78 Annex VI by H.E. President Maithripala Sirisena, The Paris Agreement and the implementation of Sustainable Development Goal 14 as stated by H.E. Prime Minister Ranil Wickremesinghe at the UN Conference on Oceans.

BACKGROUND

As global trade and tourism has increased, so has ship traffic. Ninety percent of the world's trade is conducted by commercial shipping resulting in a fourfold increase in ship traffic over the past two decades [3]. After the mid 19th century, whale collision fatalities increased due to ship travel speeds, type or size of the ship, vessel traffic density and the proximity to important whale habitats [4, 5, 6]. Vessel types involved in ship-strike fatalities vary: recreational and transportation vessels (e.g. ferries), whale-watching boats, commercial and military vessels [7]. For many cetaceans, the habitat being occupied by ship traffic is important for their survival (such as an important area for feeding, mating or rearing calves), which make a ship collision more likely [4]. Smaller vessels such as fishing boats, ferries, recreational vessels and whale-watching boats have a greater chance of hitting cetaceans due to their smaller size and high-speed engine capability [4]. Smaller boats at high speed have less visibility and opportunity to react before a collision [4] and are able to venture in to shallower waters increasing likelihood of collision [8].

Endangered blue whales (*Balaenoptera musculus*) in the Northern Indian Ocean are a poorly studied subspecies of pygmy blue whale [9, 10]. They breed six months out of phase with pygmy blue whales in the Southern Indian Ocean [11], are morphologically distinct, and have a unique call [12]. Unlike other blue whale populations, the NIO population does not migrate annually to cooler waters, but remains and feeds, breeds and calves in warm tropical waters year-round [13, 14].

Their confinement within the Northern Indian Ocean makes them particularly vulnerable to human activities. For example, the primary shipping route across the Indian Ocean overlaps with important foraging and calf-rearing areas, where commercial shipping traffic is dense [15]. This is double the shipping traffic off California's Santa Barbara Channel, which has been the focus of extensive action to reduce the likelihood of ship-strikes for the California blue whale population [16, 17]. Off Sri Lanka, overlap between the presence of blue whales and established shipping lanes (Figure 1) has led to comparatively high levels of documented ship-strike mortality. For example, in early 2012, two blue whales were killed within a 12-day period [18], with one discovered across the bow of a container ship in Colombo Port on March 20, 2012 (Figure 2) and the second observed floating dead at sea on April 2, 2012 (Figure 3) with evidence of traumatic injury likely caused by vessel strike [18, 19, 20]. To reduce energy expended when traveling, blue whales spend the majority of their time near the surface or at depths that make them vulnerable to strikes by large ships [21]. Williams et al. [22] estimated in some locations actual vessel strike mortality in baleen whales may be 10 times higher than observed, as it is expected that most struck individuals go undetected and/or sink offshore without being documented [23, 24]. For much of the year, surface currents [25] and offshore winds are also likely to carry floating carcasses offshore of southern Sri Lanka.

Tournadre [26] noted a dramatic fourfold increase in global ship traffic between the early 1990s and present, with largest growth in the Indian Ocean and Western Pacific Seas. Increases in shipping within this region reflect the redistribution of international trade and highlight the growing threat to blue whales within this region, particularly off Sri Lanka. We suggest that ship-strike is the most important cause of Sri Lankan blue whale mortality, potentially inhibiting population recovery from earlier direct exploitation [27].

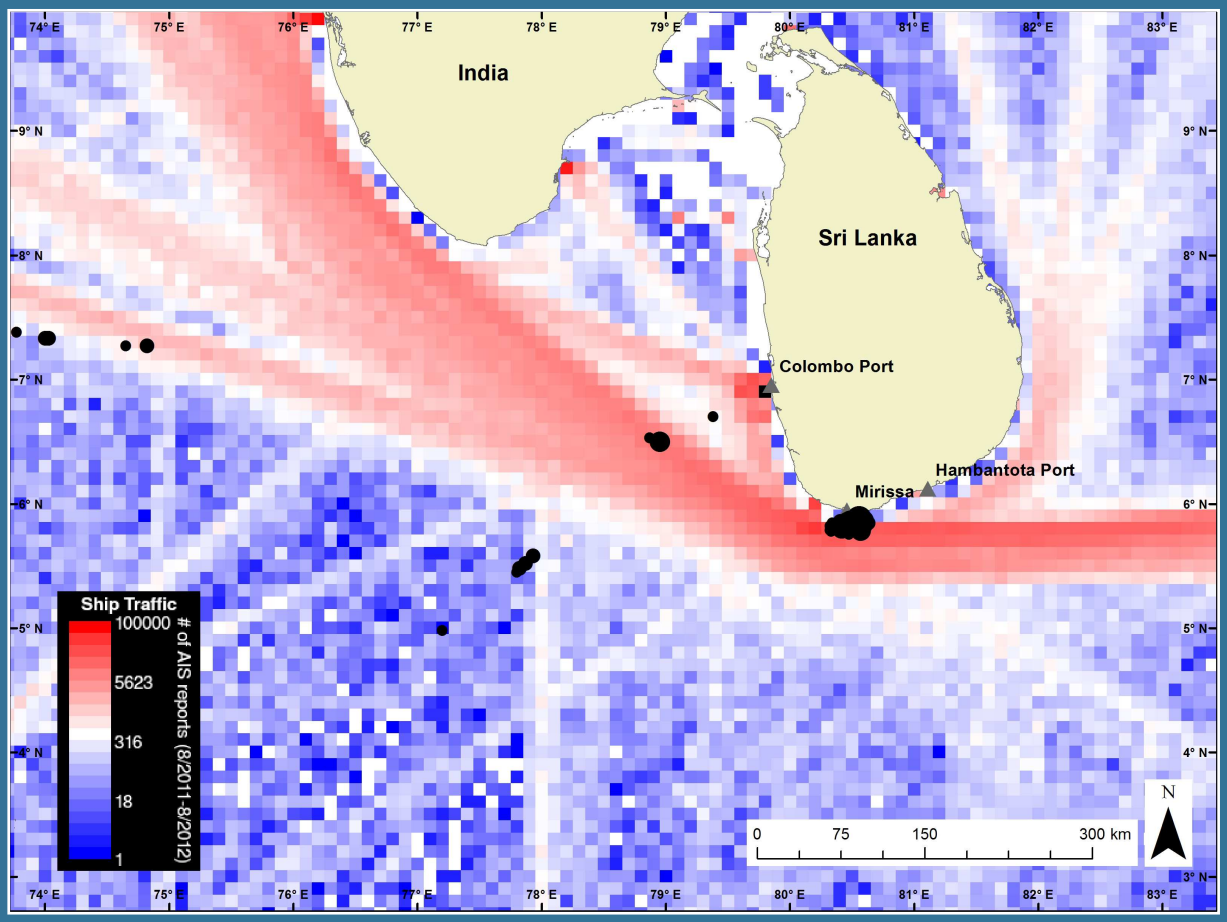

Figure 1: Map showing ship traffic frequency (red-blue), blue whale sightings (black dots) and areas of relevance around Sri Lanka. Data sources include Potemra [28], Ballance and Pitman [29], de Vos, Pattiaratchi [30], and de Vos, unpublished data.

Figure 2: Blue whale on the bow of container ship Quartz at Colombo Harbour on 20 March 2012 (Photo credit: Sopaka Karunasundara).

Figure 3: Blue whale carcass found floating at sea south of Mirissa on 2 April 2012. Large gash that almost severed tail stalk indicates that whale death was caused by ship-strike (Photo credit: Tony Wu).

REDUCING THE PROBABILITY OF SHIP-STRIKE RISK TO BLUE WHALES

Shifting the existing Traffic Separation Scheme (TSS)

The International Whaling Commission (IWC) has identified the mitigation of ship-strike risk for blue whales off southern Sri Lanka as one of high priority following a report submitted by de Vos et al [18]. Redfern et al. [31] identified areas of potential blue whale habitat in the Northern Indian Ocean using habitat models developed for the eastern Pacific, where blue whale ecology is expected to be similar. Priyadarshana et al. [32] assessed blue whale ship-strike risk using two years of survey data collected from the southern coast of Sri Lanka extending from shore out to 50 km in a 150 km band. Their results suggest that moving shipping lanes 28 km (15 nm) offshore would reduce the risk of ships striking blue whales by 95% while adding approximately 10 km (5 nm) to total transit distance between Asia and Europe [32]. In 2016, the IWC Scientific Committee agreed that the combined results of Redfern et al. [31] and Priyadarshana et al. [32] would support a proposal to the International Maritime Organisation (IMO) to move the shipping lanes should Sri Lanka so wish [33]. Moreover, this shift in the route would afford greater safety to whale-watching vessels that use these waters as part of the tourism industry. Further, as Sri Lanka's fishing fleet is largely restricted to near-shore waters, they too currently overlap with the existing shipping lanes. A shift in the shipping lanes would reduce the number of small fishing vessels within the shipping lanes by around 70% [32] increasing safety to the island's fishing fleet. Similar routing measures have been successfully implemented in Spain, USA, Canada and Panama [34] explicitly for large whale conservation (Table 1).

Table 1: Table of proposals submitted by Member States and the dates considered and approved/-adopted by the Sub-Committee on Safety of Navigation (NAV), the Marine Safety Committee (MSC), or Marine Environment Protection Committee (MEPC) and the date proposed actions were implemented by the Member State (from Silber, Vanderlaan [35]).

Proposals submitted/adopted by IMO	Member State	NAV	MSC	MEPC	Implemented
Report to MSC-IMO: vessels striking right whales	USA	–	–	June 1997	Information 1997
Mandatory Ship Reporting (MSR): east coast	USA	July 1998	December 1998	–	July 1999
Traffic Separation Scheme (TSS): Bay of Fundy	CANADA	April 2002	December 2002	–	July 2003
Traffic Separation Scheme (TSS): Cabo de Gata	SPAIN	June 2005	May 2006	–	December 2006
Traffic Separation Scheme (TSS) and Recommendatory Speed: Strait of Gibraltar	SPAIN	March 2006	December 2006	–	July 2007
Traffic Separation Scheme (TSS): Boston	USA	July 2006	December 2006	–	July 2007
Recommendatory Area To Be Avoided: Roseway Basin	CANADA	April 2007	October 2007	–	May 2008
Traffic Separation Scheme (TSS): Boston	USA	March 2008	July 2008	–	June 2009
Recommendatory Area To Be Avoided: Great South Channel	USA	March 2008	December 2008	–	June 2009
Guidance document: Measures to reduce ship strikes with cetaceans	USA			August 2008	Information July 2009

While we have largely focused on collisions with blue whales, other species are also at risk from collision with ships. In November 2012 a Bryde's (*Balaenoptera edeni*) whale was found bow-pinned on a container vessel that entered Colombo Port [36]. Further, de Vos [37] recorded a new and little known Omura's whale (*Balaenoptera omurai*) in Sri Lanka that typically occurs in near-shore waters. The risks to these species are still unclear and as such, it is important to take preventative measures to protect these and other yet to be discovered species in Sri Lankan waters.

Automatic Identification Systems (AIS) are navigational safety systems composed of radio and satellite based receivers, transmitters, and relayers. Linked to global navigation satellite systems (e.g. GPS), AIS transmits detailed information about a ship, including its position and as such can be used to track ships. AIS data from large vessels crossing the Northern Indian Ocean indicate that 20% of ship traffic off southern Sri Lanka currently transits farther offshore than the Dondra Head Traffic Separation Scheme (TSS) [32]. The vessels voluntarily transiting offshore include a range of ship types and sizes including vessels operated by most of the major container shipping companies. The establishment of a TSS with two-way traffic farther offshore would greatly help to prevent collisions between ships traversing bi-directionally within a single shipping lane.

Reducing vessel speeds

A second means to reduce the likelihood of ship-strikes is speed restrictions. Vessels like container ships, that are greater than 65 feet in length and travelling at 14 nm per hour (knots) or faster can kill a whale should a strike occur [38]. Research on the effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales (*Eubalaena glacialis*) along the US east coast showed that there were no vessel strike related deaths reported in or near active Seasonally. Managed Areas since the rule went into effect [39]. Conn and Silber [40] showed a sharp rise in mortality and serious injury with increasing vessel speed (Figure 4). Further they estimated that vessel speed restrictions of 10 knots reduced total ship-strike mortality levels of whales by 80-90%.

In March 2012 a ship-struck blue whale was found bow-pinned on a vessel that entered the port at Colombo [18]. AIS data indicate that this vessel was travelling at speeds between 16-21 knots throughout the duration of its transit between Chennai and Colombo – speeds in excess of those recommended for reducing lethal ship-strike [41].

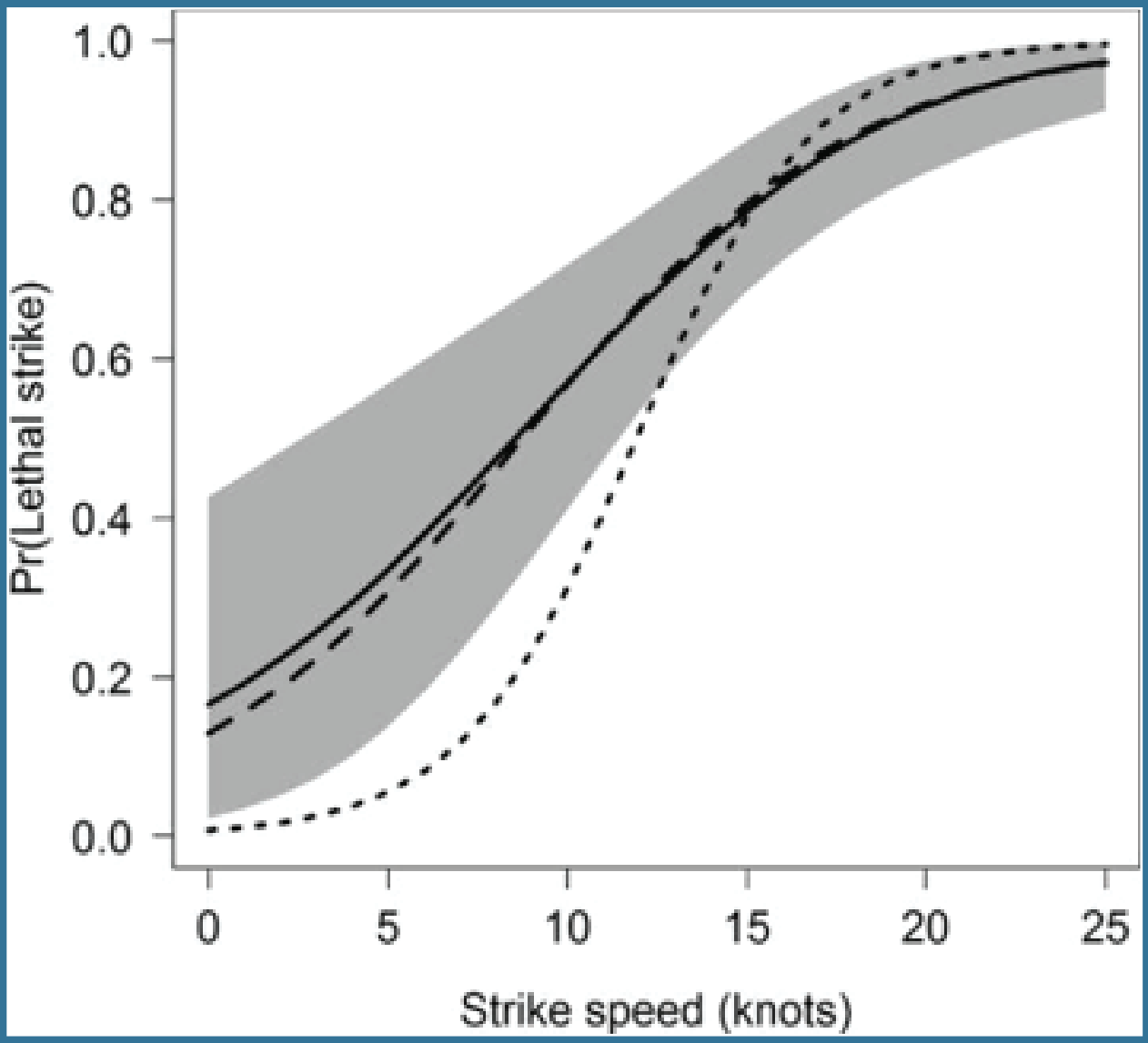

Figure 4: Probability of a lethal whale strike given strike speed. Graph shows a sharp rise in mortality and serious injury with increasing vessel speed. The dashed, solid and dotted lines give predictions from three different regression analyses reported by Vanderlaan and Taggart [58]. The grey area represents a 95% confidence interval (From Conn and Silber [40]).

Large ships are responsible for substantial amounts of worldwide emissions of greenhouse gases including carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur oxides and particulate matter [42], [43, 44]. Given that 70% of all ship emissions occur within 400 km of land, container ships can negatively affect coastal air quality [43] and contribute to global climate change. At a local and regional-scale, ocean-going ships impact human health through the formation and transport of ground-level ozone, sulphur emissions and particulate matter [45]. These emissions may be transported in the atmosphere over hundreds of kilometers, and can therefore contribute to air quality problems on land, even if they are emitted at sea [46]. Corbett et al. [45] demonstrated that particulate matter emissions from ocean-going ships could cause upward of 60,000 premature mortalities annually from cardiopulmonary disease and lung cancer. This mortality estimate does not account for additional health impacts such as respiratory illnesses like bronchitis, asthma, and pneumonia, which contribute to national cost [47, 48]. Studies such as Agrawal et al [49] showed a linear relationship between pollutant levels and distance from concentrations of shipping suggesting that moving shipping traffic further offshore would also reduce pollution along the south coast of Sri Lanka.

Similarly, because of the cubic relationship between fuel consumption and vessel speed, a small reduction in speed results in a significant reduction in air-borne pollution and greenhouse gas emissions. Khan et al. [44] found that ocean-going vessel speed reduction to 12 knots significantly lowered CO_2 and NO_x emissions by 61% and 56% respectively. A recent analysis from the Santa Barbara Channel showed that vessel speed reduction is a cost-effective and comprehensive mechanism for mitigating shipping industry whale strike casualties. The program was aimed at ameliorating two environmental problems - whale strikes and air pollution - while also benefitting the commercial whale-watching industry, local businesses, and human health.

There is strong political will to improve the health of marine ecosystems and human health. In early 2016 H. E. President Maithripala Sirisena in his capacity as the Minister of Mahaweli Development and Environment proposed the adoption of Annex VI that has been added to MARPOL 73/78 highlighting the impact of emissions from ships on Sri Lanka and the necessity to reduce emissions to minimise the impact on human health and the environment.

Sound is extremely important to many marine animals and plays a key role in communication, navigation, orientation, feeding and the detection of predators. Underwater noise from shipping is increasingly recognized as a significant and pervasive pollutant with the potential to impact marine ecosystems on a global scale [50, 51, 52]. Increasing commercial maritime trade coupled with increasing vessel speeds in that trade has increased the amount of noise that shipping traffic is spreading throughout the ocean. Today, the sound of commercial shipping is ubiquitous throughout the oceans.

Anthropogenic noise diminishes the ability of marine species to feed, breed and respond to predators [53,54] Scientific studies have reported negative impacts for at least 55 marine species (cetaceans, teleost fish, marine turtles and invertebrates) to date. There are increasing concerns about the long-term and cumulative effects of noise on marine biodiversity [55, 56]. Noise pollution created primarily by shipping traffic is known to induce a stress response in baleen whales such as the North Atlantic Right whales [57]. Mating and feeding associated calls of blue whales off southern California were disrupted in the presence of ships. Shipping noise was also said to compromise the distance over which the whales could hear and vocalise with one another [50].

RECOMMENDATIONS

Around Sri Lanka, ship-strikes are the biggest threat to Northern Indian Ocean blue whales [27]. To reduce blue whale deaths from vessel collision is to re-locate existing shipping lanes and reduce ship speeds in the vicinity of foraging blue whales. To successfully manage this growing global problem it is increasingly important to enact context and site specific interventions.

Data indicate that approximately 90% of ship traffic within Sri Lankan waters is transiting and not stopping in local ports [32]. A shift in shipping lanes for this traffic will not only reduce risk of collision with blue whales, it will also increase safety to whale-watching boats and fishing boats that use near-shore waters, help address the issue of harmful air-borne emissions and allow Sri Lanka to implement international agreements to which it is a signatory. It is important to note that any shifts in routes are negligible for ships making inter-ocean transits through the Indian Ocean. The remaining 10% of ship traffic that enters Sri Lankan ports for purposes of trade could be requested to reduce speeds in specific high risk areas as small changes in routes into domestic ports is better considered when additional studies of routes have been conducted. Increased vessel speeds have been shown to correlate with an increase in lethal or severe injuries. Laist et al. [6] found that over 90% of the whale ship-strikes (n=53) examined occurred either on the continental shelf or shelf slope with most lethal or severe injuries involving ships travelling 14 knots or faster. Wiley et al. [59] found that the lethality of collisions between ships and whales increased from 20% to 100% when speeds increased from 9 knots to 20 knots. At speeds of 10, 12, and 14 knots, the probability of a whale strike being fatal was 35%-40%, 45%-60%, and 60%-80%, respectively [59]. The results of this study suggest that reducing vessel speeds through areas of high whale density could greatly reduce the risk of lethal whale strikes.

The implementation of these recommendations would be expected to ameliorate two environmental problems - whale strikes and air pollution - while also benefitting the commercial whale watching industry, fisheries, local businesses, and human health. In addition to fuel savings and the benefits provided to whales and onshore communities, these recommendations provide entities with a number of unseen benefits. Participating vessels may receive positive public relations and press [60]. Their participation in such programs indicates environmentally friendly values that may make them more desirable to corporations that have similar environmental views and value supply chain ethics.

The benefits of these recommendations are multi-faceted. They provide an opportunity for Sri Lanka to prioritise and protect its natural resources that are important to the growing tourism industry, increase safety for the whale watching community and fishermen who depend on these waters, reduce noise pollution and emissions, provide safer waters for the growing global shipping industry and emerge as a world leader in addressing this issue. Further, it allows Sri Lanka to adhere to the commitments it has made on behalf of the oceans including the proposed adoption of MARPOL 73/78 Annex VI by H.E. President Maithripala Sirisena, The Paris Agreement and the implementation of Sustainable Development Goal 14 as stated by H.E. Prime Minister Ranil Wickremesinghe at the UN Conference on Oceans.

With your support we propose to develop a proposal to the International Maritime Organisation (IMO) that outlines the need to move the Traffic Separation Scheme 15 nm offshore for vessels transiting Sri Lankan waters and seek a speed restriction of less than 14 knots within designated areas in near-shore waters along the south coast of Sri Lanka.

ACKNOWLEDGEMENTS

This report is the culmination of many years of work. I wish to thank my funders - the Marisla Foundation, the Marine Conservation Action Fund of the New England Aquarium, the Packard Ocean Science and Technology endowment, and the Ocean Park Conservation Fund, Hong Kong. I further acknowledge my many collaborators, Dr. Robert Brownell, Tony Wu, Dr. Jessica Redfern, Dr. TJ Moore, Dr. Paul Fiedler, Dr. Karen Forney, Dr. Elizabeth Becker, Dr. Lisa Ballance (Southwest Fisheries Science Centre, NOAA), Dr. Don Croll and Dr. Bernie Tershy (University of California Santa Cruz). Thanks also due to the many students who supported me in the field. Thanks to Dr. Ashley Sitar for help editing this report to Dr. Russel Leaper for comments on an earlier version, and a debt of gratitude to Dr. Greg Silber who provided insightful comments during the preparation of this report.

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ISBN 978-955-3446-00-8