Saving the whales through better design

Reducing vessel speed and better use of navcomms could help to spare large sea mammals from accidental vessel strikes. However, better vessel design, including a reassessment of hydrofoils, could also prove useful, write Camillo De Gaspari, AMRINA and Vittorio D'Albertas

Sea mammals such as whales have been frequently injured by propeller blades and vessel strikes (illustration: Carlotta Cataldi)

Whales and dolphins play an integral role in the food chain of the marine eco-system and contribute massively to the production of global oxygen. Unfortunately, these metacognitive (self-conscious) animals are, in some cases, at risk of extinction.

When collisions occur between vessels and cetaceans ('strikes'), excessive vessel speed and sharp appendages (such as bulbous bows, hydrofoils or propellers) pose risks that could be reduced by taking precautions during the vessel design process, or during the vessel's operational life.

This article will look at the risk of collision between surface vessels and dolphins or whales, and the possible solutions that modern high-speed craft (HSC) such as USVs and hydrofoil vessels, as well as sailing vessels and small craft, can implement to safeguard these cetaceans from harm.

Frequency of accidents

There is ample evidence that marine animals enjoy advanced social behaviours and communication skills. Examples include the colony-specific singing of the humpback whale (*Megaptera novaeangliae*), the clicking of the sperm whale (*Physeter macrocephalus*) or the complex language of the Burrunan dolphin (*Tursiops australis*).

Large whales did not evolve to detect and avoid the presence of predators, ships or other approaching objects, so are at risk. The International Whaling Commission (IWC) is the main organisation dedicated to conserving whale stock, and its tasks include collating reports from various sources into the Ship Strike Database, and publishing an annual report that provides interesting statistical data regarding the frequency with which these accidents occur.

Currently, more than 1,000 collision cases are reported in the Database. In many instances, the cetacean carcasses were noticed at the port of arrival: embedded on the bulbous bow in the case of larger ships, or found stranded on the coast in other cases, with evidence of propeller wounds, fractured skulls and mutilations.

The North Atlantic, followed by the North Pacific, is the area where most cases have been reported, and where fin whales (*Balaenoptera physalus*) are the most commonly endangered species, followed by humpback whales.

In most cases, however, the strikes remain unnoticed. We are unaware of thousands of whales killed every year because these animals are negatively buoyant and, once dead, their bodies sink to the bottom of the sea, leaving no trace of what has happened. If the bodies remained afloat and visible, the public wouldn't tolerate the death toll.

For large whales, the risk of death from strikes is proportional to the speed of the ship involved. Collisions can also injure onboard personnel, especially on small craft and HSC.

Hydrofoil considerations

The first hydrofoil boat was designed and built in 1906 by Enrico Forlanin in Italy. Production of foiling vessels continued in Germany in the 1920s with Baron H. von Schertel, and throughout WWII.

In 1950, Supramar commenced hydrofoil production for passenger services on Lake Maggiore and Lake Lucerne. The PT10 Golden Arrow and subsequent PT20 and PT50 models were built under license by many yards. Hydrofoils were also designed in the Soviet Union for riverine passenger traffic.

This architecture also found a development in the experimental USS *Tucumcari*, built by Boeing in 1966, and the later Pegasus-class military ships. Since then, various nations have experimented with hydrofoil technology but it has often been discarded in favour of more robust alternatives, and because hydrofoils are complex, requiring powerful engines and greater maintenance than other HSC types.

However, hydrofoils still represent an efficient means of connecting difficult-to-access areas such as islands and archipelagos. Super-high-speed hydrofoil passenger ferries are widely used to link Japan's chain of 6,852 islands, preventing the depopulation of these otherwise remote locations, for example. The type of vessel most widely used there is the Kawasaki Jetfoil, a Boeing 929 patent (Pegasus class).

While Japan has one of the few fishing fleets that still hunts whales, there is greater domestic public awareness of hydrofoil strikes, and most of the available literature regarding the risk of collision between hydrofoils and whales has been published by Japanese scientists.

Today, hydrofoil vessels are considered exotic and are built in small numbers, but they are responsible for a significant number of injuries to sea mammals. In 1996, *Rodriquez Alijumbo* severely injured a young whale in Italy, while a 2007 strike off the coast of Busan, Korea caused one passenger death and 102 injuries, and a strike in Japan in 2019 injured 87 passengers.

Such incidents have rendered hydrofoils unpopular, necessitating seat belts to be implemented on jetfoils. The risk is heightened by their super-high speeds and the fact that, to provide a dynamic lift, hydrofoils must exert a great weight (pressure) on their leading edge, becoming very sharp. Worse, while the noise emitted by a powerboat is audible underwater, potentially alerting dolphins and whales to imminent danger, sailing hydrofoil yachts produce little to no noise or vibrations.

Speed and size

In the Pelagos Sanctuary of the North-Tyrrhenian Sea the famous Viareggio – Bastia – Viareggio powerboat race has already been banned. In some areas, navigation has been limited to zero-emission operations; in others, compliance with class notations regarding the prevention of underwater noise pollution is essential for operators who want to maintain their reputations and benefit from reduced taxes in certain ports.

Vessel speed is also a big factor. The speed range where most strikes have been recorded is 11-15 knots, while speeds between 15-20knots create the biggest risk of mortality, at 79% (Winkler et al). Personnel on larger ships may not notice the collisions, and might even keep silent about strikes to avoid negative publicity.

The size of the vessel is also a cause of danger, since larger ships must be able to identify an obstacle in time to deviate course, and the consequence of strikes with large ships are often more severe for the animals.

Together with the duty to manoeuvre and take any action to avoid the risk of collision (COLREGS), reduction of speed is mandatory in areas with a presence of whales. Restricting speed at night could also reduce the probability of collisions. Cetaceans live at lower depths during the day, emerging only for breathing. During hours of darkness they position themselves near the surface of the water foraging with krill, a crepuscular species that shuns sunlight.

This suggests that vessels could reduce their operational speeds at night to reduce both consequences and frequency of strikes. Regulations have been issued to this effect, leading to the creation of various seasonal management areas (SMAs) along the east coast of the US Atlantic seaboard for fixed periods of the year, requiring that vessels of 65ft (19.8m) and over must travel at 10knots or less.

For more than a decade, the organisers of regattas such as the Volvo Ocean Race and Global Ocean Race have provided routing instructions for the competitors to avoid high-risk areas, so that they can continue to sail at maximum speed. Reporting of sightings is encouraged through provided forms, as well as kits for the collection of any skin samples attached to the yachts after the possible strikes, to determine the species in that part of the sea.

Possible precautions

Active detection systems or alert systems are possible safety measures. Sighting systems include: high-res automated cameras (Kato et al); IR cameras; radar; forward-looking 3D fish-finders of the last generation (widely available but limited to an operational speed under 10knots); and active sonar systems.

Automatic route deviations and return to original route have also been conceptualised. All of these safety measures can also be installed on manned vessels and modern USVs.

Alerting systems that have been employed include underwater speakers, as used by the aforementioned, very manoeuvrable Kawasaki Jetfoils – but this technique requires an assessment of the population in the specific area and period of the year, as 86 species of whales exist and they produce sounds in many different frequency bands that are used for both echolocation and communication.

Training programmes for pilots and the development of specific protocols have been proposed, as well as visual observation in search of dorsal fins and blowholes, for avoidance and to identify species.

Where commercial shipping routes extensively cross the paths of whales, AIS technology (mandatory for ships of 300gt and above, and for every passenger ship regardless of size) has been deemed essential to define high-risk areas through heat maps, showing where the presence of ships overlaps with sea life more frequently. It has also been proposed to enforce these restrictions, like the 10knots speed limit and preservation of safety corridors, with punitive and non-punitive actions.

The IWC database of collisions should also be updated with strikes and encounters in a reasonable time frame, considered to be four months. Non-IWC members, such as Sri Lanka and Canada, could also provide data. ***SBI***

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