Equal Routes

Charting the Course to a Quiet Ocean

IMO Stakeholder Perspectives and Case Studies on Reducing Underwater Radiated Noise

BY EQUAL ROUTES

Authors and Contributors

Authors:
Breanna Bishop, Equal Routes
Elissama Menezes, Equal Routes
Andrew Dumbrille, Equal Routes

Reviewers:
Jase Hatcher, Friends of the Earth
John Kaltenstein, Friends of the Earth

Contributors:
John Taukäve, Oceania cultural protocol, technical advisor and researcher to Pacific delegations at the IMO. Contributor to the Just and Equitable Transition (JET) chapter.

Creative Design and Copyediting:
Designer: **Alex Hammarstedt**
Prashanna Pokharel, Equal Routes
Rachel Jai-Sho Wang, Equal Routes

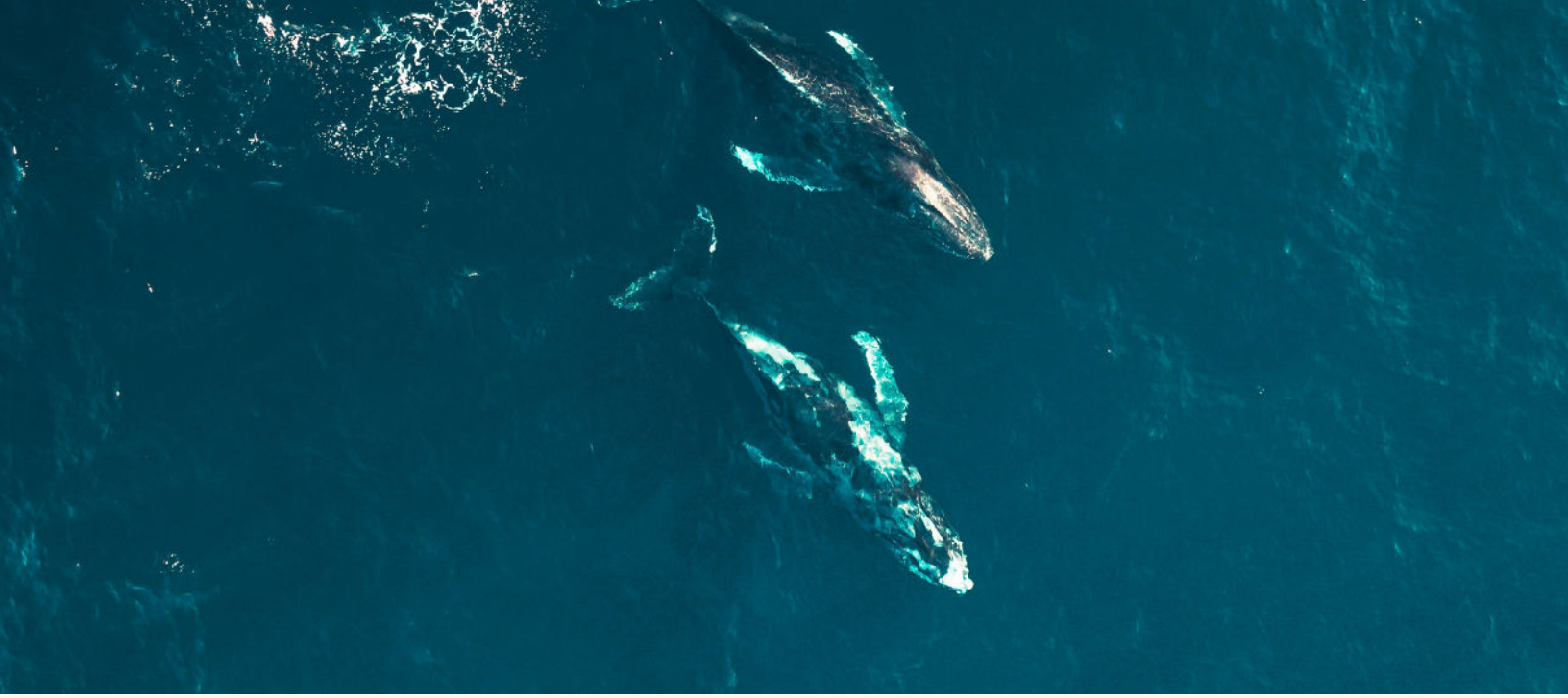
Equal Routes

Equal Routes is an organization working to build a decarbonized maritime industry that focuses on human rights, ocean health, and climate equity.

Acknowledgements:
We would like to thank everyone who contributed to the scoping of this project. We also thank all interview participants and survey respondents for their valuable contributions.

This report was made possible through the generous support of Friends of the Earth. The authors are solely responsible for the content and conclusions, which do not necessarily reflect the views of the funder.

Preferred Citation: Equal Routes. 2026. Charting the Course to a Quiet Ocean. IMO Stakeholder Perspectives and Case Studies on Reducing Underwater Radiated Noise. www.equalroutes.ca/news-resources/urn-report-1



Contents

4 Background

5 Underwater Radiated Noise from Vessels: Sources, Mitigation and Regulatory Landscape

9 Research Methodology

10 Case Study: The Arctic, its Peoples and their Rights

11 Indigenous Peoples

12 Stakeholder Survey and Interviews

14 Opportunities

20 Case Study: Just and Equitable Transition in the South Pacific

25 Challenges

28 Targets for URN Reduction by 2030 and beyond

29 Effective URN reduction requires a whole-system approach

34 Conclusions and Recommendations

36 References

Photo: Photo: Humpbacks in Australia

Background

The global shipping industry is the dominant source of anthropogenic underwater radiated noise (URN) in the world's ocean.[1] URN is a form of pollution that significantly impacts the environment, biodiversity, and people. To fully grasp the consequences of URN from ships, it is crucial to consider the unique environmental features of different geographic regions and the varying noise sensitivities of different species present there. This understanding is especially vital in regions historically characterized by low levels of anthropogenic noise, such as Inuit Nunaat and the Arctic, which are now facing rising shipping traffic.

Although the harmful effects of URN have been acknowledged for decades, management and mitigation of ship-sourced URN remains largely fragmented and sectoral, lacking a single multilateral instrument that regulates all areas and sectors. The transboundary nature of URN pollution requires a coordinated international response that addresses the current regulatory gaps.

In 2014, the International Maritime Organization (IMO) issued guidelines (MEPC.1/Circ.833) to reduce URN from commercial shipping, which was revised in 2023 (MEPC.1/Circ.906) and included supplementary guidance in Inuit Nunaat and the Arctic (MEPC.1/Circ.907). While offering some advice and best practices, the voluntary guidelines do not suggest strict rules or regulations, have been ineffective in achieving meaningful URN reductions to date, and MARPOL has yet to explicitly define URN as a form of pollution.

In 2024, the Sub-Committee on Ship Design and Construction (SDC) agreed on an Action Plan to further prevent and reduce URN from ships. The aim is to minimize the adverse effects of underwater noise on the marine environment, particularly on wildlife and Indigenous communities. The Action Plan outlines a number of tasks to be carried out by Member States through the relevant IMO organs, including initiatives such as:

- Establishing an experience-building phase (EBP) during which Member States and international organizations are invited to share lessons learned and best practices that have emerged in the implementation of the Revised Guidelines

- Developing targets and policies for URN reduction

With the EBP underway, momentum is building toward compulsory URN regulations. This study utilizes targeted interviews with experts actively engaged in URN-related work, alongside a review of available data and relevant case studies to generate insights around how URN reductions can be achieved, particularly around key targets and policy recommendations at the IMO to advance underwater noise reduction by 2030 and beyond.

Underwater Radiated Noise from Vessels: Sources, Mitigation and Regulatory Landscape

Underwater sound is essential for marine life. Because sound travels quickly and efficiently through the ocean, many marine animals have evolved strong auditory abilities and rely on it for information acquisition and exchange. The ocean is filled with natural sounds from living organisms such as whales, dolphins, and fish, as well as from active elements, including wind, waves, ice movement, and underwater volcanic activity. This combination of biotic and abiotic sounds forms a dynamic acoustic environment in which the capacity to produce and detect sound is crucial for the survival of marine species.[2]

Anthropogenic activities, including transiting vessels, have significantly increased ocean noise, transforming coastal and offshore soundscapes. Climate change, driven by ongoing fossil fuel use, is expected to further amplify these effects. Sound speed and propagation is affected by factors such as temperature, salinity, depth, and geographic

characteristics. Under a business as usual (RCP 8.5) climate scenario, global warming is projected to increase sound speed at a global scale and produce regional acoustic hotspots where climate-driven changes are particularly pronounced. This may increase the acoustic ranges of marine species[3], but will also interact with anthropogenic noise sources, including URN from shipping. With sound traveling farther or differently, noise pollution may reach species previously less exposed, intensifying stress on marine fauna.[4] This will be amplified in polar regions, where reduced sea ice leads to more frequent ice break-ups and iceberg calvings, while warming waters may also support increased shipping traffic, collectively contributing to higher levels of both biotic and abiotic noise.[5]

Long before formal scientific measurement, ocean sounds and underwater noise were recognized and deliberately used by Indigenous Peoples, including the pioneering seafarers of the Pacific Islands, who relied on sophisticated knowledge of wind, waves, land-reflected sounds, and navigational chants to guide long-distance ocean voyages[6] (see Case Study: Just and equitable transition in the South Pacific). The roots of underwater acoustics measurement can be traced to the 15th century, when Leonardo da Vinci discovered that placing one end of a tube underwater allowed him to hear the sound of a distant vessel. This simple experiment was later recognized as an early demonstration of how sound could be used to detect ships below the surface.[7] Nearly five centuries later, in 2004, the issue of URN and its impacts in the marine ecosystem was first formally raised at the IMO, with studies suggesting that URN intensity doubles every decade.[8]

Both large and small vessels contribute substantially to anthropogenic ocean noise. Large ocean-going vessels (including container ships, bulk carriers, ferries, cruise ships, and coastal freighters) are the main sources of low-frequency URN, which travels long distances and is widely used by marine species for communication and navigation. Smaller vessels, such as fishing boats, pleasure craft, and tourism vessels (excluding cruise ships), are also significant contributors, particularly in coastal regions. Some small vessels, such as tugs, can produce noise levels comparable to large ships, while the combined effect of numerous tourism and recreational vessels in shallow waters can further elevate local URN levels.[9]

URN from a vessel is categorized into three main components: machinery noise, propeller[i] and flow noise, and cavitation (from pumps) (Figure I). The relative contribution of each component varies between vessels and is strongly influenced by operating speed. At lower speeds, machinery noise typically dominates a vessel's URN signature, whereas at higher speeds, cavitation becomes the primary source.[10]

Mitigation measures to reduce URN from vessels generally fall into two categories: technical and operational strategies (Table I). Technical measures involve improvements to hull, propeller, and machinery design or modification, as well as optimization of wake flow. Operational measures encompass maintenance practices, operational adjustments, and speed management to minimize noise generation. Both new and existing ships can benefit from these URN reduction measures.

i Vessel propellers generate different types of hydrodynamic noise depending on operating conditions. This propeller-induced noise is typically classified as either cavitating, resulting from the formation and collapse of air bubbles, or non-cavitating, arising from water displacement and pressure fluctuations around the propeller blades.

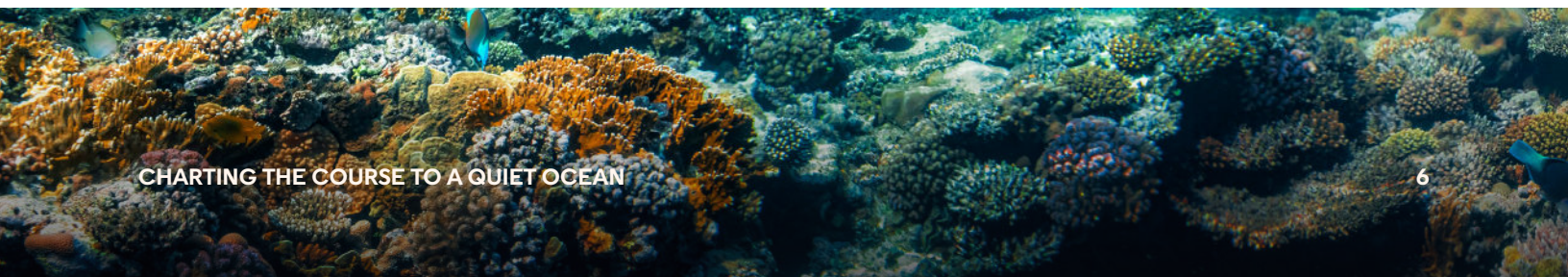
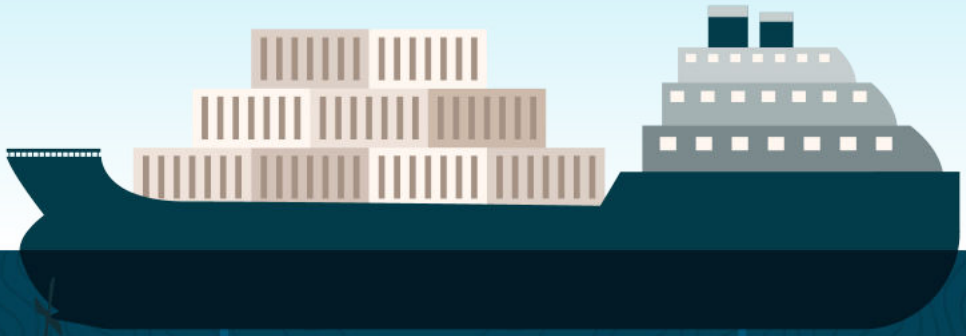


Figure I — Sources of URN from a vessel and the potential measures to address them



Propeller

TECHNICAL MEASURES

- Hull design and modification

OPERATIONAL MEASURES

- Propeller polishing and hull cleaning and coating

Rotating machinery

TECHNICAL MEASURES

- Machinery design and modifications

OPERATIONAL MEASURES

- Regular maintenance

Hull vibration

MEASURES

- Optimization of scantling, application of a decoupling coating, and structural damping.

Cavitation

TECHNICAL MEASURES

- Wake flow improvement

OPERATIONAL MEASURES

- Trim and draught optimization

Open pipes

TECHNICAL MEASURES

- Acoustic silencers (early stages of R&D)

Flow noise

TECHNICAL MEASURES

- Wake flow improvement

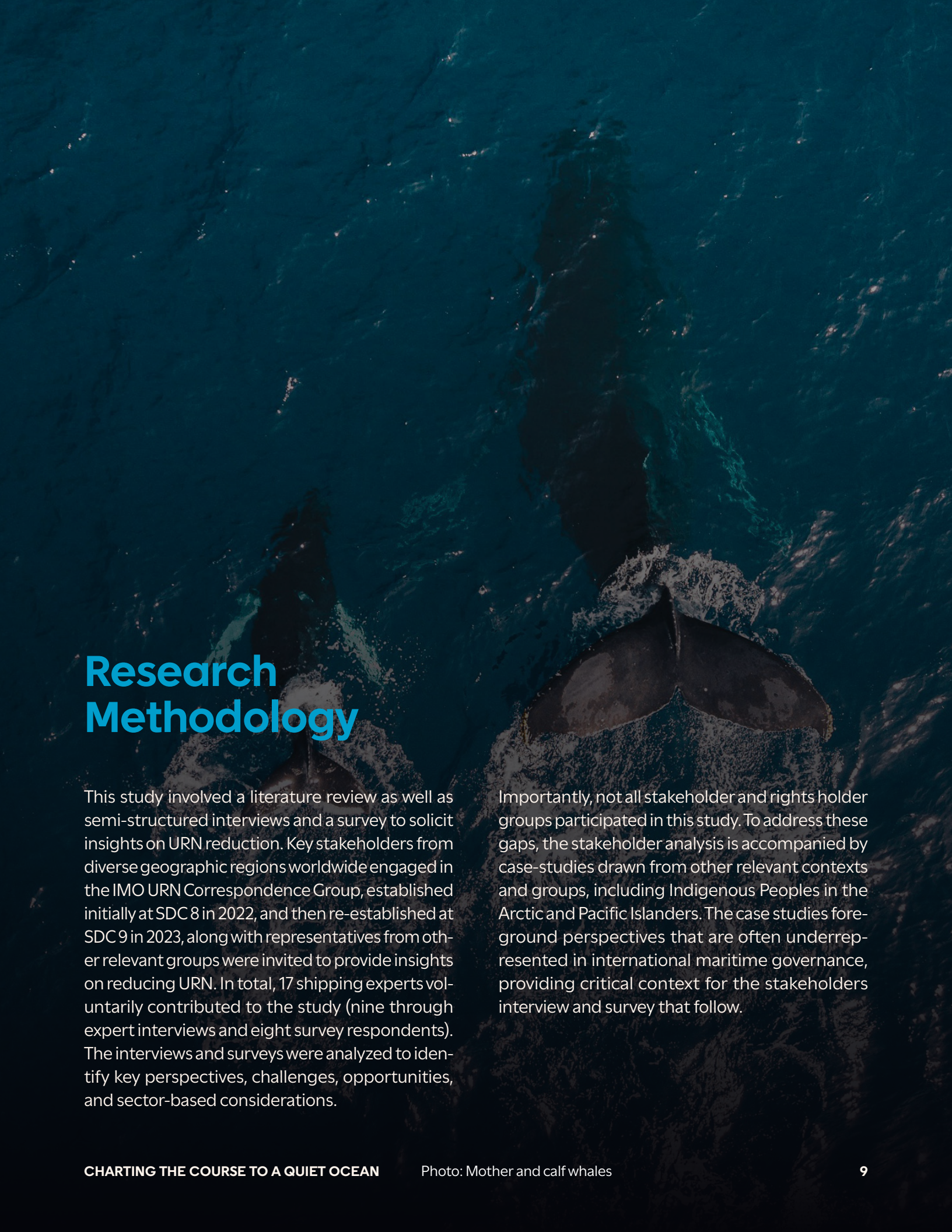
Maximizing the potential for URN reduction requires a tailored combination of technical and operational measures, taking into account vessel type, operating profile, location, available capital, and vessel age. Technical measures generally provide long-term noise reduction benefits, while operational and maintenance approaches can deliver near-term, often low-cost or cost-effective improvements. In addition to mitigating URN, these measures can yield important co-benefits such as reductions in greenhouse gas (GHG) emissions and air pollution, as well as fuel savings, though some trade-offs[11] may occur, for example between propeller design and propulsion efficiency.

The IMO is the global regulator for international shipping. Its regulations under MARPOL (International Convention for the Prevention of Pollution from Ships), first adopted in 1973, are meant to protect the marine environment and reduce pollution from acute and chronic accidents and operations from vessels. MARPOL, with its six Annexes, while providing a framework and specific rules related to air emissions, oil spills, noxious and harmful substances, sewage, and garbage does not directly regulate URN. As evidence started to mount on the effects and impacts of URN on marine species and habitats, and because of the lack of regulatory attention to the issue, the IMO adopted voluntary guidelines for the reduction of URN in 2014, revised them in 2023, and approved the dissemination of an MEPC circular on guidelines for URN reduction in Inuit Nunaat and the Arctic, developed by the Inuit Circumpolar Council (ICC) (see Arctic Case Study below). To date there is little evidence that the revised guidance from the IMO is being utilized by shipping operators.[12]

Although the IMO's Experience Building Phase and Action Plan associated with the revision of the URN guidelines are intended to quantify progress and encourage piloting of measures, it remains unclear how the guidelines are contributing to progress. Generally, if an issue isn't regulated within MARPOL or has its own mandatory framework, it isn't prioritized for implementation amongst regulators or operators. Despite the regulatory gaps and limited industry uptake of the guidance, there are regional and other under-utilized IMO tools that can contribute to progress on URN reduction.

As the shipping sector continues to explore technical, operational, and regulatory approaches to URN mitigation, stakeholders and rights holders[ii] have highlighted a range of opportunities and constraints that influence the viability of different measures. It is important to consider how different groups evaluate trade-offs, prioritize potential interventions, and envision pathways for meaningful URN reduction across local, regional, and global contexts. To address this gap and inform ongoing policy discussions, the study gathered targeted input from experts actively engaged in URN-related work, alongside a review of available data and relevant case studies.

ii Indigenous Peoples are rights holders (not stakeholders) by virtue of their pre-existing sovereignty, continuous occupation, and distinct cultures, possessing inherent rights to land, self-determination, and self-government. Governments and other actors (duty-bearers) are obligated to respect, protect, and fulfill these rights, which have been enshrined into international law through the Indigenous and Tribal Peoples Convention, 1989 (No. 169), Adopted on 27 June 1989 by the General Conference of the International Labour Organisation at its seventy-sixth session. Entry into force: 5 September 1991; United Nations Declaration on the Rights of Indigenous Peoples, Resolution adopted by the General Assembly on 13 September 2007; and the Report of the Special Rapporteur on the rights of Indigenous Peoples, José Francisco Calí Tzay, Protected areas and indigenous peoples' rights: the obligations of States and international organizations (A/77/238).



Research Methodology

This study involved a literature review as well as semi-structured interviews and a survey to solicit insights on URN reduction. Key stakeholders from diverse geographic regions worldwide engaged in the IMO URN Correspondence Group, established initially at SDC 8 in 2022, and then re-established at SDC 9 in 2023, along with representatives from other relevant groups were invited to provide insights on reducing URN. In total, 17 shipping experts voluntarily contributed to the study (nine through expert interviews and eight survey respondents). The interviews and surveys were analyzed to identify key perspectives, challenges, opportunities, and sector-based considerations.

Importantly, not all stakeholder and rights holder groups participated in this study. To address these gaps, the stakeholder analysis is accompanied by case-studies drawn from other relevant contexts and groups, including Indigenous Peoples in the Arctic and Pacific Islanders. The case studies foreground perspectives that are often underrepresented in international maritime governance, providing critical context for the stakeholders interview and survey that follow.

CASE STUDY:

The Arctic, its Peoples and their Rights

It is widely recognized that the Arctic is under significant threat from the effects of the climate crisis,[13] and from industrial development brought on by those effects. As those industrial activities increase, they directly contribute and amplify the effects of the climate crisis. For instance, diminishing sea ice due to warming trends caused by global GHG emissions is opening up Arctic shipping lanes and increasing maritime traffic,[14] which in turn contributes to further reductions in snow and sea ice from localised black carbon emissions from ship exhaust.[15] This contributes to a dangerous feedback effect, which if not mitigated, disproportionately threatens the rights, livelihoods, and cultural heritage of local communities, along with the ecosystems they depend on.

URN in the Arctic is of particular concern, not only because it is increasing due to heightened levels of ship traffic over the past decade,[16] but because of its potential pronounced impact on marine life accustomed to an acoustic environment previously characterized by low levels of anthropogenic noise. Bathymetry, cold temperatures, and native wildlife adapted to a historically quiet environment in the Arctic, mean that the harmful impacts of URN are intensified in the region.[17]

This reality led the IMO, in October 2023, to circulate the Guidelines for underwater radiated noise reduction in Inuit Nunaat and the Arctic (MEPC.1/Circ.907). These Guidelines were developed by the Inuit Circumpolar Council (ICC) to provide additional information and guidance to shipping operators who transit Inuit Nunaat and the Arctic, to enable the engagement of Inuit and other Indigenous communities, and to utilize Indigenous Knowledge in effectively reducing URN from commercial shipping. The Guidelines also address the adverse impacts of URN on marine life and food security in Inuit Nunaat and Arctic.

Photo: Inuit indigenous village, fishermen, Uummannaq, Greenland

Indigenous Peoples

Indigenous Peoples are rights holders, which are defined as individuals or social groups that hold recognized and affirmed rights. This has been guaranteed through the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), a non-binding declaration adopted by a resolution of the United Nations General Assembly. The UNDRIP affirms that Indigenous Peoples have the right to maintain, control, protect and develop their culture and traditional knowledge. Specifically, Indigenous peoples have the right to the lands, territories, waters and coastal seas and other resources which they have traditionally owned, occupied, or otherwise used or acquired (Articles 25 and 26), including the right to maintain, protect, develop, and access historical and cultural sites (Articles 11 and 12). The Arctic is made up of historical and cultural sites spanning the land, water, and ice for Indigenous Peoples.

Article 18 of UNDRIP states that "Indigenous Peoples have the right to participate in decision-making in matters which would affect their rights [...]". In accordance with Article 41 of UNDRIP, "the organs and specialized agencies of the United Nations system and other intergovernmental organizations shall contribute to the full realization of the provisions of this Declaration through the mobilization, inter alia, of financial cooperation and technical assistance. Ways and means of ensuring participation of Indigenous peoples on issues affecting them shall be established". UNDRIP cannot be realized without Indigenous Peoples' full, meaningful representation and participation in decision-making processes at all levels affecting their territories, governance, and families, including shipping.

These provisions support Indigenous Peoples engaging in governance of Arctic shipping.[18] Whether or not UNDRIP has been enshrined into law in the related states of each Indigenous territory, the spirit and intent of these articles provide a strong impetus to ensure that Indigenous Peoples are included in decision making related to governance of URN. For example, Inuit Nunaat has been home to Inuit for centuries. Inuit communities are located along the coasts of the Northwest Passage and the Northeast Passage/Northern Sea Route. Shipping is essential in supplying fuel, equipment, and other goods and services to many of these communities which are not accessible by road. At the same time, the impacts of shipping are also a threat to Inuit communities who depend on the sea for livelihoods and food.[19] For example, Narwhal are an important species for subsistence hunting, and are also highly sensitive to vessel sound, and they stop calling or move away from approaching vessels when they hear them.[20] Inuit also use ocean noises to assess potentially threatening conditions that can arise while traveling on the ocean and ice,[21] underscoring the diversity of values and practices tied to Arctic ocean soundscapes.

Because shipping is vital to many Indigenous communities in the Arctic and poses risks to the marine species and ecosystems on which those communities depend, decisions about shipping in these regions cannot be framed as a simple trade-off. These circumstances make clear that Indigenous leadership is essential to the legitimate and effective governance of Arctic shipping, ensuring that URN is understood, governed, and ultimately reduced in ways that support necessary marine transportation while safeguarding marine ecosystems, food security, and Inuit ways of life.

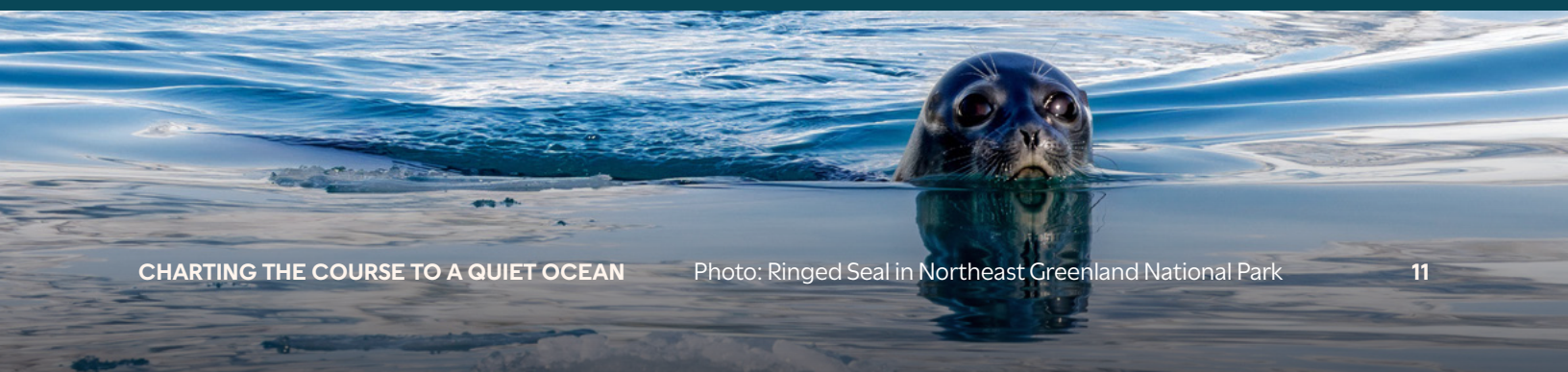


Photo: Ringed Seal in Northeast Greenland National Park

Stakeholder Survey and Interviews

The analysis now turns to a broad set of perspectives from stakeholders engaged in URN discussions at the IMO, examining how URN is understood and addressed within international maritime governance and how effective approaches might address a spectrum of viewpoints. Where appropriate, insights from the literature review are drawn upon to situate these stakeholder perspectives within a broader governance and policy context.

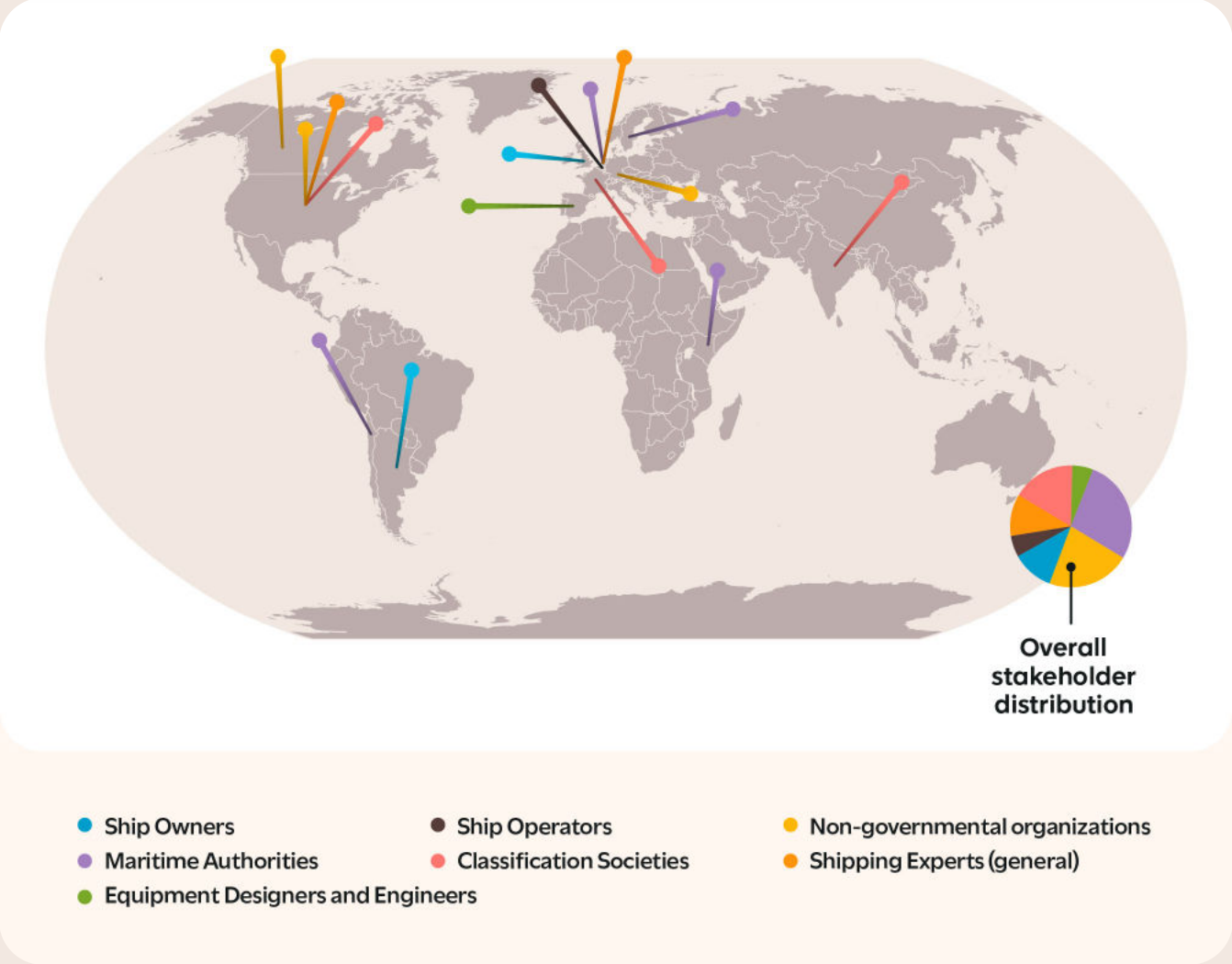
Representatives from maritime authorities, ship owners, ship operators, engineers and designers, classification societies, and non-governmental organizations contributed to either a survey or an interview to share their insights on achieving meaningful URN reduction (Figure II). These groups included perspectives from around the world, including Argentina, Belgium, Canada, Chile, France, Germany, India, Kenya, Netherlands, Spain, Sweden, UK, and USA (Figure II).

It is important to note key contextual considerations and limitations relevant to the interpretation of the findings. Many of the opinions expressed by participants reflect their individual technical approaches and professional experiences, and may or may not represent the official positions of their institutions. A key limitation of this work is that not all stakeholder and rights holder groups participated in a survey or interviews. Notably absent from this analysis are perspectives from representatives of the IMO Secretariat, shipyards and ship-breaking

facilities, banks and investors, Indigenous Peoples, and port and coastal communities, among others. Where possible, additional context has been drawn from the literature and case studies to address these gaps. These considerations should be taken into account when interpreting the results and identifying priorities for future engagement.

The majority of groups engaged through this study recognized that compulsory URN regulations are likely to be established, and while some favor mandatory measures over others, all recognized that harmonizing work on URN with decarbonization, energy efficiency, and biofouling is a critical path to accomplish meaningful URN reduction without significant financial and logistical burden. There are, however, diverging perspectives on the pathways and timing to accomplishing this. Naturally, different groups are considering different responsibilities with regards to URN reduction, including key opportunities and challenges that need to be considered.

Figure II — Stakeholder groups and country-affiliation engaged through surveys and interviews



Opportunities

Unlocking co-benefits

While addressing URN reduction is a complex endeavor, there is substantial momentum to make meaningful advances, even before mandatory regulations are implemented. Stakeholders emphasised that this can be achieved by aligning underwater noise reduction with efforts to address decarbonization, energy efficiency, and biofouling. Importantly, approaching these issues in a balanced yet integrated manner can bring about financial benefits for shipowners. At the same time, some stakeholders also highlighted the need to be cautious with how we position co-benefits so as to not lose URN within these other efforts. In particular, the IMO's current emphasis on the broader economic and geopolitical dimensions of decarbonization risks drawing attention away from underwater noise. Yet, as one stakeholder pointed out, decisions on fuel taxes and regulatory frameworks will directly influence which short-term operational measures such as speed reduction or rerouting can realistically be implemented to mitigate underwater noise.

> "We need to be sure that the work we do on underwater radiated noise is harmonized with the work being done at IMO and globally on energy efficiency and decarbonization. [...] If we can harmonize the two and get a win-win situation, then that's the best way to move forward."
>
> – **Lee Kindberg,** Starcrest Consulting

> "Symbiotic solutions between energy efficiency and underwater noise are super important, because that's the financial incentive that ship owners like and that they would be willing to do [before] mandatory measures."
>
> – **Maritime Policy Officer,** Netherlands

Stakeholders also highlighted the co-benefits that can be accomplished through operating vessels at 75% of their maximum design speed (typically requiring only a 5–10% average slowdown). This was highlighted as a practical step with multiple benefits. Reduced speeds can lower the risk of whale strikes, decrease underwater noise, cut GHG emissions, and help the shipping industry save on fuel.

Current proposals at the IMO increasingly point toward a shipping nexus (MEPC 82/7/10) approach that places biodiversity and pollution concerns on a level of urgency comparable to climate action. Under this framing, biodiversity protection and pollution prevention are treated as integral components of effective climate strategies and are grounded in principles of a just and equitable transition. This direction is further reflected in the new output set out in the development of a legally binding framework for the control and management of ships biofouling which calls for measures to account for implications of air pollution, GHGs and URN - a promising first step to ensure URN is integrated, and not an afterthought, in the development of the new legally binding framework. Using an integrated lens to assess biofouling in relation to not only URN reduction but to GHG emissions, and energy efficiency, will ensure these

companion issues are taken into account when making regulatory and fleet investment decisions to maximize overall benefits. Unmanaged fouling significantly increases drag, fuel consumption, and GHG emissions, while also exacerbating the spread of invasive aquatic species.

Revision of the IMOs Carbon Intensity Indicator (CII) also holds promise for URN reduction. In November 2022 amendments came into effect to MARPOL Annex VI which mandated ships, as of January 2023, to measure their energy efficiency and to report it against the CII framework. The CII framework sets targets to increase energy efficiency, contributing to the IMO goals for reducing GHG emissions, including an at least 40% reduction of GHG emissions by 2030, compared to 2008 levels. A first phase of the CII review was completed and is up for adoption at MEPC 84. A second crucial phase will take place in 2026-2027 with the opportunity to review the energy efficiency targets for the coming years, focus the CII more on energy efficiency than carbon intensity (important for URN) and put in place a more robust mechanism of enforcement. In this second review phase integrating specific linkages to URN reduction will ensure co-benefits are realized between the two agendas[22], and any new investments from ship owners will take into account and feed progress for both URN reduction and energy efficiency improvements.

Together, these developments signal growing political momentum within the IMO for co-benefit approaches that address URN alongside decarbonization and other environmental priorities.

Focusing on quick operational wins with a regional approach

Several stakeholders suggested that the most immediate operational scenarios for reducing URN is likely to be simple to implement, particularly at a local or regional scale. They noted that modest speed reductions near sensitive areas, such as marine sanctuaries and protected areas, can be both efficient and feasible without significantly affecting trade or broader operational constraints. Such regional measures are therefore seen as easy to adopt while delivering meaningful, locally targeted URN reductions. One stakeholder observed that while some vessels may be equipped with technology for real-time measurements to inform slow steam speeds, another approach could be to utilize a vessels' cavitation inception speed, and set targets to sail below that threshold in certain areas. Several stakeholders noted that tools such as Particularly Sensitive Sea Areas (see below) could be utilized to complement national requirements for operational measures. Some also expressed the importance of considering any socioeconomic and safety of navigation considerations with regards to operational measures.

> "Open up for regional, specific speed reduction in sensitive marine areas and a swift and transparent process to enable these, where appropriate. Technical measures are unlikely to have a regionally significant effect [in the near-term] in areas like the Baltic sea, where the fleet renewal rate is 40-50 years on average."
>
> **– Survey Respondent,** Swedish Maritime Authority

> "Whenever a URN target is being established, the target should consider characteristics of the region. For example, India falls under tropical waters, and the sound propagation of tropical waters is different. We have a warmer top layer and below sub layer and an in between thermal layer, and how the sound propagates in these layers is different."
>
> **– Akula Chaturvedi,** Indian Ministry of Shipping

Because noise impacts vary by geography, depth, and species, stakeholders called for strategies tailored to vessel-, fleet-, and region-level differences. This approach could accelerate progress in the near-term while working towards mid- and long-term reductions. Importantly, while regional measures have the potential to provide short-term wins, they are unlikely to be sufficient for achieving long-term, global reductions in URN (see Table II).

Over time, region-specific regulations may introduce fragmentation, increased complexity, and potentially conflicting requirements, which could disrupt operations and increase costs, uncertainty, and distortions of policy objectives. Ship owners and operators have noted the significant challenges posed by patchwork regulations that address the same environmental issue in different ways, for example with regulations around scrubber systems.[23] That said, ambitious regional measures can play a critical role in shaping international mechanisms. A globally coordinated approach, grounded in mandatory international regulations, can ensure harmonization, consistency, and sustainable enforcement of URN reduction measures. Therefore, a combined pathway - leveraging near-term, regionally tailored operational measures alongside long-term international regulatory frameworks - could offer the most comprehensive and sustainable strategy for effective URN reduction.

Leveraging technological readiness

Significant progress has been made in the development of low-URN technology for vessels. A stakeholder highlighted that propeller designers and engineering companies are increasingly able to integrate URN reduction into vessel design specifications. While such considerations were previously overlooked due to additional costs and limited demand, improvements in methodologies and tools now provide ship owners with greater confidence to request quieter designs. In addition, stakeholders noted that real-time vessel-mounted monitoring technologies have become more widely available, enabling ship operators to make informed operational decisions. One stakeholder emphasized that their current vessel-mounted cavitation detection technology has been developed with future URN regulations in mind. Together, these advancements indicate growing technological readiness within the industry, positioning it to achieve meaningful URN reductions through design innovation matched to future policy and regulatory standards.

> "I have observed a lot of progress on the methodology and the readiness of propeller designers and also engineering companies to consider as part of the project design constraints for low underwater noise of the ship. A couple of years ago, URN was not specified in the contracts but appeared to be an additional performance to be confirmed out of any contractual discussion between the yard, the owner and the class. Adding to the context the non-mandatory aspect of the URN-related regulation, the uptake was very low from all stakeholders. At this day, owners are more and more demanding in the new building specs to match with URN targets, such as class limits, and many more yards, often associated with skilled engineering companies, are on deck to reach these objectives."
>
> **– Eric Baudin,** Bureau Veritas

Indigenous communities have long monitored their traditional territories, and are combining traditional knowledge with modern monitoring technologies to lead URN monitoring programs. In coastal British Columbia, Canada, the Snuneymuxw First Nation is implementing such a program to monitor vessel noise and protect whale and salmon habitat,[24] demonstrating how community-led initiatives can complement technological advance-

ments in vessel design and real-time monitoring, and ensure that URN reduction strategies are both ecologically effective and culturally grounded. These efforts also highlight the importance of equity in URN governance, recognizing Indigenous rights, knowledge systems, and decision-making authority in shaping policies and actions that affect their traditional territories and marine ecosystems.

Increasing awareness

Stakeholders frequently highlighted the importance of raising awareness around URN and its impacts, noting that progress has been particularly visible within the IMO through discussions such as the URN/EE workshops (2023 and 2025) which align with advancements in research and technology. A key challenge, however, is ensuring state policy-makers have access to up-to-date evidence and guidance. In the absence of robust data, state recognition, or binding international regulations, stakeholders have limited incentives to adopt voluntary URN reduction measures, especially when implementation involves additional costs. Strengthening knowledge exchange initiatives, linking local and international efforts, and improving access to scientific data were noted by some stakeholders as critical for translating awareness into concrete actions to reduce URN. Stakeholders noted the importance of research, improved cross-program communication, independently verified data, and strong alignment with related initiatives (such as energy-efficiency programs). These efforts are essential for establishing clear, numeric reduction targets.

> "When new technologies come to the market we need to be able to determine the URN and energy impacts as well the operational performance. The assessments need to be readily available, economical and reliable. Ideally data and results would come from or be verified by an impartial source to avoid commercial bias."
>
> **– Lee Kindberg,** Starcrest Consulting

Over the past two decades, research and reporting on the impacts of URN have increased considerably[25], strengthening the evidence base available to decision-makers and providing clearer guidance on potential reduction measures (see URN

Sources and Mitigation Measures). While data availability and data-sharing mechanisms continue to evolve, possible gaps in scientific consensus should not postpone the adoption of cost-effective measures to prevent environmental degradation (MEPC.67(37)).

Aligning efforts with international commitments

The Biodiversity Beyond National Jurisdiction (BBNJ) agreement creates a major opportunity to link URN reduction with new high-seas protections. Regional initiatives such as Marine Protected Area (MPA) networks could help safeguard migratory species by aligning URN reduction measures with broader biodiversity protection. Coordinated measures across jurisdictions as well as utilizing IMO tools like Particularly Sensitive Sea Areas (PSSAs), could help harmonize shipping practices along shared migratory routes. One stakeholder noted that this will require multi-jurisdictional, multi-scale coordination required to create a common roadmap for shipping measures, as opposed to having to change compliance depending on each jurisdiction.

> "Now, the biggest opportunity [...] goes to what is going on with the ocean on a broader spectrum - let's say with the BBNJ Agreement that is going to regulate biodiversity beyond national jurisdictions. That has had a strong focus on marine protected areas and how to regulate them. [...] We could link everything that is already regulatory on the shipping industry as a coastal state or flag states, also on international space for some specific maritime protected areas that might be on the high seas."
>
> **– Manuel Fuenzalida,** Chilean Maritime Authority

In 2005 the IMO adopted guidelines for the establishment of PSSAs as an area based management tool designed to reduce the impact from shipping on the marine environment. Through specific Associated Protective Measures (APMs) such as routing, speed, and discharge restrictions, the PSSA limits harmful consequences from ships transiting in a defined ocean area. Because of the lack of regulatory framework for URN reduction, and MARPOL staying silent in this regard, the guidelines governing PSSAs don't allow an APM to be implemented explicitly for URN reduction. The PSSA guidelines only allow for APMs which have a foundation in IMO regulation. However, speed reductions are an accepted operational measure within the context of APM establishment due to their role in safe navigation, and they are widely accepted as an operational measure to reduce URN. Additionally, routing to avoid URN exposure to marine habitats is also an accepted APM. Until URN is codified within regulation, these two operational measures can be used to reduce its impact within the context of PSSA designation.

The Arctic and Inuit Nunaat illustrate the strategic and intersectional value of PSSAs, and their potential application to address URN. Sensitive ecosystems throughout Indigenous homelands are being increasingly exposed to Arctic navigation and impacts of URN as climate change accelerates the seasonal retreat of sea ice. A PSSA designation for key Arctic areas, such as parts of the Northwest Passage or the Northern Sea Route, could enable targeted measures like mandatory routing, Areas To Be Avoided (ATBA), speed restrictions, and enhanced monitoring, whilst a PSSA designation for the Central Arctic Ocean (CAO) could provide it with an ATBA classification, which would rule out trans-shipping across this vulnerable ice-reef environment.[26] The Great Barrier Reef PSSA[27, 28] demonstrates how crucial the expertise and active management of traditional rights holders are to ensuring maritime safety and preserving biodiversity.[29]

Learning from other success cases

Stakeholders also described other sectors where noise reduction has been successfully implemented and highlighted these as important reference points for the direction in which URN measures can evolve. The progress made in the aviation sector demonstrates that industry-wide quieting is both logistically and financially possible while delivering local, regional, and global benefits.

> "[Mandatory measures and URN reduction] is what, in general, I think will happen in the end. [Overall,] the most noisy ships will be [increasingly] less welcome in ports, so they will be phased out in that way. We saw the same thing happen in aviation - noisy airplanes are now almost not welcome, at least in major airports, and the most noisy planes are no longer accepted. So I think, [...] that shipping [will follow a similar path]."
>
> **– Niels Kinnening,** Shipping Expert

Increasingly, ocean rights are being recognized and enshrined into laws and policies worldwide. Many initiatives have emerged from the efforts of Indigenous Peoples and local communities. For example, in 2024, Indigenous leaders across several Pacific island nations signed the He Whakaputanga Moana (Declaration for the Ocean). The declaration recognizes whales as legal persons with inherent rights, including the right to freedom of movement, a healthy environment, and the ability to thrive alongside humanity.[30] In Linhares, Brazil, part of the ocean was granted legal personhood for the first time in 2024. The municipality passed a law that gives waves at the mouth of the Doce River the intrinsic right to existence, regeneration, and restoration, requiring the city to protect the physical shape of the river, the ecological cycles that make the waves unique, and the chemical makeup of the water. It also codifies respect for the waves' cultural and economic role in the community.[31] These cases demonstrate how locally and regionally led legislative and governance innovations can reshape norms, expectations, and regulatory approaches to generate powerful precedents for how URN reduction could be advanced through place-based leadership, rights-based frameworks.

Photo: Two Humpback whales

John Taukäve is a Rotuman and Fijian artist, researcher and advocate, whose work bridges culture and climate leadership. He works as an Oceania cultural protocol, technical advisor and researcher to Pacific delegations at the International Maritime Organization. John brings lived experiences of Pacific Island communities, descendants of the world's most advanced ocean voyagers, into IMO negotiations.

CASE STUDY:

Just and Equitable Transition in the South Pacific

by John Taukäve

There are so many different ways in which we interpret the word "sound" and the sea. There are different sounds that are connected with the sea. The wind, for instance, generates sound when it blows over the sea; and its direction and origin inform where we will fish, the direction of our voyage. How we feel and hear the wind coming through the ocean tells us its trajectory, where it has been, and what kind of message it carries - wind from the North is good. Because sound is such a central part of how we relate to the sea, any new sound enters a world already full of meaning.

It is a two-way relationship, as we also use sounds to communicate back to the sea. We have this very powerful chant called Fäg (pronounced as fang) that when we sing, things happen, the ocean responds back. We have a story about a white turtle in the sea, and when we chant a Fäg the turtle appears for a brief moment in a very specific spot on the island.

For us, sound and words are very powerful – when we speak, we want it to be right. That is why we do more listening. And that is also how we can hear the sound of the sea and the spiritual connections we hold with it. This is why changes in the ocean soundscape affect us deeply – not just environmentally, but culturally and spiritually.

Ships as lifelines, gathering spaces, and sound-makers

The western view sometimes fails to capture the full symbolism of a ship. In my island, Rotuma, Fiji, a vessel is a lifeline. It brings supplies and loved ones. Just like before, when the Pacific Islanders had their canoes and went on voyages, the whole island would gather to welcome the visitors. It has evolved to how we see the ships now – a different time but same concept: the sound of a vessel arriving signals a gathering in the community for everyone to come together to the port and share stories about what is happening overseas, to meet family members who were away.

Ships are perceived mostly by their impacts – rightfully so – but they are also important for communities to get the supplies they need to build their homes or to create adaptation for our communities facing the impacts of climate change. The ships

symbolize communal gathering where people are waiting together for the supplies they need from the main island. It is also around the port area where 'aunts' sell food in their tents, 'uncles' talk, roll cigarettes, and socialize – creating a gathering event. From the community perspective, although there is a significant amount of money paid for this service, we know we depend on it, and its arrival materializes this dependency and relationship.

This is just an average cargo ship; now imagine what a wind-powered cargo vessel arriving to the island of the descendants of the world's most advanced ocean voyagers – who used wind to power their vessels – would signify for our communities?

Communal gatherings of people waiting at ports in Rotuma Islands. Credit: John Taukäve

At the same time, with over 300 islands in Fiji, vessels are a constant in our lives, and the sounds they generate have become an issue. For Tonga, there is a migration pattern around its archipelago for whales where they come to give birth and nurse. Incidentally, it is also the best place in the world to swim with whales. The ships around Tonga could create issues for these creatures. They have established areas to avoid where vessels do not go to ensure that this migratory path is safeguarded. Because we are close to the Equator, we have a school of fishes around my region – and there is a specific route that ships must take to ensure the lagoon areas and reefs that the fish rely on remain protected.

The Pacific Islanders and their elders hold knowledge of the region – where to go to fish, sacred areas. These areas are no-go zones for ships. This is part of how we have protected the harmony between sound, sea life, and our communities.

The chant is called a 'Ki', which is a challenge – a chant that in the time of our ancestors was used before battles as a way to provoke their enemies.

John performing a chantsong called 'Ki' at the IMO plenary

A Just and Equitable Transition For Shipping

In our work at the IMO fighting for a just and equitable transition, from our perspective the equitable piece of the transition is to ensure revenue is distributed among those who are disproportionately impacted by climate change and shipping impacts, so they are not left behind. The other part of it is the 'just', which refers to workers and seafarers involved and people in the community who rely on ships. The human element of a just and equitable transition becomes alive in the discussion about justice – ensuring their livelihoods and ways of living with shipping are not disturbed.

The transition is expensive and will become more expensive, especially for remote communities already paying the most. Because we are already carrying this burden, if shipping does not transition properly, the developed countries will transition effectively and the leftover ships will be sent to these communities which will continue to pay more since these vessels will not fit within the transition framework and potentially generate more noise than newer ones. The policy ensures the revenue is distributed equitably, and the just part is also key – the human element of the transition.

The Power of Chant, Story, and Cultural Presence

Part of my current PhD study is to understand the narrative of how the IMO operates and how the Pacific has shaken the structures of the IMO – trying to decolonize it. With a background in performing art, I felt so excited to do the first ever performance in plenary. The chant I chanted was written by a chief for that moment – to be shared there. It was a challenge and acknowledgment. For someone like me from an island in the middle of the Pacific Ocean to chant in a plenary in a first-of-its-kind performance was a transformative moment of what the IMO could be like. That is how we bring humanity back.

The chant is called a 'Ki', which is a challenge – a chant that in the time of our ancestors was used before battles as a way to provoke their enemies. That is the power of words and sounds – when we chant these words they are supposed to tremble your opponent before you actually throw the first throw. The chant ensures you shake the very spiritual core of your opponent. It is also an analogy with ants and how when they go to battle, they are always in a unit together. Just like ants, when we show up in the international arena to transform shipping policies, we show up as one.

So the chant was also about acknowledging the work everyone has been doing up to that very moment while challenging the core of the decision makers in plenary so they would understand that we should not only be talking about the technicalities and policies, but also considering the humanity of what the negotiations mean for communities.

Keeping Identity While Changing Systems

The IMO has been until recently out of sight and out of mind. The IMO is legally binding to regulate shipping. If we can impact the policy but also keep our identity in that space, that could connect to other spaces of engagement, creating a ripple effect. Showing that it is possible to change despite the forces against it.

It is deeply frustrating when it does not go our way, but there is still a lot of work to be done in that space.

It is really important that the story of what is happening at the IMO is told from a different perspective. Not only from a technical one, but from a community and cultural perspective of how we see the IMO negotiations – and ensure that this element of the story is shared. You want to share what is happening at the IMO with the fishermen in the village – not a 200-page report to the community. You want to engage human to human and ensure that those at the grassroots level are aware of what we are doing internationally to protect our ocean, and understand that what happens internationally trickles down regionally and to our national and community policies.

The Pacific has the Pacific Blue Shipping Partnership[32] – trying to decarbonize our fleet. It shows how we try to impact our domestic fleet and how we try to impact international policy while transitioning our domestic fleet – translating what is international to our region. This act of translation makes clear that shipping is not just a technical matter - decarbonization and underwater noise are issues that must centre coastal communities like ours in their solutions.

The sound of a vessel arriving signals a gathering in the community for everyone to come together to the port and share stories about what is happening overseas, to meet family members who were away.

Photo credit: John Taukäve

Figure III — Summary of opportunities to advance Underwater Radiated Noise (URN) reduction before mandatory regulations.

Challenges

URN measurement and baselining

There are some technical challenges with regards to URN, particularly in the realm of measurement and baselining, which are considered by many stakeholders as the first stage in determining reduction targets, and as an essential requirement to enforce URN reduction measures. One stakeholder highlighted that it will be important to establish a measurement approach that extends across the lifecycle of a vessel, to account for how URN may change over the life and maintenance of vessels or with the adoption of new technologies or fuels, with scalability dependent on cost effectiveness. One stakeholder also pointed out the importance of a regional approach to account for variations in sound propagation and ecological characteristics of a region.

Currently, various bodies tackle baselining and measurement standards in different ways, including different classification societies, which stakeholders described as all utilizing different interpretations of ISO standards. Stakeholders from classification societies noted that unification work is underway, which can lead to more comparable and consistent measurement of URN. This will improve the determination of relative vessel quietness, as well as enforcement of URN reduction measures.[33] Additionally,

> "We really do need a more readily available, cheaper option that's widely accepted by all the stakeholders, particularly the class societies and the Member States for noise measurement. And I think a great example of that is in Vancouver [free], in Canada, the autonomous measurement facility they've got there and on the east coast with the MARS facility [low-cost]. [...] And if we had autonomous facilities at the key pinch points for shipping, like the Suez Canal, the Panama Canal, the English Channel, Singapore, you know, you could cover a very large proportion of World Shipping with relatively few measuring facilities "
>
> **– Chris Waddington,** International Chamber of Shipping

Stakeholders pointed to the value of establishing autonomous measurement facilities at shipping pinch points such as the Suez Canal, the Panama Canal, the English Channel, and Singapore Strait, which could enable a significant portion of global shipping to be measured.

Regulatory (in)congruence

Another possible challenge that stakeholders identified is regulatory congruence, particularly because URN is already being addressed (although

Photo: LNG Tanker passing through Suez Canal

not explicitly), through efforts to adhere to the IMO GHG strategy (EEDI, EEXI, CII). Adding another regulatory measure could be perceived as complicating and burdening implementation. On the other hand, URN regulation is also viewed by some stakeholders, including shipping companies, as a crucial mechanism for leveling the playing field and distributing the costs and benefits of URN reduction more equitably. From this perspective, applying uniform requirements across the sector is preferable to a situation in which only some actors invest in making their vessels quieter and more efficient. It will therefore be important to consider how best to align any URN measures with existing frameworks, ensuring they can be integrated smoothly into ongoing implementation efforts. Ultimately, alignment and regulation, rather than one without the other, will be essential to achieving sustained and significant URN reductions.

> "Noise limits across country borders would help in this approach. Marine mammals do not feel borders while limits differ per country."
>
> **– Simon Petit,** Jan De Nul

Several stakeholders emphasized challenges stemming from regulatory incongruence, particularly regarding whose priorities shape maritime regulations. They noted that maritime regulations are largely shaped by EU and Global North priorities, while the needs, data, and realities of Global South regions, many of which depend heavily on shipping for economic survival, hold far less influence. Regulatory models developed in one context are not always transferable to another, underscoring the need for regionally grounded data, perspectives, and policy pathways. For instance, reducing port and other fees for quiet ships can incentivize owners to invest in URN reduction, while raising revenues through 'noise tickets' (similar to speeding tickets) can fund infrastructure investments which could more directly contribute to just and equitable outcomes in the Global South. Ensuring voices from the Global South meaningfully influence decision-making is essential for achieving equitable and effective URN reduction.

Fleet design

Stakeholders highlighted that meaningful URN reduction is linked to designing and deploying new, quieter vessels. The slow turnover of ships (often operating for 25–30 years) makes rapid technical change difficult. Incentives may therefore play an important role: subsidies could support development and adoption of quieter ship designs, while coordinated port policies could reward low-noise vessels with easier or cheaper access. However, stakeholders noted that such measures require collaboration among competing ports to be effective.

> "We want to show the industry that there are solutions, they are feasible, that they can reduce emissions and they can reduce noise. [...] [There are] mutual benefits for addressing both at the same time, with the same budget. [...] You can include a system inside the ship that tells you how noisy you are, and then it tells you to reduce speed by two knots."
>
> **– Santiago Molins,** Técnicas y Servicios de Ingeniería

Retrofitting existing vessels also offers a promising near-term strategy for reducing URN, enabling mitigation outside of regular ship turnover timelines. At a workshop on underwater noise held by the International Maritime Organization in November 2025, BC Ferries presented a propulsion system retrofit for one of its coastal class vessels. Sea trials of the upgraded propulsion system and propeller demonstrated a 16-decibel reduction at 13.7 knots (equivalent to a 40-fold decrease in sound intensity).

The retrofit also improved energy efficiency, achieving 40% fuel savings at 14 knots,[34] highlighting its potential for a reasonable payback period.

Stakeholders also pointed to the importance of considering a range of complementary steps for URN reduction. They noted that progress will depend on implementing practical measures that can be adopted readily, such as establishing guidelines within marine protected areas to prioritize noise-sensitive zones during specific periods or in defined locations. Additional efforts should focus on scaling the retrofitting of existing vessels to incorporate technologies that reduce underwater noise. At the same time, incentivizing the development and deployment of new, quieter vessels also represents a critical pathway for achieving substantial and sustained URN reductions.

Moving beyond business as usual

The whole shipping system from contracts to routing decisions is set up in a way that does not explicitly account for URN impacts (and reduction), and stakeholders noted that enacting change is challenging and complex, particularly if the pathway for change is not agreed upon and requires coordination across multiple scales, sectors, and stakeholders. Yet, we have seen such changes accomplished around other issues, and there are new models emerging that can better enable operational changes to reduce URN in the near-term. One example mentioned by stakeholders is a decision-support tool to optimize operational and routing measures to reduce GHGs, ship strikes and URN while increasing sailing efficiency - ultimately aiming to mitigate the effects of "Sail Fast Then Wait". Taking a whole-system approach will help move beyond business as usual, especially in the near-term.

> "Sometimes it's the charterers or the owner of the goods that benefit from a speed reduction, then [...] sometimes they don't, because it's a time charter. Then they just want to get from A to B fairly quickly, and the ship owner pays for the fuel that's been burned. So [the contract structure can lead to] the benefits from reduced costs are not shared. And there are initiatives that try to make a burden or cost share."
>
> – **Andreas Dinkelmeyer,** International Fund for Animal Welfare

> "Relative to the status quo, building regulation is necessary to disincentivize other likely outcomes for continued growth of shipping."
>
> – **Survey Respondent,** Natural Resources Defence Council

Wind-assisted technologies were also identified as a promising solution that increases energy efficiency and reduces underwater noise. Stakeholders suggested incentivizing shipping companies to adopt these systems, either through retrofitting existing vessels or incorporating into new builds. Such an approach could help meet environmental regulations while lowering operating costs.

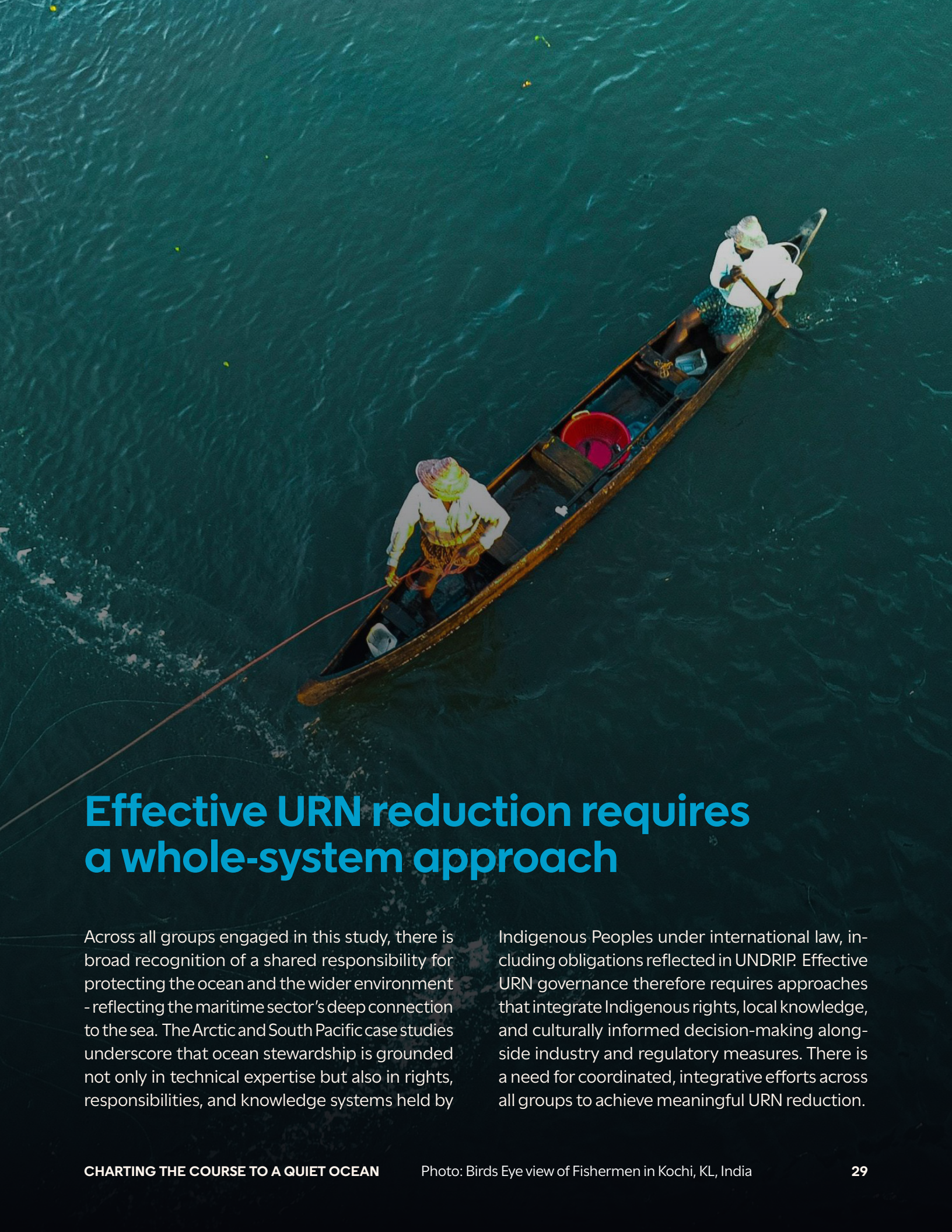
Another pathway to move beyond business as usual could be linked to fleet-wide adoption of URN monitoring and decision-support systems. Stakeholders emphasized the value of integrating URN data into existing route-optimization software that is already used to account for winds, tides, and ocean currents to reduce fuel consumption. By incorporating noise parameters into these systems, vessels can plan routes and adjust speeds to avoid sensitive areas, remain within required noise limits, and improve overall environmental performance.

Targets for URN Reduction by 2030 and beyond

Survey respondents proposed a wide range of what they considered to be ambitious yet achievable URN reduction targets for 2030. Several suggested quantified reductions, including 3 dB for existing ships, 5 dB for retrofits, and 10 dB for new builds; a 2 dB global reduction by 2030; increased reduction in the medium and long term; a 50% reduction from 2020 levels; and a broad goal of a statistically significant decrease in total sound energy input. Others emphasized foundational measures rather than specific decibel targets, including establishing a baseline URN measure for all vessels over 400 GT, implementing more restrictive zones in sensitive areas, and adopting speed limits in protected areas. One respondent suggested 2035 as a more realistic timeline for achieving major reductions. Overall, responses reflect an interest in quantitative measures and policy-oriented pathways toward URN reduction.

Global ambient noise is expected to rise by about 3 dB per decade, largely driven by increasing transport activity. To achieve a 3 dB reduction, each ship would need to cut its noise by at least 4 dB by 2033 and 11.38 dB by 2050.[35] A recent study noted that across the Arctic Ocean, the median difference between 2019 and 2030 underwater noise levels was 5 dB, denoting nearly a quadrupling of sound pressure in the panarctic acoustic environment by 2030 due to predicted diminished sea ice and increased vessel traffic. This increase is not uniform, with some areas predicted to experience a drop in noise, while much of the region would experience an increase, up to or exceeding 10 dB.[36] Given these projections, even larger reductions per vessel would be necessary to offset the regional spikes in ambient noise and achieve overall mitigation goals.

The authors and contributors to this report acknowledge the complexities and varying views on setting and implementing URN targets. We can look to the UNFCCC's 1.5 degree target, the CBD's 30X30 or the IMO's striving for 80% GHG reduction by 2040 as examples of how targets focus efforts and resources, and provide timelines and needed urgency in order to make progress. URN is likely not an issue that can be excused from a similar approach. Targets are imperfect but essential. The most promising for their development likely relies on establishing ship based alongside area based goals, which was reflected in the views from many of the stakeholder interviews.



Effective URN reduction requires a whole-system approach

Across all groups engaged in this study, there is broad recognition of a shared responsibility for protecting the ocean and the wider environment - reflecting the maritime sector's deep connection to the sea. The Arctic and South Pacific case studies underscore that ocean stewardship is grounded not only in technical expertise but also in rights, responsibilities, and knowledge systems held by Indigenous Peoples under international law, including obligations reflected in UNDRIP. Effective URN governance therefore requires approaches that integrate Indigenous rights, local knowledge, and culturally informed decision-making alongside industry and regulatory measures. There is a need for coordinated, integrative efforts across all groups to achieve meaningful URN reduction.

Some of the core, rights holder and stakeholder-specific efforts include the following:

Indigenous Peoples and Local Communities: Exercise leadership in identifying culturally and ecologically sensitive marine areas, species, and seasonal patterns affected by URN. Contribute knowledge to the design of URN mitigation measures, monitoring programs, and operational guidelines. Lead governance and management arrangements related to shipping and URN with trusted partners, ensuring that mitigation strategies support food security, livelihoods, and cultural practices. Where desired and appropriately resourced, participate in community-based monitoring and data interpretation initiatives.

Classification Societies: Standardize the interpretation of ISO standards that inform quiet-vessel class notations across all classification societies. Continue advancing ongoing harmonization efforts within IACS. Facilitate knowledge exchange by engaging vessel owners and operators (particularly those that do not operate in European waters where URN requirements have been established through the Marine Strategy Framework Directive to share insights from implemented practices.

Regulators and Maritime Authorities: Implement speed regulations and operational measures in sensitive areas. Support URN measurement programs and integrate data into policy decisions. An effective initiative includes the Protecting Blue Whales and Blue Skies Initiative along the U.S. California coast. The IMO plays a central role in coordinating these efforts and in creating governance frameworks that recognize Indigenous rights, enable meaningful participation, and support context-specific solutions for reducing underwater radiated noise.

Ports: Implement URN reduction incentive programs (such as those employed in the Ports of Vancouver and Prince Rupert). Where possible, establish or support measurement facilities (see for example, facilities operating in the Ports of Vancouver, Genoa (formerly at Fos le Mer, France), Sweden and the MARS Facility in Canada), and wider adoption of noise reduction within existing incentive schemes.

Engineers and Designers: Continue to drive technological innovation and expand market availability of quieting and measurement technologies that support real-time operational decision-making, while ensuring that newbuild standards consistently incorporate effective quieting measures.

Shipowners and operators: Invest in quieter vessel designs through retrofitting (utilizing existing drydocking to minimize additional costs) and adoption of onboard URN monitoring systems where possible. Integrate operational measures like slow steaming in sensitive areas and utilize decision-support systems to maximize adaptive operational strategies and benefits. Participate in data-sharing initiatives to benchmark noise performance.

The cumulative efforts of these groups will advance URN reduction, as demonstrated by pilot projects such as GloNoise and the High Ambition Coalition for a Quiet Ocean, which highlight the value of coordinated, multi-stakeholder initiatives in supporting a whole-system approach.

Table II presents an overview of short- medium- and long-term targets, conditions, and considerations to achieve meaningful and equitable URN reduction. This is the culmination of insights from across all interviews, survey responses, and case studies and offers key pathways as well as equity considerations to ensure a just and equitable transition.

Table 2 — Targets, conditions, and considerations to ensuring short-term momentum on URN reduction is sustained while moving towards long-term URN strategy

	Short-term (voluntary)	Medium-term (quasi-mandatory)	Long-term (mandatory)
Measures	Operational measures	Retrofitting	New vessels
Scope	Regional	Fleet and vessel	Comprehensive (global framework)
Target	Adopt operational measures (slowdown, avoiding sensitive areas, re-programming routing) PSSAs (MEPC 84/11/X) and also national requirements are a good way of controlling the most sensitive areas Progressive baselining of the majority of the internationally operating fleet Implement noise management plans (vessel-level) Integrate URN into decarbonization, energy efficiency, and biofouling IMO requirements	Set-up a benchmark or baseline target to meet through retrofitting (i.e., decibel levels before/after a retrofit) Implement propeller and hull optimization retrofits during scheduled drydocks Continue refining approach to improve URN reductions and frequencies of reduction Mandatory noise management plans; not specifying content, but have step-wise increases in how strict the plans are Mandatory IMO regulations and guidelines provided after the end of the Experience Building Phase (EBP)	Use a reference group of existing ships, measure how loud they are, and require new ship designs to be quieter by a chosen number of decibels

	Short-term (voluntary)	Medium-term (quasi-mandatory)	Long-term (mandatory)
Conditions	Complement decarbonization efforts already underway (as opposed to working against them - finding the balance to add incentive, not burden to ease adoption) Develop enabling technologies to support source-level reduction and measurements Sensitive regions calibrated into nautical charts to facilitate ship operator implementation Need to implement cost-sharing contracts and decision support systems that enable slow steaming Advance programs that provide reputational recognition to the shipping industry for adherence to voluntary guidelines, reflecting evidence that reputational incentives may be more effective than financial incentives.	Economic and reputational incentives to implement retrofits Diplomacy and democracy critical to reach buy-in necessary for successful quasi-mandatory measures	Alignment with energy efficient fuel and ship design to improve EE and URN reduction Real-time URN measurements available to support monitoring (onboard) and enforcement
	Center just and equitable transition principles by protecting coastal livelihoods and directing revenues and solutions to the communities, workers, and ecosystems most harmed, especially those dependent on healthy oceans.		
Considerations	Consider socioeconomic impacts of measures, particularly those which may lead to penalties under decarbonization frameworks, as the implications for countries depending on global trade could have significant social and cultural consequences through increased pricing on goods. Improve information sharing on URN.		

Figure IV — Pathways to advance meaningful URN reduction

Conclusions and Recommendations

Stakeholders and case studies highlighted a range of initiatives as critical guideposts for advancing effective and equitable URN reduction, including port incentive schemes, technical and operational measures, Indigenous leadership with the integration of Indigenous knowledge into monitoring and governance, and centering the human element of a just and equitable transition to ensure that coastal communities' livelihoods and ways of living with shipping are not disturbed.

A just and equitable transition in shipping must address underwater noise by directing revenues and solutions to the communities, workers, and ecosystems most harmed by its impacts, particularly those who rely on healthy oceans for their livelihoods and cultures. Equity in URN reduction requires ensuring that outdated, noisier vessels are not displaced onto vulnerable and remote regions, and instead advancing policies that center justice, equity, and meaningful reductions in underwater noise. Despite the challenges discussed, stakeholders identified significant opportunities that reflect a strong and shared ambition to advance URN reduction.

1. **Justice and equity must be centred in URN mitigation measures:** URN policies often reflect the priorities of the most influential actors, leaving many coastal and shipping-dependent regions overlooked. Ensuring that diverse regional perspectives shape context-specific solutions is essential for equitable and just outcomes.

2. **Integration is important to unlock co-benefits:** URN reduction is most effective when paired with other operational and environmental goals. Co-benefits provide both financial and ecological incentives to advance URN reduction.

3. **Short-term wins are achievable:** Operational measures and localized interventions can provide immediate reductions without waiting for fleet renewal or a global regulatory framework.

4. **Data and measurement can advance (but not delay) progress:** Scalable, harmonized monitoring systems are foundational for both voluntary and mandatory reduction strategies.

5. **Regulatory clarity and alignment matter:** Ensuring coherence with existing frameworks, and a clear path for mandatory measures, will reduce implementation complexity and encourage investment.

6. **Shared responsibility can advance systemic change:** Collaborative action among ports, regulators, shipowners, and technology providers is required to transition from business as usual to industry-wide quieting.

Taken together, these findings suggest that URN reduction is a socio-technical problem, requiring aligned incentives, policy frameworks, technological innovation, and cross-sector collaboration in order to advance a just and equitable approach to URN reduction. This underscores the need for a whole-system approach to URN reduction, one that requires buy-in, participation, and cooperation across all stakeholders and rights holders to more equitably distribute the costs and benefits of URN reduction.

As noted previously, priority setting is often driven by the most influential actors, frequently located in the Global North. Mandatory regulations could help address existing inequities, particularly given the limited effectiveness of a voluntary approach to date. However, the development of such regulations must actively centre those most affected by URN impacts, including communities that have been structurally excluded from decision-making, to ensure that they do not reproduce or reinforce existing inequities. Harmonized regulation, consistent measurement and baselining standards, and alignment with existing IMO frameworks will be essential to avoid fragmentation and ensure a level playing field.

Beyond its technical dimensions, URN is experienced through deep cultural relationships with the ocean. While social, cultural, geographic, and political contexts vary, the leadership of Indigenous Peoples and local communities provides vital guidance for developing more responsive, inclusive, and culturally grounded approaches to governing URN in ocean spaces.

References

1 Ainslie, M. A., Martin, S. B., Trounce, K. B., Hannay, D. E., Eickmeier, J. M., Deveau, T. J., Lucke, K., MacGillivray, A. O., Nolet, V., & Borys, P. (2022). International harmonization of procedures for measuring and analyzing of vessel underwater radiated noise. Marine Pollution Bulletin, 174. https://doi.org/10.1016/j.marpolbul.2021.113124

2 Fisheries and Oceans Canada. (2024). Primer on ocean noise and its impacts. https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41255951.pdf

3 Affatati et al. (2022). Ocean Sound Propagation in a Changing Climate: Global Sound Speed Changes and Identification of Acoustic Hotspots. Earth's Future, 10(3). https://doi.org/10.1029/2021EF002099

4 Ibid.

5 Fisheries and Oceans Canada. (n 2).

6 Genz, J.H., Bardwell-Jones, C., Coffman, M., Dey, D., Defngin, A., Feinberg, R., Hao, C., Huke, H., Joab, T., Kabutaulaka, T., Kelen, A., Kirch, P.V., LaBriola, M., Ledua, S., Masterson, I., Mawyer, A., Morris, T., Myazoe, J., Nuttall, P., Pfalzgraf, F., Raigetal, H.L.,, and Tamagyongfal, S. (2023). Voyaging in the Pacific. Volume 8 of Teaching Oceania Series, edited by Joseph Genz. Honolulu: Center for Pacific Islands Studies, University of Hawai'i–Mānoa. https://hdl.handle.net/10125/105330

7 Michael V Namorato. (2000). A concise history of acoustics in warfare. Applied Acoustics, 59(2). https://doi.org/10.1016/S0003-682X(99)00021-3

8 Shipton, M., Obradović, J., Ferreira, F., Mišković, N., Bulat, T., Cukrov, N., Diamant, R. (2025). A Database of Underwater Radiated Noise from Small Vessels in the Coastal Area. Scientific Data, 12(1). https://doi.org/10.1038/s41597-025-04584-x

9 Fisheries and Oceans Canada. (n 2).

10 Smith, T.A. and Rigby, J. (2022). Underwater radiated noise from marine vessels: A review of noise reduction methods and technology. Ocean Engineering. 266(1). https://www.sciencedirect.com/science/article/pii/S0029801822021461#b108

11 De Jong, K., Murray, C. C., Anabitarte, A., Bailey, S., Drake, L., Fernandes-Salvador, J.A., Hassellov, I.-M., Heibeck, N., Jalkanen, J.-P., Lehikoinen, A., Merchant, N., Nylund, A.T., & Redfern, J.V. (2025). Trade-offs and synergies in the management of environmental pressures: A case study on ship noise mitigation. Marine Pollution Bulletin, 218. https://doi.org/10.1016/j.marpolbul.2025.118073

12 WWF. (2019). Filtering through the noise: Benchmarking study on the implementation of the International Maritime Organization's Underwater Vessel Noise Guidelines. https://wwf.ca/wp-content/uploads/2022/01/Benchmarking-Study-on-URN-IMO-Guidelines-Report-Final.pdf

13 IPCC. (2023). 6th Assessment Report Regional Fact Sheet - Polar Regions. https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Polar_regions.pdf

14 Paddison, L. (2025). This sea route has been dismissed as too treacherous. China's taking the risk. CNN. https://www.cnn.com/2025/10/03/climate/china-arctic-shipping-northern-sea-route

15 ICCT. (2021). Black carbon emissions from Arctic shipping: a review of main emitters and time trends. https://cleanarctic.org/wp-content/uploads/2023/04/ICCT-BC-2021-briefing-for-CAA.pdf

16 Arctic Council. (2024). Arctic Shipping Update: 37% Increase in Ships in the Arctic Over 10 Years. https://arctic-council.org/news/increase-in-arctic-shipping/

17 PAME. (2025). Underwater noise in the Arctic: Understanding impacts and defining management solutions. https://oaarchive.arctic-council.org/items/9e6e1682-b0b4-44cf-a331-a361f11f8601/full

18 Wang, W. (2023). UNDRIP rights to guide the governance of the Northern Low-impact Shipping Corridors initiative. Marine Policy, 155. https://doi.org/10.1016/j.marpol.2023.105737

19 Huntington, H.P., Olsen, J., Zdor, E., Zagorskiy, A., Shin, H.C., Romanenko, O., Kaltenborn, B., Dawson, J., Davies, J., & Abou-Abbsi, E. (2023). Effects of Arctic commercial shipping on environments and communities: Context, governance, priorities. Transportation Research Part D: Transport and Environment, 118. https://doi.org/10.1016/j.trd.2023.103731

20 Thornhill Verma, J. (2025). 'The narwhals stop calling': how the noise from ships is silencing wildlife in the Arctic. The Guardian. https://www.theguardian.com/environment/2025/nov/25/shipping-noise-arctic-whales-narwhals-sound-quieter-vessels

21 Bishop, B., Paquette, E., Carter, N., Ljubicic, G., Oliver, E. C. J., and Aporta, C. (2025). Inuit uses of weather, water, ice, and climate indicators to assess travel safety in Arctic Canada, Alaska, and Greenland: A scoping review. FACETS, 10. https://doi.org/10.1139/facets-2024-0107

22 Dumbrille, A., and Menezes, E. (2024). Efficiency may be the one-size-fits-all solution for marine shipping. National Observer. https://www.nationalobserver.com/2024/07/08/opinion/efficiency-one-size-fits-all-solution-marine-shipping

23 Shipping Federation of Canada. (2025). Scrubber Systems in Canada. Letter to Transport Canada Marine Safety and Security. https://shipfed.ca/wp-content/uploads/Briefs-Submissions/2025-01-17-CommentsOnScrubberSystemsInCanada-SFC.pdf

24 Gupta, S. (2025). First Nation leads effort to monitor orca-threatening ship noise. https://www.indigenouswatchdog.org/update/first-nation-leads-effort-to-monitor-orca-threatening-ship-noise/

25 Prospathopoulos, A. M. (2025). Advances in the monitoring, assessment and reduction of underwater noise from vessels with respect to its impact on marine life—A short review. Oceanography & Fisheries Open Access Journal, 18(3). http://dx.doi.org/10.19080/OFOAJ.2025.18.555987

26 Andreadakis et al. (2025). The Arctic Ocean Region: Biodiversity, Governance And Protective Measures. Arctic Report, World Maritime University & 90 North Foundation. http://dx.doi.org/10.21677/251111

27 Great Barrier Reef Marine Park Act 1975

28 Hill, R., Grant, C., George, M., Robinson, C.J., Jackson, S., and Abel, N. (2012). A Typology of Indigenous Engagement in Australian Environmental Management: Implications for Knowledge Integration and Social-ecological System Sustainability. Ecology and Society, 17(1). https://doi.org/10.5751/ES-04587-170123

29 Andreadakis (n 18).

30 Kauffman, C., Haas, C., Putzer, A., Bajpai, S., Leonard, K., Macpherson, E., Martin, P., Pelizzon, A. and Sheehan, L.. Eco Jurisprudence Monitor. V2. 2025. Distributed by the Eco Jurisprudence Monitor. https://ecojurisprudence.org/initiatives/he-whakaputanga-moana-declaration-for-the-ocean-treaty/

31 Pacific Blue Shipping Partnership. (2024). https://mcstrmi.org/projects/pacific-blue-shipping-partnership/

32 Kaminski, I. (2024). For the first time, part of the ocean has been granted legal personhood. Hakai Magazine. https://hakaimagazine.com/news/for-the-first-time-part-of-the-ocean-has-been-granted-legal-personhood/

33 Ainslie et al. (2025). (n. 1)

34 Bae, Chanwoo. (2025). Working towards a quieter fleet: BC Ferries' URN Journey. Presentation at 2025 Workshop on the relationship between ship energy efficiency and underwater radiated noise. Available at https://sway.cloud.microsoft/O9T8ZP3rYy4rzbxd?ref=Link

35 Vakili, S., White, P., & Turnock, S. (2025). Advancing a sustainable maritime future: Integrating energy efficiency and underwater radiated noise reduction strategies in commercial shipping. Marine Pollution Bulletin, 215. https://doi.org/10.1016/j.marpolbul.2025.117835

36 PAME. (2025). (n 17)

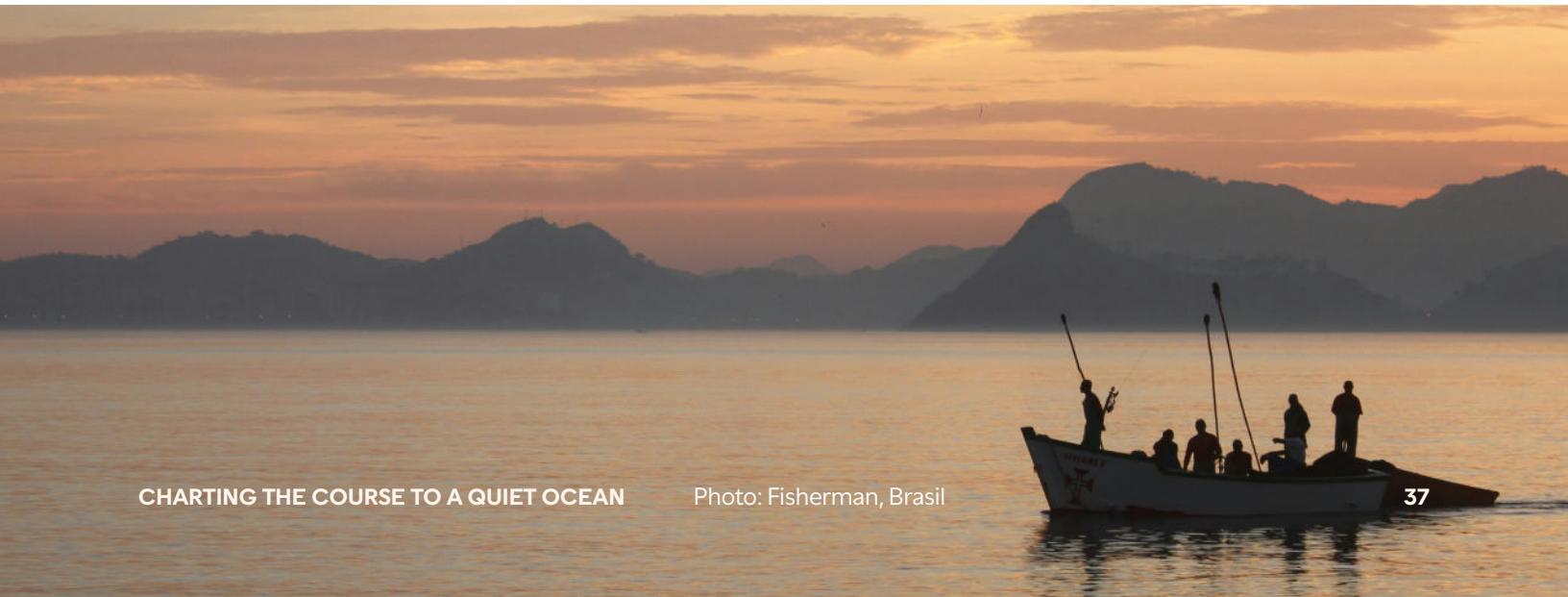


 Photo: Fisherman, Brasil