SC/67A/HIM/03

Potential application of Automatic Identification System (AIS) data extracted from a public platform to monitor ship-strike of whales

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INTERNATIONAL WHALING COMMISSION

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Introduction

A container ship, the *Quartz*, with a length of 258 m docked in the Colombo Harbour, Sri Lanka (6° 56' N and 79° 50' E) at 6:30 am on 20 March 2012. The *Quartz*, managed by CMA CGM, arrived from Chennai, South India having travelled along the southeast coast of India and east coast of Sri Lanka prior to turning west along the southern coast and north along the west coast of Sri Lanka where it docked. After it docked, a dead blue whale (*Balaenoptera musculus*) with an estimated total length of 60 feet (18 m) was discovered wrapped over the bulbous bow. The photographs obtained from Marine Pilot Sopaka Karunasundara (Figure 1) allowed for positive identification of the species.

Figure 1: Blue whale wrapped on the bow of container ship *Quartz* at Colombo harbour on the 20 March 2012.

An initial report on this incident was submitted for discussion to the International Whaling Commission (IWC) in June 2013 where the issue of blue whale ship-strike in Sri Lankan waters was highlighted as a threat to the population [1]. As a result, the IWC declared this population as one in urgent need of conservation research. Besides information on the general direction of travel

of the *Quartz* between Chennai and Colombo, little information was available on speed, trajectory and time taken to travel the distance.

Automatic Identification Systems (AIS) are tracking systems composed of VHF (Very High Frequency) receivers, transmitters, and links to communications, displays, and shipboard sensors. Using an external global navigation satellite system (e.g. GPS), AIS can derive information about a ship's position and timing. However, access to such data is often cost prohibitive to many researchers, highly protected by governments, and if access is obtained, its use requires processing skills that may not be readily available.

Global Fishing Watch is a public platform that allows anyone in the world to monitor and track 60,000+ of the world's largest commercial fishing vessels in near real-time. The AIS data of each vessel is extracted, processed and fishing activity data is provided to the public through a user-friendly platform. As a result, Global Fishing Watch, while currently developed to track Illegal, Unreported and Unregulated (IUU) fishing activities, has countless potential applications that can be explored. In an experimental use of the Global Fishing Watch dataset, we extracted data on a known cargo vessel, the *Quartz*, that was involved in a ship-whale collision around Sri Lanka. This data was then used to analyze ship travel speeds to understand vessel movement patterns through its journey. While data on non-fishing vessels is included in the Global Fishing Watch dataset, it is currently not available as part of the public platform.

Methods

Using Global Fishing Watch data we were able to extract ship movement speeds of the *Quartz* based on its name and unique ship ID on the dates of interest to track the vessel's transit between the ports at Chennai and Colombo.

Results

The vessel transited between Chennai and Sri Lanka at speeds exceeding 16 knots throughout the duration of its journey (Table 1). Because of the nature of the satellites and location of interest, travel trajectories had to be assumed for some portions of the journey due to the 7-8 hour lag periods while at other points, satellite data was available over shorter time spans providing higher accuracy.

Table 1: AIS data extracted for transit of the *Quartz* between Chennai and Colombo. This information was obtained using Global Fishing Watch.

Date	Timestamp	Latitude	Longitude	Speed	Course
18/3/12	17:15	12.29029	80.60506	16.7	164.8
18/3/12	17:22	12.2578	80.61465	17	163.9
18/3/12	21:50	11.00652	80.981	17.7	165
18/3/12	21:52	10.99889	80.98325	17.5	163.3
18/3/12	21:52	10.99802	80.98351	17.7	163.6
19/3/12	5:06	8.87388	81.58515	19	164.3
19/3/12	9:16	7.603678	81.9701	18.6	164.3
19/3/12	9:18	7.59452	81.97277	18.6	164
19/3/12	9:23	7.569652	81.97995	18.8	164.6
19/3/12	16:53	5.930147	80.98382	20	251.8
19/3/12	16:58	5.922243	80.95661	19.9	259

19/3/12	18:31	5.832723	80.4492	20.7	269.8
20/3/12	4:44	6.950292	79.85287	0	13

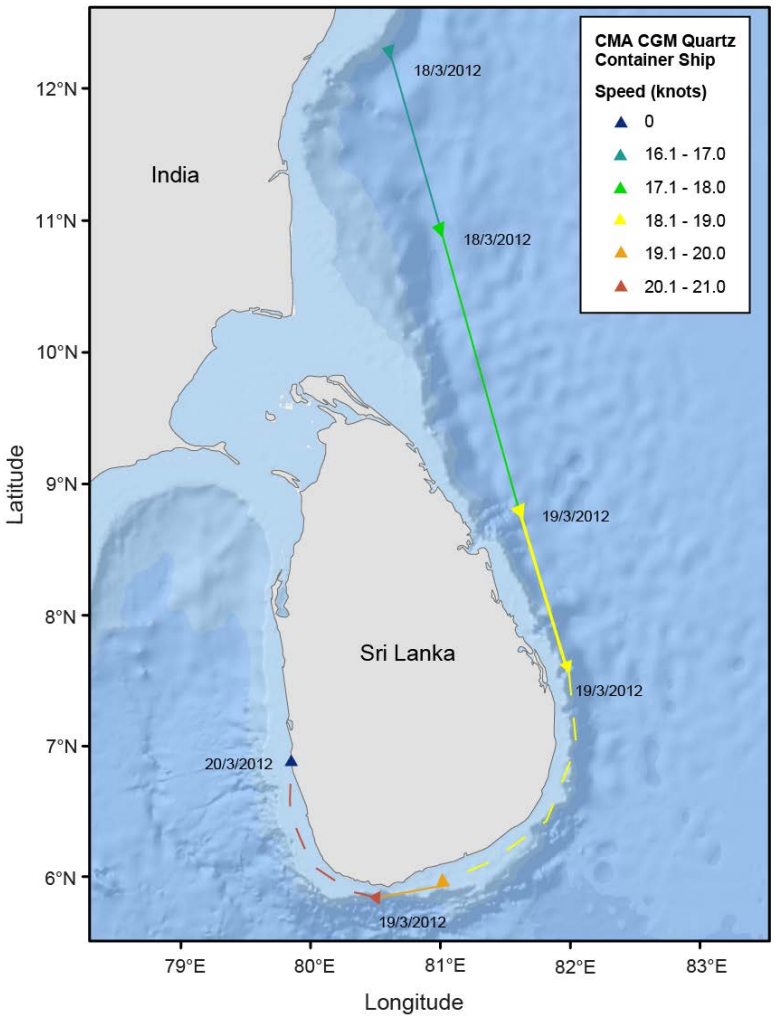

Figure 2: Trajectory of the *Quartz* on its transit between Chennai and Colombo between 18 March and 20 March 2012. Arrowheads represent points for which AIS data is available. Lines depict trajectory of travel between points. Dashed lines represent assumed trajectory of travel due to sparse data between two points. Colours represent varying vessel speeds through the transit period.

Discussion

The *Quartz* cruised at speeds between 16-21 knots during the voyage between Chennai and Colombo. During this 3-day transit period, a blue whale was struck and killed as it was found wrapped around the bow of the *Quartz* on arrival at its destination port in Colombo. Bow-pinned whales have been previously reported off Mexico, in the North Atlantic and the North Pacific [2]. In all three cases, the ship's crew was unaware that they had struck a whale. Whales off California and the Gulf of St. Lawrence bear scars likely caused by collisions with vessels [3] [4] while more recently a blue whale was struck and killed by a ship in Puerto Montt, Chile [5].

Around Sri Lanka, ship strikes are considered the biggest threat to the Northern Indian Ocean blue whales [6]. An emerging strategy to reduce blue whale death by ship strike has been to move

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-specific interventions. Off California, ship strike has been mitigated by shifting shipping lanes within areas of overlap between blue whale home ranges that corresponded with areas of high productivity and commercial shipping lanes. As a result, Irvine et al. [7] recommended a southward shift of the shipping lanes within the high use area of the Santa Barbara channel, between July and October. Further, they advocated the closure of the northern shipping lane leading to and from the port of San Francisco Bay between August and November or the creation of an east-west lane extending to the 2,000 m isobath before bifurcating in order to reduce the likelihood of blue whale ship strike. These recommendations highlight the need for context-specific interventions to address this globally prevalent issue.

Global Fishing Watch is a multi application tool that allows the remote monitoring of our oceans using Automatic Identification Systems (AIS). Although originally designed to monitor fishing activities, it has numerous applications which are currently being explored. Using Global Fishing Watch data we were able to extract information about the *Quartz*, a vessel that was involved in a whale-collision in March 2012, and reconstruct its transit between India and Sri Lanka to analyse speed of movement. Increased movement speeds have been shown to correlate with an increase in lethal or severe injuries. Laist et al. [2] 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.

The Global Fishing Watch map currently displays commercial fishing activity and commercial fishing vessel tracks, when selected. However, the case of the *Quartz* exemplifies the ability of AIS data to provide transparency into marine mammal-vessel interactions through a public platform like Global Fishing Watch. A tool like Global Fishing Watch makes extraction of this kind of data easier than archived GIS data. The inclusion of large vessel movement data into platforms like Global Fishing Watch, though not currently a feature of the platform, would provide anyone anywhere access to AIS data for the purposes of monitoring ship strike risk to large whales. This is particularly important for researchers and decision makers as it is an effective means of extracting valuable information that can be used for the protection of natural resources.

Conclusions and recommendations

Ship-strike of large whales is a global threat that will predictably increase with the growth of ship traffic around the world [8]. Many such incidences go unreported or undocumented. However in some cases where evidence of ship strike is available, the information required to reconstruct the incident for analysis is unavailable. Data derived from Automatic Identification Systems (AIS) whether live or archived therefore provide an opportunity to explore these incidents further for the purpose of establishing means of mitigating future ship-strike events.

In order to reduce ship strike mortality of endangered cetaceans such as the blue whale, AIS data could be used to influence shipping lane locations. Aggregated AIS data overlaid with whale population density data could expose where small policy changes could have big impacts to reduce whale mortality. Global Fishing Watch is one potential platform for helping scientists access the AIS data necessary to work towards this policy change.

Acknowledgements

The authors wish to thank Bjorn Bergman, Analyst at SkyTruth, Paul Woods, CTO of SkyTruth, and Lacey Malarky, Analyst at Oceana, for assistance extracting the data used in this paper.

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