MARCH 2023

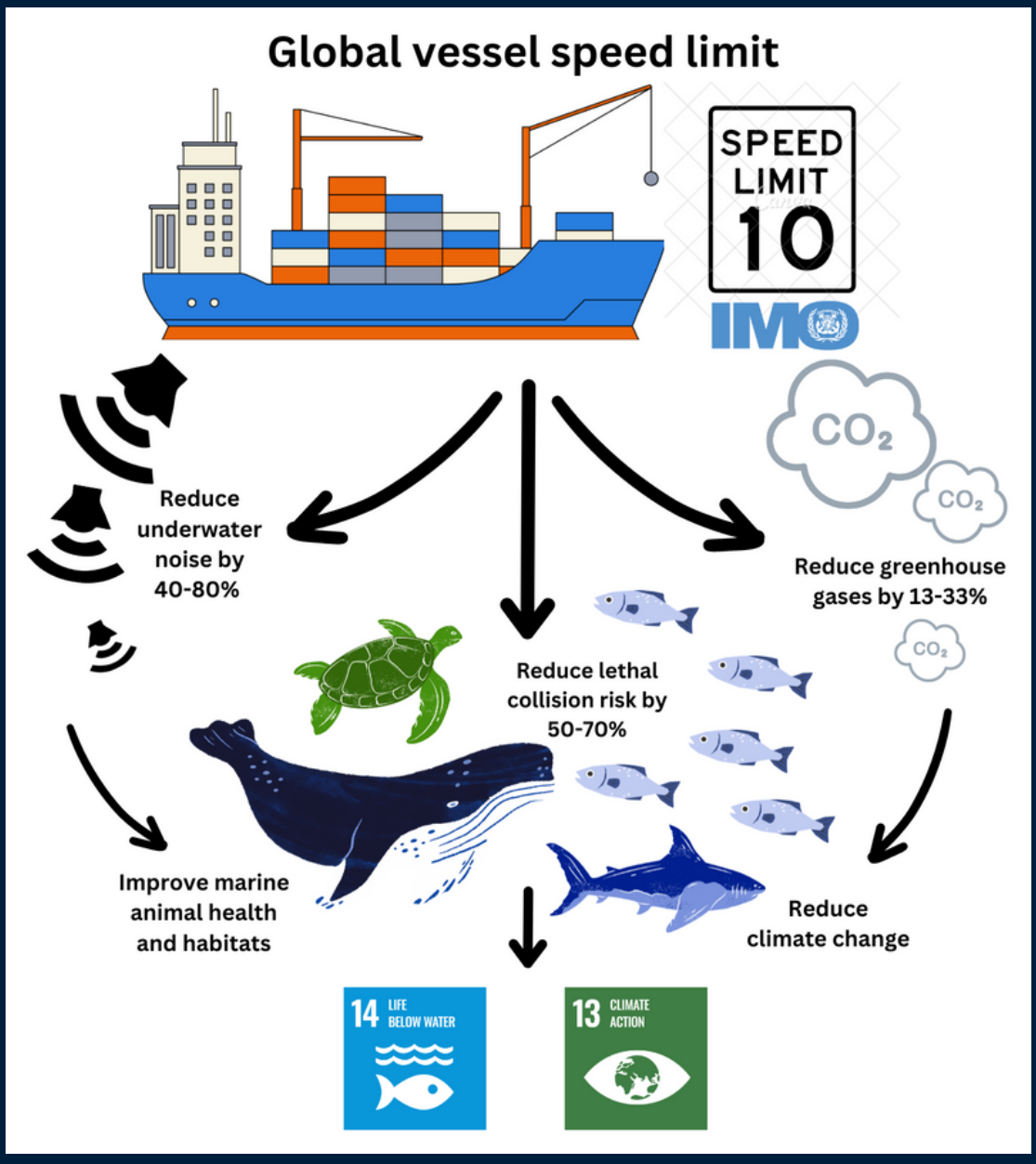
In advance of the July 2023 Marine Environment Protection Committee 80th Session (MEPC 80) of the International Maritime Organization (IMO), this brief has been prepared for the Working Group on Reduction of Greenhouse Gas Emissions from Ships by an independent consultant.

NO NEED FOR SPEED: GLOBAL MARITIME SPEED LIMIT FOR LIFE BELOW WATER

Key Points

- Commercial shipping is responsible for a large portion of global emissions, underwater noise pollution, and deadly collisions with marine life.
- To achieve SDGs 14 and 13, short-term interventions are needed while new technologies develop.
- Slowing ship speed can have a high impact on emissions and safety for marine life (reductions of 13-33% GHGs, 50-70% strike lethality, 40%-80% noise).
- MEPC 80 recommended to adopt mandatory global speed limit of 10 knots for large commercial vessels, conduct stakeholder analysis to determine limits for other vessels, and enable flag and port states to enforce with remote monitoring and fines.

IMAGE: CARGO SHIP ON OCEAN (ROBERT SO / PEXELS)



Infographic alt text: Global Vessel Speed Limit will:

- Reduce underwater noise by 40-80%
- Reduce lethal collision risk to marine animals by 50-70%
- Reduce greenhouse gas emissions by 13-33%

This will help reduce climate change and improve marine animal health and habitats, contributing to Sustainable Development Goals 13 (Climate Action) and 14 (Life Below Water).

CONTEXT

Maritime shipping is a critical component of the global economy. Ninety percent of global trade is transported via fossil-fueled ships (OECD, n.d.), amounting to eleven billion tons yearly (UNCTAD, 2022); however, this comes at a cost of climate change-inducing greenhouse gases (GHGs) and harm to marine animals from collisions and underwater noise pollution. Each of these issues worsens with increasing ship speed. Given the challenges of an industry that is global, risk-averse, locked-in with long-lived capital equipment, and preferential to short payback timescales (Rehmatulla and Smith, 2015), no-regrets, short-term interventions are needed to address the immediate challenges of climate change and marine biodiversity as summarized in SDGs [1] 14 Life Below Water, specifically 14.1 Reduce marine pollution and 14.2 Protect and restore marine ecosystems, and SDG 13 Climate Change (UN Department of Economic and Social Affairs, 2023).

IMAGE: SDG 13 CLIMATE ACTION AND SDG 14 LIFE BELOW WATER ICONS (UN DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, 2023)

IMAGE: GLOBAL SHIPPING ROUTES VISUALIZED ON WORLD MAP (SHIPMAP.ORG)

[1] Sustainable Development Goal

GHG Emissions

While ocean shipping is the most energy efficient transportation (IMO, 2009), it accounts for about 3% of anthropogenic emissions (IMO, 2020). Even though fuel efficiencies are improving, an increase in freight volume is increasing fuel consumption and GHGs (Olmer *et al.*, 2017). Vessel speed is typically 10-20 knots [2] (Figure 1) (Leaper, 2019). While the 2008 financial crisis led to an industry-wide slowdown to save fuel costs, speeds and emissions have been increasing since 2013 despite a temporary reduction during the COVID-19 pandemic (Olmer *et al.*, 2017; UNCTAD, 2022). Slowing speed by 10% (30%) could decrease GHG emissions by 13% (33%), even accounting for adding vessels to maintain total freight capacity (Figure 2) (Faber *et al.*, 2017). Other estimates are more optimistic at 20-40%, but it is widely agreed that speed cuts are one of the most effective and immediate emissions measures (Xing *et al.*, 2020).

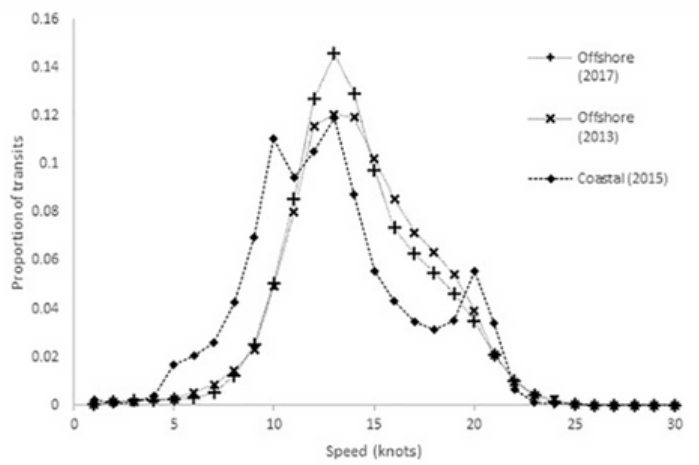


Figure 1: Proportion of transits vs. speed for offshore and coastal traffic sampled from the Indian Ocean and Mediterranean Sea, 2013-17. Vessel speed is typically well above 10 knots (Leaper, 2019).

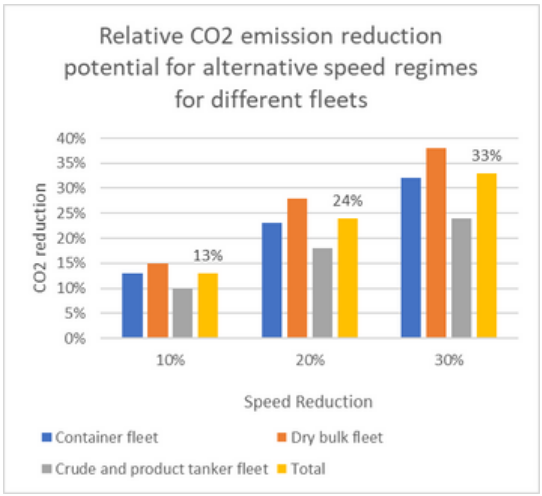


Figure 2: Potential CO2 reduction for the largest (by yearly transport amount) ship types while maintaining total freight capacity (by adding ships) over different speed reductions: 13% for 10% speed, 24% for 20% speed, 33% for 30% speed (Adapted from Faber *et al.*, 2017)

Ship Strikes

Though there are no reliable global estimates, on the U.S. East coast alone, collisions are a cause of one-third of whale deaths and hundreds of sea turtle deaths (NOAA Fisheries, 2022a, 2023). These estimates and the species known to be affected are likely underreported because collisions are often unnoticed (Figure 3). Animal collisions with ships, which sometimes damage ships depending on their size, cause injury and death to wildlife through blunt force and propeller cuts (Schoeman *et al.*, 2020). Ship strikes become more lethal with increasing speed (Vanderlaan and Taggart, 2007; Work *et al.*, 2010). Measures such as automated warning systems, propeller guards, and

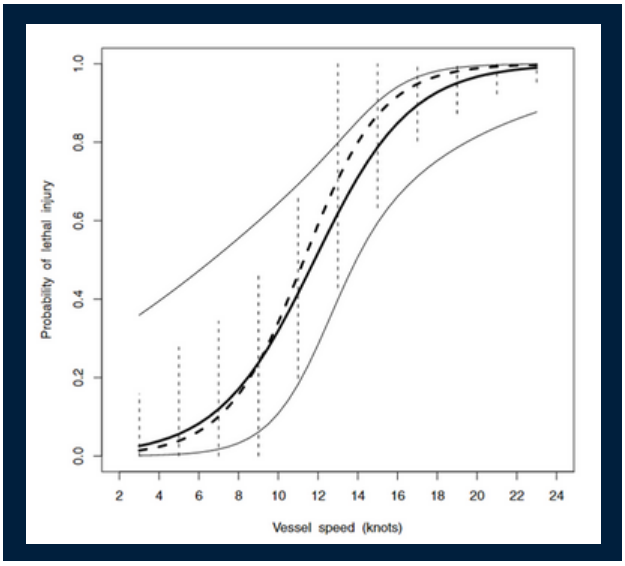
[2] Knot: One nautical mile per hour; 1 nautical mile = 1.85 km (Encyclopaedia Britannica, 2023)

acoustic deterrents have been proposed, but the only proven preventions are separating animals and ships or reducing ship speeds (IWC, 2021; Schoeman *et al.*, 2020). Because there are no hard borders in the ocean and animals have dynamic habitats, separation with designated areas is difficult (Rosenbaum *et al.*, 2014), thus speed controls are needed. A study of ship-whale strikes found a sharp increase in lethality above 8 knots, and collisions 15 knots were generally 100% fatal (Figure 4) (Vanderlaan and Taggart, 2007). Though a slower speed increases travel time and potentially the number of ships, models indicate that the reduced mortality of slower collisions mitigates the increased encounter likelihood. Speeds below 11.8 (10) knots reduce lethality by 50% (70%) (Vanderlaan and Taggart, 2007).

Figure 3: Species known to be affected by ship strikes include whales, dolphins, porpoises, manatees, sharks, seals, sea lions, sea otters, sea turtles, penguins, sturgeon, sunfish. Collisions are usually unnoticed because the animals are much smaller than the ship or the bodies sink below the surface (Schoeman *et al.*, 2020)
Left to right: Manatee (PublicDomainImages / Pixabay), Whale Shark (Lachlan Ross / Pexels), Sturgeon (Igor Kamalev / Pexels), Penguin (Webandi / Pixabay), Whale (Shasin Satuei / Pexels), Bottlenose dolphin (Claudia14 / Pixabay), Sea turtle (12019 / Pixabay)

IMAGE: YACHT SPEEDING ON OPEN WATER (MARIA DOMNINA / PIXABAY)

Figure 4: Logistic regression (solid line) of lethality of ship strike to whale vs. vessel speed. 95% confidence interval in solid thin line. Risk of lethality reduced to < 50% below 11.8 knots (Vanderlaan and Taggart, 2007).



Noise Pollution

Marine noise pollution is a critical and little-understood issue, and shipping is the biggest source of anthropogenic noise in the ocean (Erbe *et al.*, 2019). Noise is transmitted more easily in water than air, and depending on conditions it can travel thousands of miles (NOAA, 2023). The impacts on marine life, both vertebrates and invertebrates, include stress, behavior changes such as leaving foraging habitats, masking communication, or interfering with hunting (Figure 5) (Chahouri *et al.*, 2022; Erbe *et al.*, 2019). Speed and ship design are the most significant factors in determining noise levels (Leaper and Renilson, 2012); due to the long lives of ships and the difficulty of retrofits (Rehmatulla and Smith, 2015), speed limits are the most immediate intervention. The largest component of ship noise is from cavitation [3]; running below the cavitation inception speed, which is typically around 10 knots, decreases noise levels significantly (Leaper and Renilson, 2012). Voluntary speed limits of 10 knots in Vancouver harbor were found to significantly reduce the noise from ships (Figure 6), even though the lower speed causes longer transit times through the study area (Joy *et al.*, 2019; MacGillivray *et al.*, 2019), making speed reduction an effective and immediate tool to lower noise levels. A 10% (30%) speed reduction could decrease global underwater noise levels by 40% (80%) (Leaper, 2019).

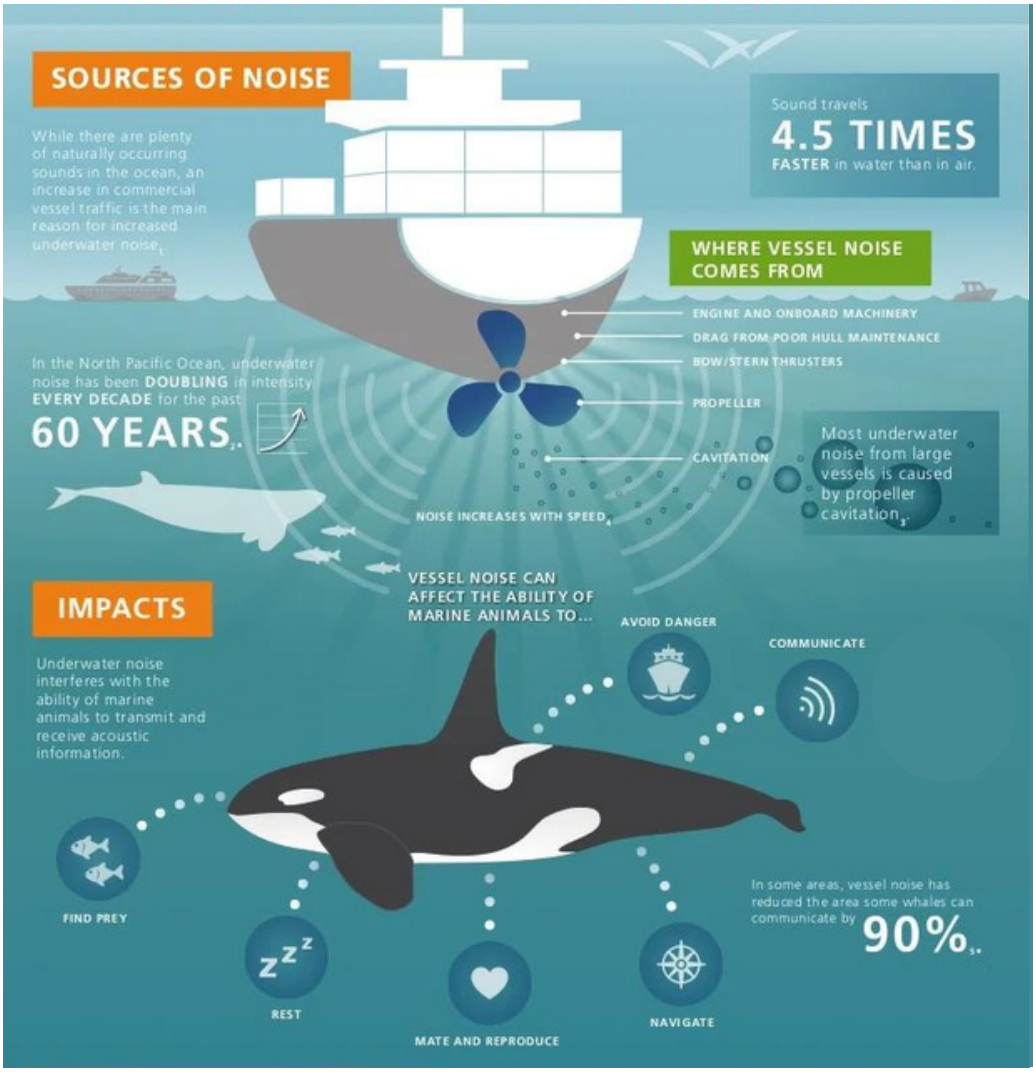


Figure 5: The impacts on marine life include stress, behavior changes such as leaving foraging habitats, spending more time traveling to avoid noise and less time resting or socializing, masking communication, interfering with hunting, disrupting mating, or affecting the health of offspring (Chahouri et al., 2022; Erbe *et al.*, 2019). Image adapted from Port of Vancouver (n.d.)

[3] Cavitation occurs when propellers move so fast that they create bubbles of low pressure that then snap closed (Leaper and Renilson, 2012)

CURRENT REGULATIONS

International Regulations

There is currently no international maritime speed regulation. The Initial IMO GHG Plan of 2018, ratified by 105 parties representing 97% of merchant shipping as an amendment to Annex VI to MARPOL [4] (IMO, 2022), outlines emissions goals and abatement strategies. The Plan aims to reduce total GHG emissions from international shipping by at least 50% by 2050 as compared to 2008. This includes a mandatory Energy Efficiency Design Index for new ships and Ship Energy Efficiency Management Plan for all ships (though execution of the plan is not required) (IMO, 2018). No update to the Plan has included any speed regulation to date despite being proposed in 2019 (IMO, 2022). New rules taking effect in 2023 now include mandatory reporting of fuel consumption and emissions intensity (IMO, 2022); reducing speed is indirectly encouraged as a pathway to decrease emissions intensity. Existing mandatory regulations do not address the impacts of shipping speed on marine life through collisions and noise.

National Regulations

Some speed management areas have been established as a mitigation for ship-whale collisions, such as Hauraki Gulf in New Zealand, the Port of Vancouver in Canada, and various points on the U.S. eastern seaboard (see Box 1) (GL Reynolds Environment and Sustainability Consultant, 2019). These have had some success in reducing noise and lethal ship strikes (Crum *et al.*, 2019; Laist *et al.*, 2014; MacGillivray *et al.*, 2019) tempered by low compliance and limitations in regulated area and vessel type. For example, the compliance with U.S. mandatory seasonal limits of 10 knots was at best 66% and at worst 13% (Pfleger *et al.*, 2021). Voluntary limits were generally ignored, but citations and fines encouraged the most compliance (Ebdon *et al.*, 2020; Freedman *et al.*, 2017; Silber *et al.*, 2014). Versions of 'dynamic' areas are used to create temporary avoidance or slow zones where whales have been spotted, but these are rarely observed: only 15-50% cooperation is achieved in U.S. voluntary slowdown areas (Pfleger *et al.*, 2021), and no ships avoided the temporary zones in New Zealand during one study (Ebdon *et al.*, 2020). One reason for non-compliance cited by mariners was the unpredictable nature of the areas (Ebdon *et al.*, 2020). Small speed limit zones also only work within their borders which discounts the borderless nature of marine life. Further, speeding up and slowing down for protection areas decreases fuel efficiency, which is highest at a constant speed (Faber *et al.*, 2017).

[4] International Convention for the Prevention of Pollution from Ships

Economic Effects

Slower shipping may necessitate an increase in vessels to maintain the volume of transportation which would limit improvements in GHGs, collisions, and noise; however, studies accounting for the increase still project improvements (Faber *et al.*, 2017; Joy *et al.*, 2019; Vanderlaan and Taggart, 2007). Slower journeys may also impact supply chains, but experts estimate that 90% of deep-sea freight is not time-critical, and an increase on an already weeks-long transit could be absorbed (McKinnon, 2016). Another concern is that slowing could cause modal shifts towards road or air transport, causing more emissions; however, large time and cost differences make major shifts unlikely (Rodrigue, 2020). Supply chains were not greatly affected by the 2008 voluntary slowdown (McKinnon, 2016). Additionally, an analysis of U.S. speed rules found no clear evidence of decreased economic activity at affected ports (Industrial Economics Incorporated, 2020). There is also concern that speed limits could impact remote geographical areas (IMO, 2018); however, a hypothetical case study of South American exports found less than a few tenths of a percent impact on exports and a smaller impact on the total economy (Faber *et al.*, 2017). An important concern is that reducing speed too far below ships' design speed could worsen other operational aspects such as incomplete combustion, emissions of other pollutants, and engine vibration (Xing *et al.*, 2020). Thus, the speed limit should be chosen to avoid these inefficiencies.

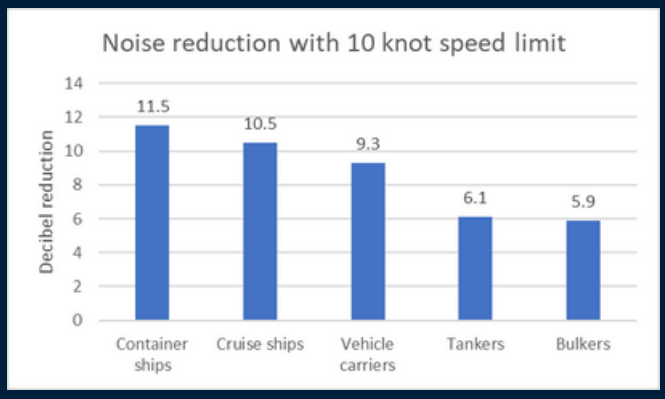


Figure 6: Noise reduction found by MacGivillray (2019) under voluntary 10 knot limit by different vessel types: 11.5 dB for container ship, 10.5 dB for cruise ships, 9.3 dB for vehicle carriers, 6.1 dB for tankers, and 5.9 dB for bulkers.

IMAGE: AERIAL VIEW OF SHIP IN PORT (RAFAEL DE CAMPOS / PEXELS)

IMAGE: AERIAL VIEW OF MOTHER AND BABY GRAY WHALE (IVAN STECKO / PEXELS)

BOX 1: CASE STUDY OF U.S. SEASONAL MANAGEMENT AREAS

North Atlantic Right (NAR) whales are an endangered species with only ~366 individuals left. To reduce deadly ship collisions with them, NOAA [5] established ten seasonal management areas (SMAs) in important NAR whale habitats in 2008 (Figure 7). SMAs have a mandatory speed limit of 10 knots for vessels greater than 65 feet. After implementation, there was some reduction in ship strikes notwithstanding low compliance (Crum et al., 2019; Laist et al., 2014; Silber and Bettridge, 2012). Despite these efforts, in 2017 many NAR whales began dying (92 out of the less than 400 whales alive in 2010), with the top known cause ship collisions (NOAA Fisheries, 2022a), many of which occurred outside of SMAs or with exempted small vessels (National Marine Fisheries Service, 2020). Amendment considered for 2023 include expanding SMAs and including vessels from 35 feet (NOAA Fisheries, 2022a) because incomplete speed regulations did not end collisions. Speed limits must cover all vessels and areas to be effective.

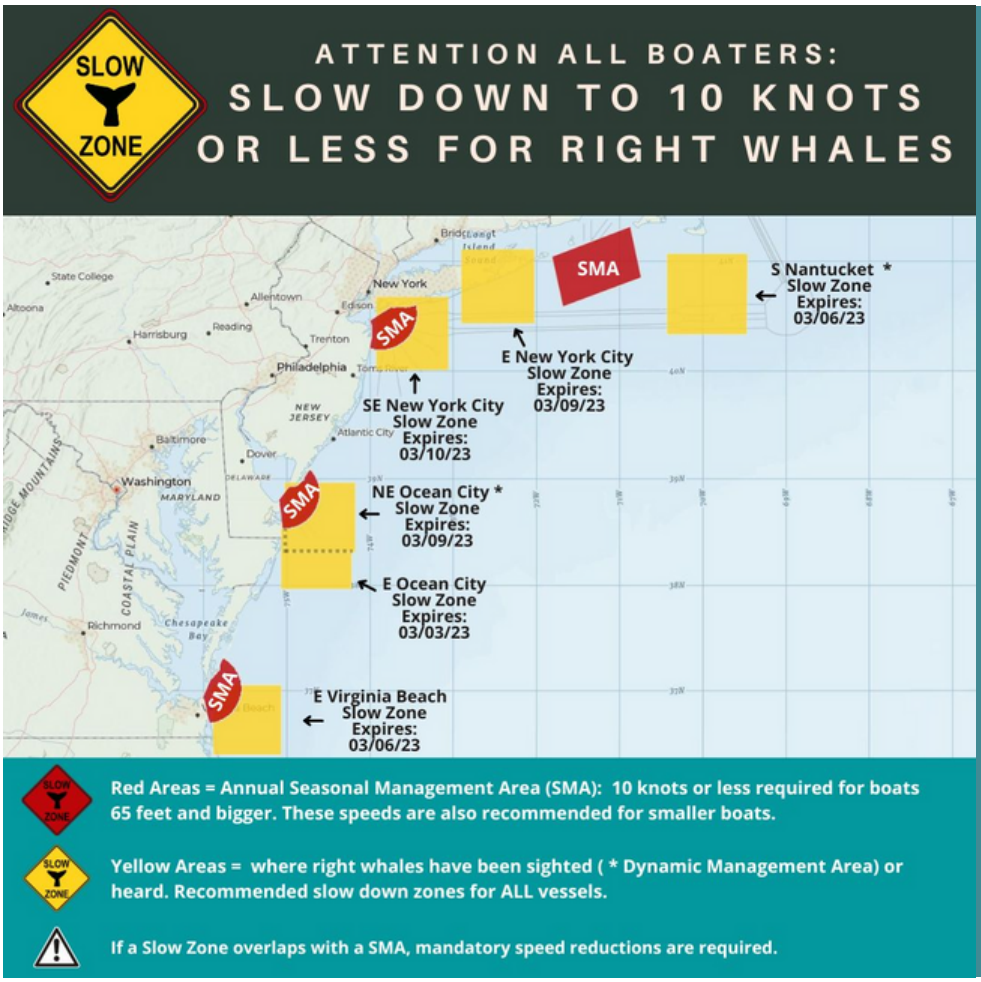


Figure 7: U.S. Seasonal Management Areas and Dynamic Management Areas for the mid-Atlantic area around Nantucket, New York City, Ocean City, and Virginia Beach (NOAA Fisheries, 2023)

[5] National Oceanic and Atmospheric Administration (USA)

POLICY RECOMMENDATIONS

For the IMO GHG Plan

To reduce climate change, marine pollution, and protect ecosystems, the MEPC should:

1. Create a **mandatory global vessel speed limit**. It should be comprehensive due to the global and borderless nature of emissions, noise pollution, and marine life (Leaper, 2019). Exceptions should be limited (e.g., rescues and scientific missions).

2. **Stakeholders should be consulted** to determine speed limits to account for differences in boat designs creating technical issues at extremely low speeds (Faber *et al.*, 2017) while still respecting emissions and marine animal safety (e.g., a zero emissions and noise pollution vessel should still be limited to prevent collisions). **The starting recommendation is ten knots** especially for large merchant ships as below this speed the lethality of collisions and cavitation noise are reduced.

3. The **limit should apply to maximum rather than average speed**, as variable speeds reduce fuel efficiency. A global limit rather than a patchwork of different management areas will also ensure simplicity, consistency, and easier route planning for mariners (Ebdon *et al.*, 2020).

4. As punitive enforcement is the most effective compliance mechanism (Faber *et al.*, 2017; Silber *et al.*, 2014), **fines should be levied** at the same magnitude as port penalty fees for late arrivals to ensure schedules are not prioritized over safety (Pfleger *et al.*, 2021). Individual states must enact laws to ensure that vessels under their flag are obeying international law, and port states also have leverage over ships entering their national waters and harbors (Zwinge, 2010). Both flag and port states may have incentive to enforce limits by collecting fines for infractions. **Enforcement via remote monitoring** is possible through AIS [6], which is already used by some states to apply existing speed limits (NOAA Fisheries, 2022b).

[6] AIS: Automatic Identification System, required by IMO for vessels larger than 300 gross tons and all passenger vessels, and required by most countries on smaller vehicles; transmits vessel identification information, GPS location, heading, and speed via radio signals several times per minute (IMO, n.d.)

FURTHER READING

- *Regulating speed: a short-term measure to reduce maritime GHG emissions* (Faber et al., 2017)
- *The multi-issue mitigation potential of reducing ship speeds* (GL Reynolds Environment and Sustainability Consultant, 2019)

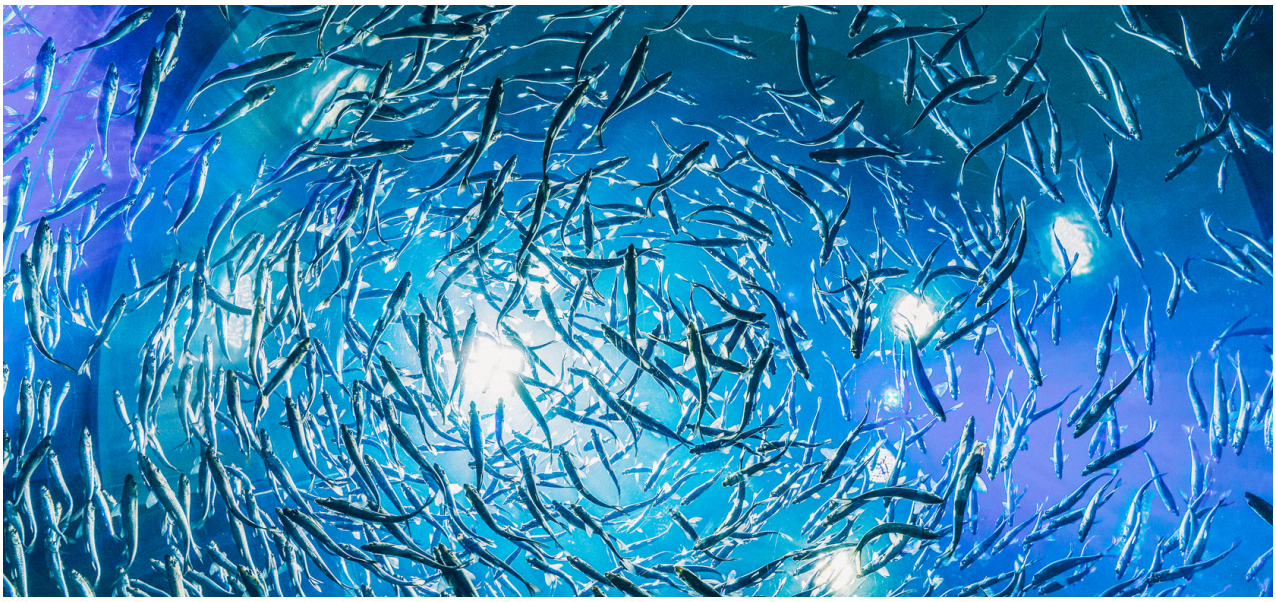


IMAGE: UNDERWATER VIEW OF SCHOOL OF FISH (HARRISON HAINES /PEXELS)

IMAGE: CARGO SHIP PULLED BY TUG BOAT (VICTOR PUENTE / PEXELS)

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