



Lessons From Placing an Observer on Commercial Cargo Ships Off the U.S. West Coast: Utility as an Observation Platform and Insight Into Ship Strike Vulnerability

Kiirsten Regina Flynn* and John Calambokidis

Cascadia Research Collective, Olympia, WA, United States

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*Correspondence:

Kiirsten Regina Flynn
kflynn@cascadiaresearch.org

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Ship strikes of whales are a growing concern around the world and especially along the U.S. West Coast, home to some of the busiest ports in the world and where ship strikes on a number of species including blue, fin, and humpback whales have been documented. This trial program examined the feasibility, logistics, industry cooperation, and effectiveness of placing an observer on board a commercial ship. An experienced marine mammal observer went on five voyages, spanning over 8 days on ships operating between U.S. West Coast ports. Daylight observations were conducted over 68 h and covered over 1300 nm as ships transited between three ports [Seattle, Oakland, and LA/Long Beach (LA/LB)]. Sightings of large whales were reported on all ($n = 42$), totaling an estimated 57 individuals that included humpback, blue, fin, and beaked whales. Close encounters of large whales occurred (on one occasion a near miss, estimated at 40 m, of two humpbacks), and on another, a ship chose to alter course to avoid whale sightings in its path identified by the observer. All ships personnel cooperated and voluntarily aided in the observations even after initial skepticism by some crew about the program. While most effort on mitigating ship strikes along the U.S. West Coast has focused on shipping lanes, the vast majority of these sightings occurred outside these lanes and on the transit routes, emphasizing the need for added attention to these areas. This experiment demonstrates the effectiveness and promise of observations from ships providing critical information on whale locations at risk to ship strikes.

Keywords: ship strike, ship observers, blue whales, humpback whales, fin whales, shipping lanes

INTRODUCTION

Ship strike of large whales have become an issue of growing concern worldwide and along the U.S. West Coast in particular (Redfern et al., 2013; Rockwood et al., 2017). The eastern North Pacific Ocean (ENP) and specifically coastal waters of the U.S. West Coast are utilized by a number of threatened or endangered large whales including blue whales, fin whales and two

(Mexico and Central America) distinct population segments (DPS) of humpback whales (Carretta et al., 2017). Ship traffic along the U.S. West Coast operate from major ports including those in the north based in Washington and British Columbia that transit out the Strait of Juan De Fuca, those based in San Francisco Bay including Oakland, Richmond, and San Francisco and in the Southern California Bight (SBC) home to Los Angeles/Long Beach (LA/LB), one of the world's largest ports. Ships transiting to and from these ports can go through five west coast National Marine Sanctuaries (NMS), areas identified as biologically important areas (BIAs) for the endangered blue and humpback whales, and for high densities of feeding gray whales (Calambokidis et al., 2015). With large ports and large commercial vessels transiting through these rich marine areas, comes the potential for ship strikes (Redfern et al., 2013; Rockwood et al., 2017; Moore et al., 2018).

Ship strikes of blue, fin, humpback, and gray whales have been frequently documented along the U.S. West Coast (Laist et al., 2001; Douglas et al., 2008; Rockwood et al., 2017) and second only to entanglements in the leading cause of human caused mortality to large whales along the U.S. West Coast (Carretta et al., 2017). Blue and fin whales appear to be particularly susceptible to ship strike mortality along the U.S. West Coast (Berman-Kowalewski et al., 2010; McKenna et al., 2015) though Monnahan et al. (2015) question whether ship strikes threaten the recovery of eastern North Pacific blue whales. Mitigation efforts increased after detection of seven blue whale carcasses triggered an unusual mortality event in 2007 (Abramson et al., 2009), and four of those deaths were attributed to vessel strikes (Berman-Kowalewski et al., 2010). In 2009, the Channel Islands National Marine Sanctuary (CINMS) recommended shipping lane changes (Abramson et al., 2009), which were put into place in 2013. In 2011, the National Oceanic and Atmospheric Administration's (NOAA) Office of Marine Sanctuaries also established a Joint Working Group (JWG) to assess ship and whale interactions including ship strike and acoustic impacts in the Gulf of the Farallones and Cordell Bank, to create a list of recommended mitigation measures (Joint Working Group, 2012). The JWG concluded that in order to reduce lethal ship strikes, a reduction in the co-occurrence of ships and whales had to occur. In their 2012 report, their recommendations included modification of shipping lanes, creation of dynamic management areas (DMA) in regions of high whale concentrations, education and outreach initially engaging and informing the commercial industry, and the creation of a real time monitoring and whale sighting network with commercial ship participation (Joint Working Group, 2012).

Placing dedicated marine mammals observers on board vessels has been proposed as an effective method for getting sighting information and helping to avoid collisions with large whales (Weinrich, 2004; ACCOBAMS, 2005; David et al., 2005; Weinrich et al., 2010; Gende et al., 2011; Couvat and Gambaiani, 2013). We report on a pilot program putting an observer on ships transiting between U.S. West Coast ports to document sightings along these routes, help quantify the threat to whales from ships and also evaluate the feasibility of using these platforms as an expanded source of sighting reports which were all part of the recommendations of the JWG.

MATERIALS AND METHODS

With the assistance of the Pacific Merchant Shipping Association, we worked with two shipping companies that transit between ports on the U.S. West Coast. While many ships using U.S. West Coast ports including the ships we worked with transit to more distant ports including Hawaii and Asia, we only sought transits between U.S. ports. All trips were conducted by the senior author, an experienced marine mammal observer and a licensed captain with professional experience in the maritime industry, which was valuable in negotiating with the companies with assurances she would not disrupt ship operations. The bridge height of commercial vessels is set up to provide the vessel operators the most unobscured 360° view possible for safe operations regardless of the position of the bridge (forward, mid, or aft). Ships we worked with included vessels with both forward and mid-aft bridges (**Figure 1**), for the latter the height of the containers carried on the ships never extends above the bridge height but did partially obscure visibility directly in front of the ship.

Shipping companies and the ship's officers agreed to provide access to the vessel bridge to the observer during all daylight hours. Ship passages occurred from May to September, periods of known occurrence of feeding baleen whales off the U.S. West Coast. Specific voyages were selected based on the vessel having the highest likelihood of being in a shipping channel during the most amount of daylight hours to allow for either entering or exiting shipping lanes into San Francisco and LA/LB, California (**Table 1**).

The observer was on effort approximately 4 h at a time during all daylight hours in all conditions, with 30-min breaks in between observation periods. Environmental (Beaufort, visibility, cloud cover, and precipitation) and effort data were recorded at the beginning and end of each on-effort period and any time conditions changed. During on-effort periods, continuous scans of the horizon were made from the bow to approximately 60° port and starboard with the naked eye and occasionally with a 7 × 50

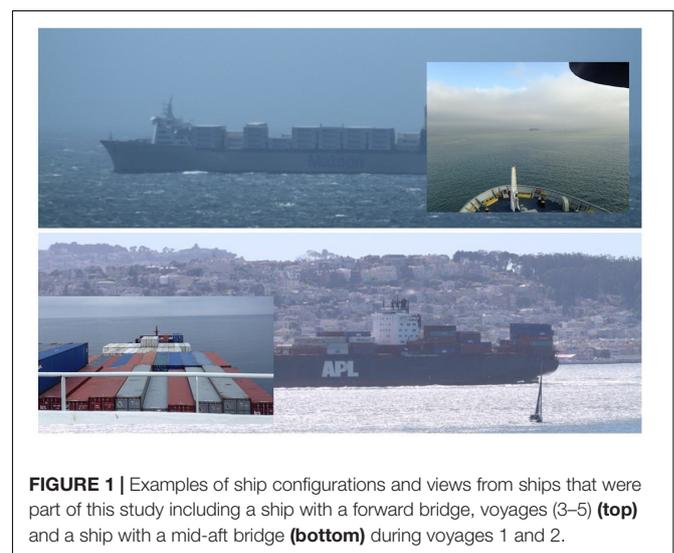


FIGURE 1 | Examples of ship configurations and views from ships that were part of this study including a ship with a forward bridge, voyages (3–5) (**top**) and a ship with a mid-aft bridge (**bottom**) during voyages 1 and 2.

TABLE 1 | Voyage numbers, dates of travel and ship specifications of ride-alongs.

Voyage	Date	Company	Transit	Vessel	Bridge position	Length (m)	Bridge deck Height off water (m) loaded
1	May 29–30, 2013	APL	San Pedro, LA to San Francisco, CA	Thailand	Mid-aft	276.3	40
2	August 1, 2013	APL	Long Beach, CA to Oakland, CA	Singapore	Mid-aft	276	40.29
3	September 26–27, 2013	Matson	Oakland, CA to Long Beach, CA	Mokihana	Forward	262.2	34.7
4	June 1–2, 2014	Matson	Seattle, WA to Oakland, CA	Manoa	Forward	262.2	34.7
5	June 5, 2014	Matson	Oakland, CA to Long Beach, CA	Mokihana	Forward	262.2	34.7

reticle compass binoculars. Species identification and behavior determination was aided with the help of binoculars. The sighting position and distance from ship of the whales was estimated for 5 of the 6 voyages, using the ship's GPS position, reticle reading of the whale's position below the horizon, angle off of ship's bow in 10° increments and height above the water. Group size and behavior if known was also recorded for any marine mammal. Data were collected both on an app based platform, SpotterPro, on a tablet (to test and demonstrate such a system to the crew) as well as on datasheets or a laptop. During observational watches, engagement with the crew offered informal discussions and educational opportunities for both crew and observer.

RESULTS AND DISCUSSION

Sighting Locations

A total of 42 large whale sightings of an estimated 57 individuals were made during 68 h and 1,387 nm of observation effort during five voyages spanning 8 days as ships transited between U.S. West Coast ports (Tables 2, 3). While 60% of large whale sightings were of unconfirmed species identity (species sometimes too distant even with the binoculars to identify), those that were identified included humpback, blue, fin and beaked whales (Table 3). Large whales were sighted on all five voyages representing six of the 8 days observations were made. Two days without sightings were the shortest days (2 and 5.5 h of observation). Even though sighting conditions varied widely and included some very poor weather (45 + knots of wind at one time and 25 foot seas) the bridge height above the water still provided good visibility. In addition to large whales there were also sightings of pinnipeds and small cetaceans.

The majority (76%, 32 out of 42) of the large whale sightings were on coastal ship transit routes along the coast outside the designated traffic separation lanes leading to major ports (Figure 2 and Table 3). Average ship speed while traveling coastally and outside traffic separation schemes ranged from 18 to 23 kts while inside the designated shipping lanes speed was slower, 11–18 kts (Table 2). There were six close encounters with large whales on five of the six trips with four of these outside the shipping lanes and two in the lanes. A sighting was deemed a close encounter if the whale was estimated to be less than 300 m from the vessel. One of these (outside the lanes) was considered a near miss (estimated at 40 m) of two humpback whales.

Our results demonstrate the potential large role that ships traveling along the coast may play in ship strikes and how most of

the risk for these ships may be outside of the designated shipping lanes near ports (versus ships that head offshore toward principal destinations in Asia after leaving the shipping lanes). Most of the focus of management efforts on the designated shipping lanes around major ports (San Francisco and Los Angeles/Long Beach). Our findings are consistent with encounter models of ships and whales that demonstrated a majority of strikes likely occur outside the designated traffic separation lanes even though the rate may be highest in the lanes (Rockwood et al., 2017).

Experience Working on Vessels and Feasibility for Future Use

There was a high degree of cooperation from ship's personnel to the observer. Once introduced to and educated on the topic of whale strikes and explanations of the presence of a marine mammal observer not being a regulatory professional, all ships personnel on the bridge assisted and aided in the sightings, even when the observer was off effort. This cooperation came where there was initial skepticism by some crew on sighting whales with several crew saying they had never seen a whale while on watch on the bridge and were surprised at the amount of sightings detected on our trip, while others indicated that they see whales often and maneuver around them periodically. During down times on the bridge, discussions with crew included the feasibility of their recording sightings without a dedicated marine mammal observer and the best ways to achieve this. There was a repeated suggestion by crew that this could best be achieved by integrating marine mammal observations and recording into existing reports they already were conducting. Even though a poster to help identify whales and report sightings had been circulated to shipping companies operating out of LA/LB, it was not present on most vessels and in the cases where present crew seemed unfamiliar with it.

On two occasions, the ship's crew took initiative to alter course to avoid whales informing the observer of their intent. One of these involved some distant sightings in the ships path that prompted a small course alteration so they were no longer dead ahead and the other, the mate employed hand steering to avoid a closer sighting of a whale. Though not requested by the observer, these responses could have been influenced by our presence. Observations of whales directly ahead on board the vessels with a mid-aft bride were more difficult since the bow was over 180 m ahead of the observer position and containers blocked the view immediately in front of the vessel as seen in Figure 1.

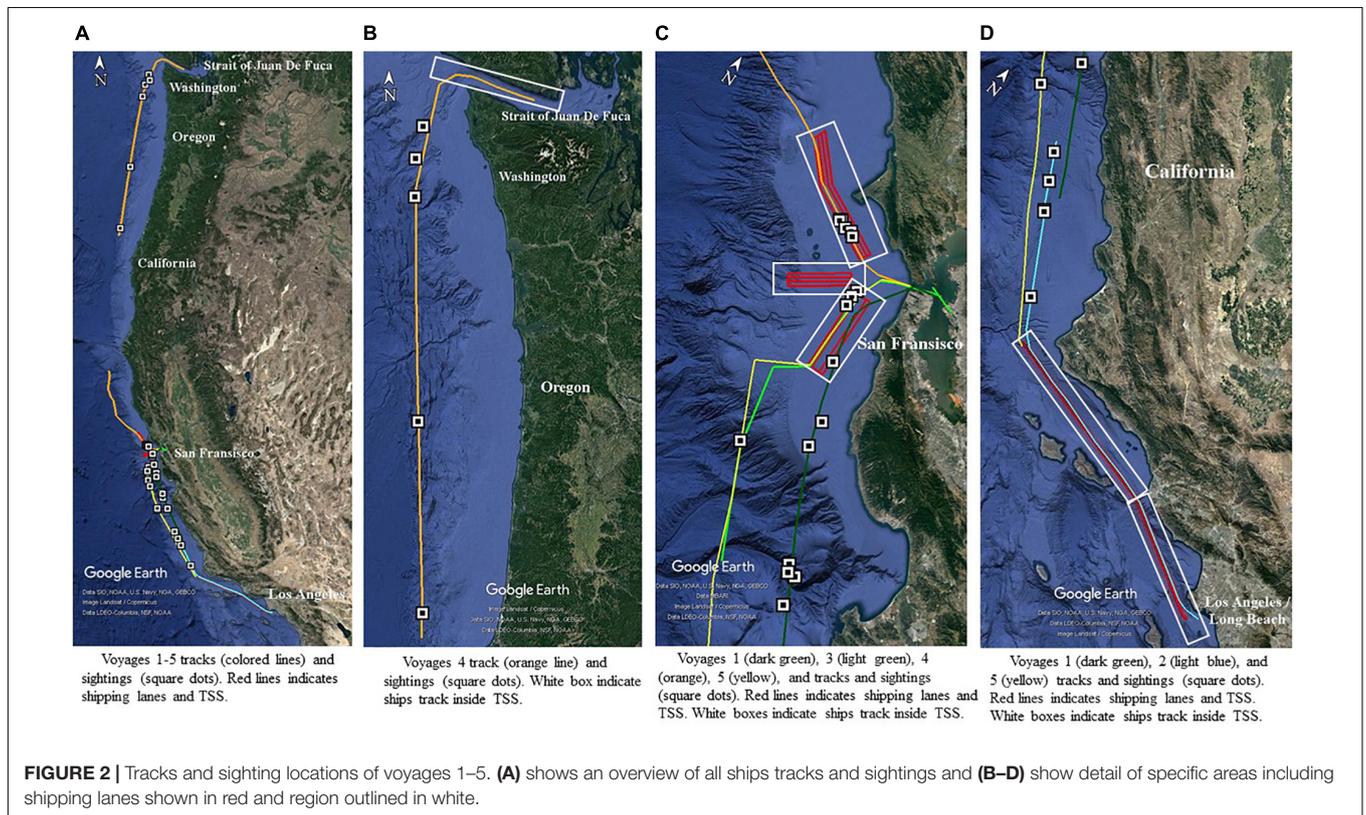
This pilot study was more successful than anticipated both verifying the value of ships as an observation platform and

TABLE 2 | Dates, region, and on-effort length, sighting conditions, and speed of ship ride-alongs.

Date (Voyage)	Region	Effort (h)	Beaufort	Visibility (nm)	Total on-effort track length (nm)	Speed outside shipping lanes (kts)	Speed inside shipping lanes (kts)
May 29, 2013 (1)	Southern California	2	3–4	10–15	15.8	na	10–13
May 30, 2013 (1)	Central California	8.5	4–6	5–15	168.5	20–24	10–14
August 1, 2013 (2)	S. Central California	12.5	1–6	3–15	225.4	15–18	12–17
September 26, 2013 (3)	Central California	7.5	5	15–20	101.6	18–23	na
September 27, 2013 (3)	Southern California	5.5	1	3–10	97.1	18	10–12
June 1, 2014 (4)	N. WA to Central OR	13	1–4	5–20	355	22–25	22–24
June 2, 2014 (4)	Central OR to Central California	7.5	4	0.5–10	172.2	17–25	14–22
June 5, 2015 (5)	Central to S. California	12	2	0.25–5	251.9	14–25	11–18

TABLE 3 | Numbers of sightings and individuals of large whales, inside and outside shipping channels.

Voyage	Large whales	Large whale outside shipping channels	Large whale inside shipping channels	Humpbacks	Blue whales	Fin whales	Cuvier's	UnID'd whales
1	8 (9)	7 (8)	1 (1)	2 (3)				6 (6)
2	5 (6)	5 (6)		1 (2)				4 (4)
3	3 (4)	3 (4)			1 (2)			2 (2)
4	13 (18)	7 (11)	6 (7)	2 (4)	4 (5)			7 (9)
5	13 (20)	10 (15)	3 (5)		1 (2)	1 (1)	1 (3)	10 (14)



showing the frequency of encounters of large whales for vessels transiting along the coast. This is consistent with findings in other areas regarding the value of dedicated marine mammal observers placed on board ferries and cruise ships (Gende et al., 2011; Harris et al., 2012; Williams et al., 2016). Weinrich et al. (2010)

demonstrated that observers aboard fast ferries detected whales faster and at larger distances than the crew. Commercial vessels bridge height above the sea surface, the wide field of view, all designed for safe operations and the ships stability, make an excellent marine mammal viewing platform. While our

visual observations were limited to daylight conditions, other approaches (e.g., infrared) could be used to expand this to nighttime periods when whales are closer to the surface and more vulnerable to ship strikes (Calambokidis et al., in press).

CONCLUSION

Our findings demonstrated:

- (1) the value of ships as an observation platform along the U.S. West Coast, providing real time data on whale occurrence along ship transit routes,
- (2) the important role ships that transit along the coast between U.S. ports may play in ship strikes,
- (3) the potential for ship self-reporting especially if done in conjunction with better reporting methods and training by experienced marine mammal observers accompanying some trips,
- (4) the potential ability of ships to avoid whale concentrations if spotted early enough.

These findings have resulted in plans to conduct future trips with observers to improve sample size (planned for 2019–2021) with an ultimately goal of having ship personnel conduct their own observations and reporting.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

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AUTHOR CONTRIBUTIONS

Both authors conceived and designed the study, revised the manuscript, and read and approved the submitted version of the manuscript. KF collected the data and wrote the first draft of the manuscript. JC designed the data analysis.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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