

# **ATTACHMENT E.3**

North Atlantic where ship collisions constitute a higher proportion of strandings. With North Atlantic populations of humpback whales and fin whales estimated at 10,600 whales (Smith *et al.* 1999) and more than 20,000 whales (International Whaling Commission 1992), respectively, vessel-related deaths several times higher than numbers reported in this paper would still constitute a small portion of their total populations. However, in combination with other causes of human-related mortality (*e.g.*, entanglement in fishing gear and whaling), vessel-related deaths may warrant consideration in relevant population models and management programs. Also, high numbers of ship strikes in some areas, such as collisions with humpback whales off U.S. mid-Atlantic coastal states and fin whales in the western Mediterranean Sea, could be a source of concern for some local population segments.

For highly endangered populations numbering in the low hundreds of animals, where the loss of even a few individuals can be significant, ship collisions can be a major recovery obstacle. This certainly is true for northern right whales in the western North Atlantic, and also could be true for western North Pacific gray whales, which may be near the minimum number necessary for recovery (Rice *et al.* 1984), and for northern right whales in the western North Pacific, which may number in the low hundreds (Perry *et al.* 1999). The small population of blue whales that feed in the Gulf of St. Lawrence, Canada, also may warrant concern. Although highly endangered bowhead whale populations off northeastern Canada, Greenland, northern Europe, and Russia are well removed from most ship traffic, they too could be at risk if year-round northern sea routes develop in their Arctic habitats.

### *Conclusions*

For some small whale populations or population segments, ship collisions can pose a substantial threat. Massive injuries on stranded ship-struck whales suggest large vessels are the principal source of severe injuries to whales. Currently, anecdotal records provide the only information for evaluating vessel operating factors related to ship strikes. Although such records have significant weaknesses, they merit consideration absent other data. Accounts found in this review suggest that most whales hit by ships are not seen beforehand or seen only at the last moment. Collision avoidance strategies dependent on detecting and avoiding whales therefore may be ineffective for large ships with limited maneuverability. Where steps are needed to reduce collision risks, advanced planning to avoid or minimize travel distances through high-use whale habitats or to reduce vessel speed in waters where whales are likely to occur may be more effective. Collision accounts compiled here suggest that serious injuries to whales may occur infrequently at vessel speeds below 14 kn and rarely at speeds below 10 kn. Therefore, there may be benefit in management actions designed to reduce vessel speed below at least 14 kn to reduce the impact of vessel collisions on large cetaceans.

Further research is needed to identify areas where collisions between ships and whales are most frequent and to help further evaluate and improve upon

mitigation measures. To assess the frequency, location, and circumstances of such collisions, vessel operators, port pilots, and other port officials should be asked to record and immediately report any collisions with whales or whales carried into port on bows of ships. Reports should be made promptly to resource management officials or marine mammal stranding coordinators so that involved vessel crews can be interviewed, and navigation and engine logs can be examined for information on when, where, and at what speed the collision occurred and the behavior of whales before and after being hit. Also, stranding program participants should routinely look for and record injuries caused by ships on all beach-cast whales. For whales belonging to small populations or population segments that may be affected by low levels of human-related mortality, it would be prudent to flense stranded whale carcasses to the bone to look for internal injuries caused by ship collisions.

Further research also is needed to better assess whale behavior and responses near transiting ships of different types and sizes. Studies of the frequency and intensity of sound produced by different types of ships at different depths, distances, and directions (particularly in front of vessels), and the responses of whales engaged in different behaviors to those signals would be helpful for determining whether or at what distance whales may be able to detect and avoid ships. Studies to document and assess other ship-generated signals that might cause a startle response in whales directly in front of approaching ships, such as low amplitude, high-intensity hull vibrations, and bow wave effects, also should be made. Studies also should be undertaken to better identify habitat-use patterns of whales and correlations between environmental parameters and whale distribution to improve advice to mariners on when and where whales are most likely to occur.

Research on alternative management actions also should be considered. Potential studies include periodic review of the feasibility of evolving technologies to provide vessel operators with real-time data on the presence and location of whales along navigation routes. Possible options might include bottom-mounted sonobuoys along established vessel traffic lanes through important whale habitats to relay information on whale locations to ships, and further research similar to that by André *et al.* (1997) on the possible use of sound to alert whales to approaching ships.

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Appendix 1. Anecdotal descriptions of collisions between self-propelled ships and whales.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
May 1885	Unknown	Minor injury	Pilot boat; <i>Alexander M. Lawrence, No. 4</i> ; Size unknown	13 kn	32 km east of Nantucket, MA, USA	The vessel's port bow suddenly collided with a large whale. The vessel dipped until water nearly reached her hatches and seemed in such imminent danger of capsizing that those below rushed on deck. Looking back they saw the whale rolling about as if in distress. (No reference was made as to whether or not blood was seen.) The vessel sustained no damage.	Nantucket Inquirer and Mirror 65(48), May 30, 1885 cited in Allen 1916
Mid-1930s	Unknown	Killed	Steamer, <i>Maunganui</i> ; 131 m	15 kn	Near Raratonga, South Pacific	While steaming from New Zealand, the ship collided with a large whale which was cut almost in half. Impaled across the ship's bow below the water line, it was necessary to stop and run astern for a few minutes to remove the carcass.	W. Cummings <sup>a</sup>
August 1952	Unknown	Unknown	Navy destroyer, <i>USS Tweedy</i> ; 93 m	14 kn	139 km off Montauk, Long Island, New York, U.S.A.	At 1300 in fine weather and calm seas enroute from Guantanamo, Cuba, to Boston, Massachusetts, a large whale about 15 m long was seen awash and swimming slowly about 90 m ahead and 18 m to port. A few seconds before impact it submerged to a shallow depth. The impact was not felt, but it caused severe damage to the sonar dome necessitating dry-docking in Boston.	W. Cummings <sup>a</sup>
Fall 1953	Unknown	Killed	Aircraft carrier, <i>USS Sicily</i> ; 169 m	~20 kn	Northern Yellow Sea	After midnight under a full moon and in calm seas a sudden shudder was felt throughout the ship. The bow lookout reported something on the bow. The engines were stopped and the object on the bow was identified as a whale. The ship had to back full to dislodge the whale, which then sank. There was no damage to the ship.	W. Cummings <sup>a</sup>
12/25/54	Unknown	Unknown	Passenger ship; <i>Maori</i> ; 133 m	18 kn	11 km off Kaitiaki, South Island, New Zealand	Very early in the morning while steaming northward, the vessel collided with a large whale and incurred damage to the stem bar protecting the rudder. The bar was twisted to port about two feet out of plumb.	W. Cummings <sup>a</sup>
3/22/55	Sperm whale	Killed	Steamship; <i>Amerskørk</i> ; 144 m	17 kn	89 km west of Cape Gardafui, Canary Islands	After a mysterious jolt, the crew found that a 10-m sperm whale had been struck on the head and body and become lodged on the bow below the water line. The ship was stopped and the engines were reversed to remove the whale's carcass from the bow. It was thought the whale was struck while it was sleeping.	Slijper 1979

Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
February 1960	Unknown	Severe injury	Passenger ship; name unknown; 13,000 tons	Unknown	West of Cape Reinga, North Island, New Zealand	At about 1100 a large school of whales crossed ahead of the vessel. Before evasive action could be taken, the vessel's propeller struck a whale causing the vessel to shudder and the engine speed to slow noticeably. The whale was seen thrashing with its back sliced by the propeller and bleeding. The other whales in the school circled about the injured animal.	W. Cummings <sup>a</sup>
September 1961	Unknown	Severe injury	Cargo vessel; name unknown; ~8,000 tons	14 kn	Caribbean Sea	At about 1500 a whale was sighted lying at the surface just prior to the collision in a light sea and good visibility. After the collision, the whale was seen thrashing in the wake with blood in the water.	W. Cummings <sup>a</sup>
1963	Unknown	Severe injury	Passenger ship; name unknown; 14,000 tons	18 kn	Equatorial Pacific	Numerous whales, possibly including cow-calf pairs, were in the vicinity. In midafternoon, with good visibility and low swell, a whale thought to be surfacing in front of the vessel was struck. A small amount of blood was seen in the water; the whale appeared to swim away slowly. The ship sustained no damage.	W. Cummings <sup>a</sup>
11/29/65	Sperm whale	Minor injury	Whale catcher boat; <i>Sinox City</i> ; 41 m	Unknown	~200 km W of San Francisco, California, USA; 37°30'N, 123°31'W	While on a whale-marking research cruise amid a harem school of about 50 sperm whales, the vessel approached a cow-calf pair. The female dove while the calf played at the surface alongside the boat as it passed. When the female was seen surfacing, the vessel's engine was immediately disengaged, but there was a strong thump as the whale was struck. The thrashing whale and feces-filled water was seen in the boat's wake. The starboard propeller was bent necessitating drydock repair.	W. Cummings <sup>a</sup>
July 1967	Unknown	Killed	Navy cruiser; <i>USS Newport News</i> ; 219 m	Unknown	South of Halifax, Canada	After dark enroute to San Juan, Puerto Rico, it was determined the vessel's speed was too slow for the number of propeller revolutions being registered. A crewman was sent to look for obstructions on the bow and reported a whale was stuck to the bow. The ship had to be stopped and backed down to remove the whale which then sank unidentified.	W. Cummings <sup>a</sup>



## Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
10/9/67	Unknown	Killed	Passenger ship; SS <i>Brazil</i> ; 232 m	Unknown	Approaching Gaspé, Quebec, Canada	At about 0700 a crewman reported hearing a flapping noise on the ship's bow. A large whale 15–18 m long was observed impaled on the bow. Before entering Gaspé harbor, the vessel had to use reverse thrust to dislodge the whale. A passenger filmed the animal, which was nearly cut in half, as it was dislodged.	W. Cummings <sup>a</sup>
March 1972	Unknown	Severe injury	Boston whaler; name unknown; 4 m	>25 kn	Las Perlas Islands, Panama, Pacific Ocean	At about 1000 while running at top speed, a small whale surfaced directly in front of the boat. The boat struck the whale and went right over the animal breaking off the tow ring firing in the animal's flesh. After the collision, the animal was seen thrashing with blood coming from the wound.	W. Cummings <sup>a</sup>
Between 11/72 and 2/73	Unknown northern right whale?	Killed	Bulbous bow container ship; <i>Young America</i> ; 207 m	21–23 kn	~97 km east of Boston, Massachusetts, USA	Upon arriving at the Boston harbor pilot station from Cadiz, Spain, the crew of the harbor pilot boat noticed a whale lying across the ship's bulbous bow. Prior to that time the crew was unaware they had struck a whale. The whale had no apparent propeller wounds or signs of bleeding. Reverse engine thrust was used to remove the whale from the bow. Based on an unexplained decrease in ship speed, it was thought the whale had been hit at night about 3–4 h before reaching the pilot station.	J. Murphy II <sup>b</sup>
October 1973	Unknown	Killed	Navy destroyer; <i>USS Whipple</i> ; 133 m	Unknown	Bay of Bengal, Indian Ocean	At around midnight the vessel struck and killed a large unidentified whale. The collision caused no damage to the vessel.	W. Cummings <sup>a</sup>
12/26/73	Killer whale	Severe injury	Commercial ferry; <i>Comex Queen</i> ; 152 m	15–18 kn	Straits of Georgia, British Columbia, Canada	At 1545 a crunch was heard at the ship's stern and blood was seen in the wake. A bull, a cow, and two calf killer whales surfaced off the stern and the ship circled back to within a few feet of the whales. A calf was seen bleeding profusely from visible propeller slashes. The bull and cow cradled the calf between them to prevent it from turning upside down. The ship stayed with the animals for 10–15 min before leaving. The ship sustained no damage.	Ford et al. 1994

## Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
4/23/74	Unknown, gray whale?	Severe injury	Private motor yacht; <i>Brynette</i> ; 18 m	10.5 kn	<2 km off Baja Peninsula, Mexico	At 1530, while on auto pilot, the boat suddenly veered to port and started shaking. The engines were stopped immediately and a large whale surfaced at the stern with deep propeller gashes down the mid section. A large pool of bloody water soon formed. It was thought the whale must have come up directly under the boat because passengers on the bow at the time were looking down at the water and saw no whale before the collision. The boat sustained no damage.	W. Cummings <sup>a</sup>
Late 1974	Unknown	Severe injury	Commercial ferry; name unknown; 4,000 tons	17 kn	Cook Strait, New Zealand	During the afternoon in moderate seas and good visibility, the twin screw ferry struck and possibly killed a whale. Blood was noticed in the water after the vessel passed. The ship sustained no damage.	W. Cummings <sup>a</sup>
1/22/75	Gray whale	Killed	Navy hydrofoil; <i>Flags-taf</i> ; 72 tons	51 kn	Off Pt. Loma, California, USA	At 0728 about 2.4 km south of Point Loma, the ship hit a whale while foil-borne returning to San Diego. The vessel came to a dead stop within about 30 m, but no injuries to the 18-member crew were reported. The vessel sustained considerable damage to its rear struts. The crew lost sight of the whale but the next day a dead whale with a severed tail stranded near the collision site.	Anonymous 1975
7/5/80	Blue whale	Killed	Tanker; <i>Bald-butte</i> ; 203 m	21 kn	64 km west of Ensenada, Mexico	Upon entering Los Angeles harbor a dead whale floated to the surface near the ship. The crew was unaware of the collision until then. The collision location was inferred from notes in the ship's log about a sudden decrease in speed from 39 to 35 km/h and a change in the bow wake. The whale's spine was broken.	Patten et al. 1980, Alexander 1980
10/24/80	Blue whale	Killed	Bulbous bow freighter; <i>Evershine</i> ; 174 m	Unknown	North Pacific	Upon arriving in Seattle, Washington, from Taipei with an intermedate call at Port Angeles, California, a 18-m blue whale drifted free of the ship's bow. It was not known when the whale was hit, but it was thought to have been on the bow for at least five days given the slow ship speed enroute from Port Angeles.	Norris 1980
August 1984	Fin whale	Severe injury	Whale-watching vessel; name unknown; 28 m	16 kn	Stellwagen Bank Massachusetts, USA	At dusk while returning to port at full speed, a fin whale surfaced immediately in front of the vessel. There was no time to take evasive action. After the collision the whale was not resighted but blood was seen in the water around the vessel.	M. Weinrich <sup>c</sup>

## Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
10/16/84	Southern right whale	Killed	Hopper dredge; <i>D.E. Patterson</i> ; 110 m	Unknown	East London Harbor, South Africa	At 0730 after receiving a report of right whales in the area and advice to be alert for them, a cow-calf pair suddenly surfaced directly in front of the dredge as it passed a breakwall. The calf took the full brunt of the impact and as the vessel passed over it, the calf was struck by the propeller. After attempts by the crew to support its bleeding calf, the calf crossed the waterway, stranded on a small beach and died. The cow remained in the area several hours.	Best <i>et al.</i> , in press
1/24/85	Unknown	Severe injury	Navy frigate; <i>USS Hepburn</i> ; 126 m	Unknown	Off Southern California, USA	While underway with a bridge watch posed, crew on the fantail/flight deck noted a large pool of blood astern and the back and tail of a large whale. Although the watch did not see the whale and there was no noticeable bump, the ship's hydrophone operator detected an increase in the ship's radiated noise astern. An increase in vibration in the aft part of the ship also was noted. Divers sent down to survey the hull reported significant damage (a 1.6-m tear) in the leading edge of a propeller blade. The propeller had to be replaced at a cost of \$125,000.	T. Tucker <sup>d</sup>
3/5/88	Gray whale	Unknown	Tanker; name/size unknown	Unknown	Outside Los Angeles Harbor, Southern California, USA	A small pod of migrating whales was seen directly ahead of a tanker bearing down on them. The whales seemed unaware of the approaching ship until it was about 30 m away when the pod suddenly increased speed and dove to avoid the ship. The last whale to dive was hit. The ship continued on without changing course or speed. The event was video taped from a nearby whale-watching vessel.	Heyning and Dahleim, in press
9/7/88	Southern right whale	Killed	Twin screw ferry; <i>Barrier</i> ; 171 m	12-13 kn	7 km outside Port Elizabeth Harbor, South Africa	The ferry was accelerating on leaving the port at 1653 when nine whales were seen ahead of the vessel crossing the bow. They failed to dive, an impact with at least one animal was felt, and blood was seen in the water immediately thereafter behind the ship. Three days later two dead right whales stranded nearby, one with propeller gashes and a damaged rostrum, the other with no external wounds	Best <i>et al.</i> , in press

Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
4/16/91	Unknown	Unknown	Navy hydrofoil; <i>Aquila</i> ; 24 m	>40 kn	Off Key West, USA	At ~0900 while foil-borne, the ship struck a whale causing a rapid landing threw the crew forward. Port and starboard aft strut actuators were severely damaged, port and starboard steering arms broke, ruptured seawater piping caused flooding of the gas turbine, the hull was warped in numerous places, and starboard diesel engine shifted forward off its mounts. Repairs cost \$1 million.	T. Tucker <sup>d</sup>
6/21/91	Humpback whale	Minor injury	Whale watching Vessel; <i>Mary Elizabeth</i> ; 14 m	5–10 kn	Stellwagen Bank, Massachusetts, USA	At about 1700, the vessel and another whale-watching boat were alternately observing a mother-calf pair and a single animal. The <i>Mary Elizabeth</i> left the cow-calf pair to move to the single animal about 90 m away. While doing so, the whale, a photo-identified animal named "Rocker," surfaced a few yards off the starboard bow, apparently lunging to avoid the vessel. The engine was immediately disengaged, but the bow struck and rode up over the whale. It resurfaced off the stern. The vessel's naturalist observed the whale and reported no injuries and normal swimming behavior. However, observers on a third whale watching boat approaching from about a mile away photographed the animal with a fresh shallow nick between its nares and dorsal fin. Over the next six years, the animal was resighted annually (except 1996) at Stellwagen Bank. Photos show the wound healed with no apparent effect to the whale.	K. Sullivan <sup>e</sup> ; S. Young <sup>f</sup>
7/6/91	Unknown	Killed	Coast guard cutter; <i>Chase</i> ; 84 m	22 kn	>185 km E of Delaware Bay, USA; 38°21.5'N, 73°06.5'W	At ~1845 in calm seas and clear weather, two large whales, possibly sperm or right whales, were seen by the bridge watch surfacing 46 m ahead crossing the bow. They dove quickly perhaps trying to avoid the ship. A few seconds later the ship vibrated and the engine was disengaged. As the ship slowed, a calf about 4.6 m long rolled from under the stern bleeding profusely from large propeller gashes on its side. It rolled a few times, settled nose up for a few minutes, and sank "obviously dead." The two large whales surfaced, circled back to the ship, lingered a while, and then left. Both propellers were damaged.	U.S. Coast Guard 1991

## Appendix 1. Continued.

Date	Species struck	Fate of whale	Vessel type, name/size	Speed	Location	Description of event	Source
February 1992	Sperm whale	Killed	High-speed ferry; name unknown; ~20 m	45 kn	Canary Islands; 27°56'N, 14°34'W	A description of the event is not available, however the collision reportedly resulted in the death of one passenger.	André <i>et al.</i> 1997
4/4/92	Unknown	Severe injury	Research vessel; <i>Surveyor</i> ; 89 m	14 kn	~19 km W of Callao, Peru	In late morning, a biologist on the bridge saw a large whale surface a few hundred yards ahead of the ship. A few minutes later, a shudder was felt throughout the ship. Immediately afterward, blood was seen in the ship's wake from which it was concluded that a whale had been struck. Numerous whales were seen shortly before the event. The vessel sustained no damage. Upon entering the port of Burnie, Tasmania, a dead 12-m whale was found draped over the ship's bulbous bow. Based on a sudden unexplained decrease in vessel speed, the Captain presumed the whale was hit at 0400, about 4 h before entering port. A necropsy indicated the whale was alive when struck. The event was the first record of a Bryde's whale from Tasmanian waters.	D. Ainley <sup>g</sup>
5/15/92	Bryde's whale	Killed	Bulbous bow container ship; <i>City of Burnie</i> ; 121 m	~14 kn	Bass Strait, Australia		H. Wapstra <sup>h</sup>
6/20/92	Fin whale	Minor injury	Whale-watching vessel; name/size unknown	Unknown	Tadoussac, St. Lawrence Estuary, Canada	The vessel collided with the fin whale while watching. After the collision a wound was visible on the animal's back in front of the dorsal fin.	N. Menard <sup>i</sup>
1/5/93	Northern right whale	Killed	Coast Guard cutter; <i>Point Francis</i> ; 25 m	15 kn	6 km off St. Augustine, Florida, USA, 30°02'44"N, 81°16'04"W	At ~1515 in heavy fog, a whale surfaced off the bow and was struck before evasive action could be taken. The whale, a calf, was badly lacerated by the propellers. Two bumping sounds were heard during the event. The ship stayed with the calf for two hours; the calf's mother stayed ~275 m away occasionally slapping the water with her pectoral fin. Three days later the calf was found floating dead offshore and was towed ashore for necropsy. The ship sustained no damage.	National Marine Fisheries Service 1995; Bonde <sup>j</sup>
7/29/93	Fin whale	Minor injury	Whale-watching vessel; name/size unknown	Unknown	Bergeronnes, St. Lawrence Estuary, Canada	While moving toward a humpback whale and letting another boat pass, a fin whale surfaced and struck the bow of the vessel. A wound was subsequently observed on the animal's back.	N. Menard <sup>i</sup>