

Research Article

Report on 14 Large Whales That Died due to Ship Strikes off the Coast of Sri Lanka, 2010–2014

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The greatest threat to cetaceans in Sri Lankan waters was considered to be the direct take of small- and medium-sized cetaceans using harpoons and/or as bycatch until recently. However, ship strikes have probably been occurring for years but have not been recognized for what they were. For the current study, only animals with visible and prominent injuries related to collisions were evaluated. Data gathered between 2010 and 2014 included the species, morphometry, location, and date; tissue samples were collected for genetic analysis. When possible, a complete necropsy was conducted; otherwise, partial necropsies were conducted. The study confirmed 14 reports of ship strikes between whales and vessels out of all the strandings reported from 2010 to 2014. Most strikes ($n = 09$, 64%) involved blue whales (*Balaenoptera musculus*), although three other species were also documented, one Cuvier's beaked whale, two great sperm whales, and one Bryde's whale, as well as one unidentified baleen whale. Collision hotspots such as the southern waters of Sri Lanka are areas that warrant special attention in the form of vessel routing measures or speed limits, research on cetacean ecology, distribution, daily and seasonal movements, public service announcements, increased law enforcement presence, and other measures.

1. Introduction

Collisions between cetaceans and ships, known as “ship strikes,” have been reported from all around the world [1, 2]. Ship strikes are a source of injury and mortality for cetaceans worldwide but, as described below, documenting these events and their outcome is a significant challenge. The frequency of reported ship strikes has tended to increase in recent years because of an increase in maritime traffic, the greater speed of the vessels, and perhaps improved monitoring. Historical records suggest that ship strikes fatal to whales first occurred late in the 1800s as ships began to reach speeds of 13–15 kn, remained infrequent until about 1950, and then increased during the 1950s–1970s as the number and speed of ships increased [1]. The rate at which whale-ship collisions occur, the type of vessels involved, and the extent to which these events affect particular populations of cetaceans are largely

unknown factors. Collisions with whales occur with all types of vessels, namely, cargo, tankers, cruise ships, and fishing vessels, although they are more frequent with bigger and faster vessels [1, 2].

Accurate documentation of whale-vessel collision is difficult for several reasons ranging from cases where operators are unaware that a collision should be reported to situations where the crew are unaware that a collision has even taken place [2]. The latter scenario applies especially to large ships. Sometimes vessels may not report collisions for reputational reasons. In Sri Lanka, ship strike victims that wash ashore sometimes go unreported as they make landfall in remote beaches of the Island.

Determining that a stranded cetacean died from collision is especially difficult in Sri Lanka because of the logistical challenge of performing a complete necropsy. The challenges include the remote location of most carcasses, a lack of

personnel trained in identifying ship strike injuries, fear of government regulations that can criminally sanction those individuals who handle a wild carcass, however, providentially encountered, and the nonexistence of an organization that deals with strandings and ship strikes and maintains a database of such events.

Although the effect of ship strikes on the population of cetaceans is not serious for the majority of cetaceans, it is a significant human-related threat, indeed perhaps the most important in Sri Lankan waters for the larger cetaceans. There is anecdotal evidence that, in waters off the southwest coast of the island, Balaenopterids may be changing their behaviour to counter the harassment that may be encountered from the passage of fast, large cargo vessels (Figure 6) and whale-watching boats (Figure 8) (per. comm. Prabanath). These cetaceans may be changing their swim paths, for example, by travelling further away from the littoral.

In general, collisions occur in coastal areas where whales concentrate for feeding or breeding [1]. On a global scale, the most frequently involved cetaceans in ship strikes include fin whales, right whales, humpback whales, grey whales, minke whales, blue whales, and sperm whales [1, 2]. Studies carried out by Cascadia Research have shown that a worldwide increase in ship strikes has raised concern for some of the large Balaenopterid whales. According to Panigada et al. [3], the minimum mean annual fatal collision rate increased from 1 to 1.7 whales/year from the 1970s to the 1990s in the Mediterranean Sea.

In Sri Lanka, there is evidence of an increased incidence of ship strikes based on strandings in a number of beaches around the island, although not all carcasses are found/examined. The authors and collaborators have been examining cetacean carcasses stranded around Sri Lanka for many years and have observed that many large whales bear signs of major trauma, which infers that ship strikes were the cause of death. Similar observations have been made on small- to medium-sized cetaceans stranded around Sri Lanka.

Informed management of whale stocks relies upon accurate estimates of the rate of serious injuries and mortalities from ship strikes. As such, the International Whaling Commission (IWC) factors in the number of mortalities from ship strikes with estimates of fisheries bycatch when developing recommendations for large whale conservation. The need for a standardized quality control system to validate collision reports has been recognized by the IWC Vessel Strike Data Standardization Group (VSDG) which formed in 2005 to examine the issue of ship strikes with cetaceans. Since 2007, the group has been developing a global ship strike database that aims, among other things, to identify the level of uncertainty associated with individual records based on strandings and eyewitness collision accounts [4].

The IWC database classifies collision reports into six categories, namely, definite ship strike, probable ship strike, possible ship strike, not a ship strike, whale initiated collision, and rejected report; however, these categories do not yet have standardized definitions. Each report is reviewed by the VSDG, and an incident is only classified as a “definite ship strike” if all members are unanimous.

Here, we document recent cases of collisions between whales and ships around Sri Lankan waters and we use this information to help recommend prevention measures for ship strikes around Sri Lankan waters.

2. Materials and Methods

This opportunistic study was based on the reports of dead whales close to shore or on the beach which originated from various sources, including the Sri Lanka Navy, local government bodies, the Department of Wildlife Conservation, local police stations, and the Coast Conservation and Coastal Resource Management Department. When a report of a stranded cetacean was received, the animal was examined in as much detail as logistics allowed. When possible, a complete necropsy was conducted; otherwise, partial necropsies were conducted. The data, gathered between 2010 and 2014, included the species, morphometry, location, and date; tissue samples were collected for genetic analysis. For the current study, only animals with visible and prominent injuries related to collisions were evaluated.

3. Results

We verified 14 reports of ship strikes between whales and vessels out of all the strandings reported from 2010 to 2014 (Table 1). Most strikes ($n = 09$, 64%) involved blue whales (*Balaenoptera musculus*), although three other species were also documented, one Cuvier's beaked whale ($n = 01$, 7%), two great sperm whales ($n = 2$, 14%), and one Bryde's whale ($n = 01$, 7%), as well as one unidentified baleen whale ($n = 01$, 7%) (Table 1). The species of the unidentified baleen whale was uncertain, even with DNA analysis, due to the advanced stage of decomposition.

4. Discussion

On one occasion, a pair of blue whales, thought to be cow and calf, were involved in a ship collision; both animals bore injuries. In 2010, a blue whale was severed in half (Figures 1 and 2); the two body parts made landfall within 3 km of each other and the part aft the dorsal fin had a series of six parallel vertical slashes along its right side (record number in Table 1). Another blue whale with a large gash that almost severed its tailstock was seen floating out at deep sea off Mirissa [5], while another blue whale was draped on the bulbous bow of a container ship that docked at Colombo (Figure 3). Most stranded blue whale carcasses were reported from the southern coast with others coming from the northwestern coastline (Figure 5).

Bryde's whale had part of its fluke missing and was in good condition; based on the fact that the carcass did not smell, it was considered to be fresh. Of the two great sperm whales, one animal washed ashore in Payagala and had a damaged rib cage and damaged vertebrae. A necropsy was conducted on the specimen and it was evident that the animal had collided with a very large object. The other great sperm whale had lesions on the caudal peduncle; this specimen was in a high state of decomposition. The report on Cuvier's beaked whale

TABLE 1: Recorded ship strikes between whales and vessels.

Record number	Date	ID (species)	Location	Carcass condition code*	Sex*	Length	Remark
(1)	22/07/2010	Blue whale	Hikkaduwa	3	F	22 M	Lesion on rostrum and the lower jaw was damaged
(2)	17/09/2010	Blue whale	Mount Lavinia	3	F	19.5 M	Damaged vertebrae
(3)	7/3/2010	Baleen whale	Kahawa	4	U	—	In an advanced state of decomposition
(4)	28/08/2010	Blue whale	Kahawa/Seenigama	3	U	21 M	Severed in half (necropsy performed)
(5)	27/09/2010	Great sperm whale	Pinwatta	5	F	7 M	Lesion on caudal peduncle. The carcass was mummified
(6)	17/10/2010	Blue whale	Chilaw	4	U	20.8 M	Damaged rostrum
(7)	4/7/2011	Bryde's whale	Uswetakeiyawa	2	U	14.8 M	Part of the fluke missing with a clear lesion
(8)	8/1/2011	Great sperm whale	Payagala	2	F	9.14 M	Damaged vertebrae (necropsy performed)
(9)	17/01/2011	Cuvier's beaked whale	Batticaloa	2	F	5.48 M	Damaged vertebrae (necropsy performed)
(10)	24/11/2011	Blue whale	Matara	3	U	19 M	The vertebrae were severely damaged
(11)	20/03/2012	Blue whale	Colombo Harbour	2	U	—	Draped on the bow of a ship
(12)	2/4/2012	Blue whale	Mirissa	2	U	—	Floating out at sea with a cut on the caudal peduncle
(13)	23/09/2012	Blue whale	Wellamadama	2	F	15 M	Signs of blunt trauma aft the dorsal fin
(14)	23/09/2012	Blue whale	Wellamadama	2	M	7.3 M	Signs of blunt trauma before the dorsal fin

*Carcass condition code: 1: alive, 2: fresh dead, 3: moderate decomposition, 4: severe decomposition, 5: mummified/skeletal. *Sex code: M: male, F: female, U: unidentified.



FIGURE 1: Anterior part of the blue whale.



FIGURE 2: Posterior part of the blue whale.



FIGURE 3: The blue whale draped on the bow of a ship. Photo credit: Sopaka Karunasundara.



FIGURE 4: Cuvier's beaked whale.

was from Batticaloa. According to fishermen in the area, the animal had collided with a large vessel when surfacing. The carcass was fresh; it had its entrails protruding (Figure 4). A thorough necropsy was performed on the dead Cuvier's beaked whale. During our study from 2010 to 2014, a couple of live blue whales were observed with propeller mark on their bodies off the southern coast.

The first formally documented ship strike in Sri Lanka was that of a great sperm whale (*Physeter macrocephalus*) that washed ashore in Mannar in 1889 [6]. However, it was not until 2004 when the 275 m container vessel *Cyprine* docked at Colombo Harbour with a Bryde's whale draped across its bow that Sri Lankans became aware of the danger to the country's marine fauna through ship collisions. Up until that time, the greatest threat to cetaceans in Sri Lankan waters was considered to be the direct take of small- and medium-sized cetaceans using harpoons and/or as bycatch. However, ship strikes have probably been occurring for decades but have not been recognized for what they were. Struck whales may sink to the ocean bottom or float offshore or be consumed by predators such as sharks. Anecdotal evidence gathered by the authors from fisher suggests a greater rate of accidental whale deaths than can be assessed by stranding data alone. Further, carcasses washing up in remote beaches may be burned by local residents or left simply unrecorded. Therefore, the magnitude of ship collisions with cetaceans is hard to assess accurately in Sri Lanka.

As Jensen and Silber [2] mention, crew of large cargo vessels are generally unaware of collisions and typically notice the accident only if the whale becomes stuck on the bow.

Furthermore, the lack of a reporting requirement for ship strikes in Sri Lankan waters is unhelpful in terms of obtaining accurate statistics. Shipping lanes off southern Sri Lanka are some of the busiest in the world and are in the middle of high concentrations of large whales and other cetaceans (Figure 7). The occurrence of genetically distinct populations of cetaceans such as blue whales in these waters [7] adds to the urgency of the need to compile data on these vulnerable species.

It is not just the fact that whales are physically at the surface that puts them at risk; they may also be so preoccupied with feeding, socializing, courtship, mating, or some other activity, which makes them oblivious to the presence of vessels. Richardson et al. [8] found that several of the great whale species were markedly less responsive to a ship's approach when they were engaged in feeding. There are also many accounts of ship collisions with resting great whales around the world [9]. Also, with keels of modern large ships submerging well beyond 15 meters, the chances of accidental strikes of cetaceans are high.

In individuals where necropsies were carried out, we found blunt trauma injuries such as broken bones and a focal area of hemorrhaging to be more common than sharp trauma injuries such as propeller wounds. Studies carried out by Silber et al. [10] indicate that whales at the sea surface are more likely to be hit by the bows of ships than whales submerged near the surface which are more likely to suffer propeller strikes. The majority of blunt trauma injuries in our sample were sustained by blue whales. This may be due to

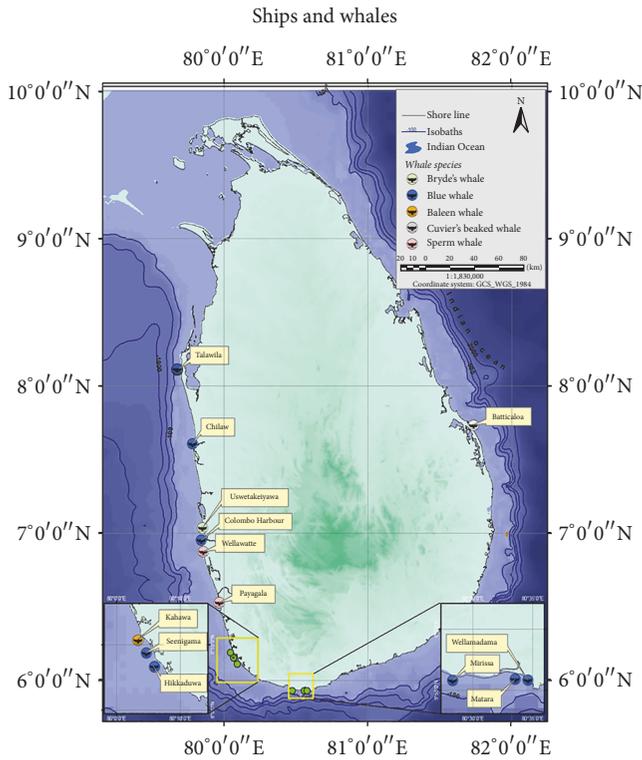


FIGURE 5: Locations of the stranding recorded around Sri Lanka.



FIGURE 6: A Bryde's whale surfaces in close proximity to a cargo ship at Mirissa.

the relative abundance of this species in the sea lanes just off Sri Lanka. Moreover, blue whales in Sri Lanka typically make short, shallow dives [11, 12] and spend a relatively high proportion of their time feeding, socializing, and resting at the surface making them relatively more vulnerable to blunt trauma impacts.

We documented collisions with four of the 30 species of cetaceans known to occur in Sri Lankan waters; 64% of the reports involved blue whales, 14% great sperm whales, 7% Bryde's whales, and 7% Cuvier's beaked whales. It must be recognized that the records compiled here may be biased towards blue whales because of the year-round occurrence of the species in seas close to shore. Also, the fact that most records of strandings come from the western and southern coasts of the island leads to the suspicion that the presence of researchers near the capital Colombo may bias results.

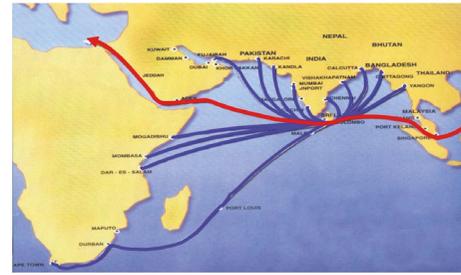


FIGURE 7: Shipping lanes around Sri Lanka (source: Sri Lanka Ports Authority).



FIGURE 8: A blue whale off Mirissa, southern Sri Lanka, surrounded by boats and ships.

Nevertheless, the overwhelming number of live and dead reports involving blue whales indicates that they are the most heavily impacted species, at least in terms of absolute numbers. There is also a seasonal trend in strandings, with the highest number of reports occurring in August and November [13]. It is not clear to find so few collisions with great sperm whales ($n = 2$) given their abundance in Sri Lankan waters. Also, the highest number of strandings of any great whale in Sri Lanka is that of the great sperm whale [13]. This species is most commonly observed in waters off northwest and northeast Sri Lanka, areas that are relatively light in ocean-going vessels, and this may explain the statistic. Collisions with Bryde's whales ($n = 1$) were also rare, a surprise given the large number of sightings of the species in Sri Lankan waters. Are they able to sense the approach of vessels better than blue whales or are there behavioural characteristics that help the species avoid being hit?

Although there have been several records of beaked whale strandings and their occurrence in the fisheries bycatch, it was a surprise to find evidence of a fatal strike involving a Cuvier's beaked whale, a species that, as far as we are aware, lives in waters far offshore and is rarely seen in waters close to land [14, 15].

The 14 whales that we concluded had died from ship strike trauma from 2010 to 2014 represent the minimal number of whale mortalities from ship strikes in Sri Lanka during the time period. Over the same time span, over 24 large whales were reported stranded/dead in Sri Lanka (strandings inspected by the authors and reports of strandings). Only three of the 14 carcasses were necropsied and all were

assessed to be victims of ship strikes. Although 11 of the 14 strandings recorded were not necropsied, they were all assessed as victims of collision based on external or internal injuries. It is alarming that so many whale carcasses wash ashore around the island with no attempt being made to perform necropsies or even being recorded by the relevant authorities. Partly this is because there is a dearth of trained persons to carry out investigations and a lack of facilities. Interest of Government and NGO in the matter also seems minimal. Worse, the fauna protection ordinances of the Department of Wildlife Conservation make it very risky for researchers to undertake investigations without proper official sanction; criminal charges can potentially be invoked to punish investigators. The result is paralysis and wasted opportunity.

The 24 stranded whales investigated here likely represent a fraction of the individuals washed ashore on Sri Lanka's beaches in 2010–2014. The stench of rotting carcasses and the absence of much official interest in stranded whales militate rapid burial in situ by local authorities. Thus, cause of death is impossible to ascertain, the species involved can only be guessed at, and there is no agreement as to the number of strandings. Ilangakoon [13] reported 66 known large whale strandings between 1889 and 2004 but none of these fatalities were considered as ship strikes due to the lack of information. The figure is undoubtedly an underestimate due to the lack of proper documentation.

When a dead whale is reported in Sri Lanka, there are limited resources and personnel to respond and conduct a necropsy. Whether a necropsy is pursued or not depends on a variety of factors, including the condition of the carcass (which can range from fresh to skeletal), location, resources, and accessibility. Priority may be given to species that are rarely encountered or for which little data exists, such as beaked whales, or incidents with possible anthropogenic interaction such as suspected ship strikes and entanglement.

Studies carried out in the Gulf of Mexico suggest that, on average, only 2% (range: 0–6.2%) of cetacean carcasses are recovered [16] and low detection rates (range: <1%–17%) have also been documented in several cetacean species in other areas [17–20]. The magnitude of ship strike mortalities in Sri Lanka, as indicated by the present data, suggests that many ship strikes mortalities are likely going undetected in floating and beachcast whales that are not examined. A good example is the great sperm whale that washed ashore in Kokilai in northeast Sri Lanka. By the time researchers were notified, the carcass had been burnt by the local villagers due to the stench. Only the skeletal remains were left. However, species identity was evident from the skull.

The map created for this paper is the first regional look at the geography of collisions in Sri Lanka (Figure 5) and may be a useful approach for analysis of other collision datasets outside Sri Lanka. High-risk areas need to be closely examined and coupled with predictive modelling to assess areas where conservation actions may be targeted to prevent future vessel collisions. Protective measures applied to relatively small areas with reliably high whale densities may yield a disproportionately large reduction in collision risk and impact fewer vessel operators compared to other

mitigation measures [21]. As whale populations and vessel traffic continue to change, improved data collection and validation of collision reports will enhance our understanding of collision with the ultimate goal of reducing the frequency of vessel-whale collisions in Sri Lankan waters. If proper action such as mandatory vessel speed limits could be implemented successfully, the number of whale strikes would be reduced drastically. To reduce right whale (*Eubalaena glacialis*) deaths caused by ship collisions along the US East Coast, a rule was implemented on 8 December 2008 requiring all vessels ≥ 65 feet (19.8 m) to travel 10 knots (18.5 km h^{-1}) or less in 10 seasonal management areas (SMAs). According to Laist et al. [22] based on the 18-year prerule period, bootstrap resampling analyses revealed that the probability of finding no ship-struck whales in or near SMAs during the first 5-year postrule period would be a statistically significant reduction in such deaths ($p = 0.031$). Suitable measures should be adopted to minimize possible collisions.

5. Conclusion and Recommendations

Collision hotspot such as the southern waters of Sri Lanka, especially around the Dondra Head area, is one of the busiest shipping routes in the world; over 5000 ships navigate past these waters each month. These large ships traverse directly above the feeding ground of the least known population of blue whales in the world [7] and other large and small cetaceans. Thus, these waters warrant special attention in the form of vessel speed limits and even perhaps moving of the shipping lanes (10–15 nautical miles further south). Moving the shipping lane will not have an impact on the financial gain to the country as only a small percentage of these ships dock at harbours around the island.

Furthermore, it will be prudent to educate the local whale watching operators about whale watching ethics/regulations, as most operators are unaware of such regulations. Observations by the authors have seen large cetacean being harassed off the waters of southern Sri Lanka, pushing the animal further out to sea towards the shipping lanes (Figure 8). If the relevant government bodies create a synergy to protect and monitor the waters off southern Sri Lanka and implement strict guidelines towards whale watching operators, it will help in the long-term protection of the large cetaceans that are found in and around Sri Lanka. We recommend that research on cetacean ecology (especially the blue whales found around Sri Lanka), distribution, daily and seasonal movements, public announcements, and increased law enforcement presence, and monitoring will help towards the conservation and protection of marine mammals around Sri Lanka. Furthermore, the data acquired from these surveys will help in formulating comprehensive management plans and proposals to be presented for consideration by the International Maritime Organization (IMO) towards moving the shipping lane.

If Sri Lanka, as nation, does not take a stand now, it will be too late, because in the near future maritime traffic will increase with even larger vessels being deployed, as international commerce expands, to feed the ever-growing demand. Not only do cetaceans die from colliding with ships,

but sound from the ships and ballast water from the vessels affects their natural behaviour and the local ecosystem.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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