Solutions for Our Climate

Report

An Assessment of Environmental and Social Impacts of LNG Carriers

SFO°C
Solutions for Our Climate

Solutions for Our Climate(SFOC) is an independent policy research and advocacy group that aims to make emissions trajectories across Asia compatible with the Paris Agreement 1.5°C warming target.

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An Assessment of Environmental and Social Impacts of LNG Carriers

Abstract

The world's oceans host some of the planet's most biologically diverse and culturally significant ecosystems, many of which are formally recognized under international conservation frameworks, including UNESCO World Heritage and Marine Protected Areas. At the same time, these marine spaces are increasingly intersected by global energy transport routes. This report examines Liquefied Natural Gas (LNG) carriers as a largely unassessed component of this interaction. Drawing on scientific literature, vessel-tracking data, and international case studies, it analyzes how LNG carrier operations-through emissions, underwater noise, ballast water discharge, and concentrated traffic-create cumulative environmental and social impacts that remain outside conventional assessment frameworks. By situating LNG shipping within broader environmental and governance considerations, the report addresses a persistent gap in the oversight of global gas supply chains.

Executive Summary

Context and Regulatory Oversight While Liquefied Natural Gas (LNG) carriers are central to global LNG trade, their impacts remain overlooked due to a formalistic interpretation of mobility, which allows them to bypass Environmental Impact Assessments (EIAs). Over the past decade, the global LNG fleet has tripled in size, yet EIAs for new gas developments typically stop at the onshore terminal. This creates a regulatory gap that ignores the recurring environmental and climate risks inherent in their operation.

Environmental and Social Risks Case studies from regions undergoing rapid LNG expansion, including Mozambique, the Philippines, the U.S. Gulf Coast, Mexico, and Canada, illustrate that LNG carrier operations contribute to biodiversity loss and marine ecosystem degradation. LNG shipping routes increasingly intersect sensitive areas, including UNESCO-designated whale habitats, coral reefs, and artisanal fishing grounds.

Financial Vulnerability and Stranded Assets As high-value assets ($250M+) with its operating lifespan over 30 years, LNG carriers face a structural misalignment with climate goals. Under 1.5°C demand scenarios, $48 billion in LNG carrier investments are projected to become stranded assets by 2035. This looming oversupply creates significant financial exposure through increased market volatility and debt risk.

Strategic Recommendations To mitigate these systemic risks, this report proposes the following structural reforms:

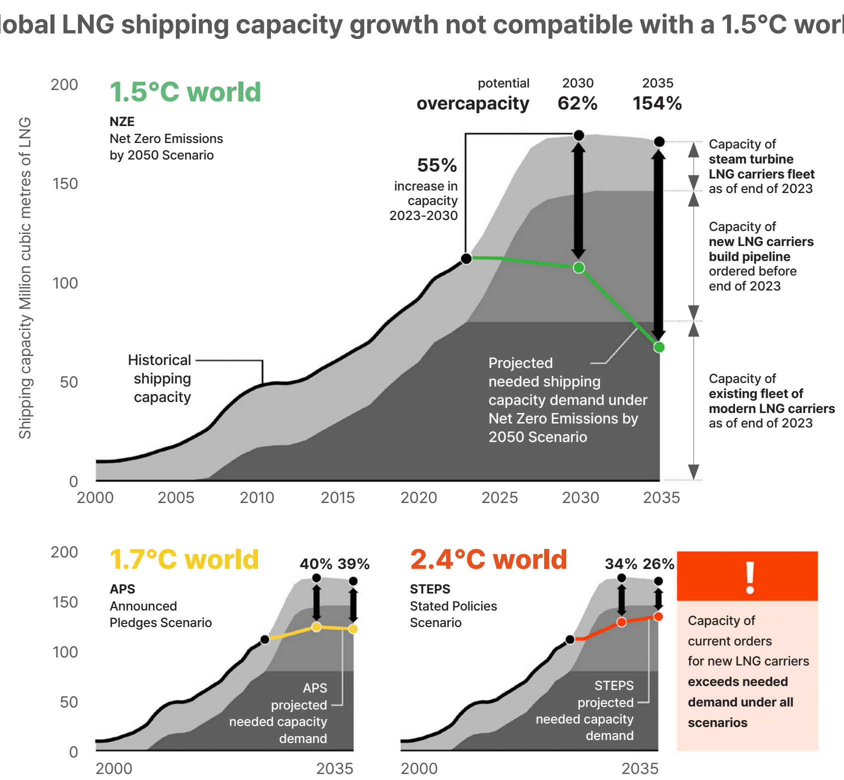
- **Expansion of EIA Scopes**: Integrate full-lifecycle shipping impacts into project-level environmental assessments
- **Methane Mitigation**: Implement stringent regulations on methane slip from vessel engines and monitoring standards
- **Operational Standards**: Strengthen enforcement of ballast-water management and underwater noise-control
- **Green Finance Alignment**: Exclude LNG carriers from green finance taxonomies to reflect their actual climate impact

Introduction

Liquefied Natural Gas (LNG) carriers are a critical yet under-examined component of the global fossil fuel infrastructure. As specialized vessels designed to bridge production terminals and import markets, they serve as the essential midstream link enabling the extraction, distribution, and consumption of gas. Given the inherent geographical limitations of pipelines, LNG carriers provide the necessary capacity for the current scale of international trade; without this maritime logistics chain, the global expansion of the LNG sector would be physically constrained.

As of 2026, the global LNG fleet exceeds 700 vessels, with over 285 additional ships on order.[1] This expansion continues despite a growing divergence between shipping capacity and climate-aligned demand.[2] According to 2024 analysis by Climate Analytics, an oversupply of LNG carriers is projected across all major energy scenarios. Under the International Energy Agency's (IEA) Stated Policies Scenario (STEPS), the most conservative outlook, the 2030 surplus is expected to exceed 40% of current fleet capacity, equivalent to approximately 275 modern carriers.[3]

Figure 1. Historical and projected LNG shipping capacity, compared to what is needed under the 2023 IEA scenarios



Source: Climate Analytics (2024)

1 Clarksons Research. (2025). World fleet register database

2 SFOC (2025), No Room for More: Why LNG Carriers Are a Climate and Financial Risk

3 Climate Analytics. (2024). Still Adrift: Updated assessment of the global energy transition's impact on the LNG shipbuilding industry.

This oversupply creates significant financial risks. Research from the University College London (UCL) Energy Institute and Kuehne Climate Center reveals that in a net-zero aligned transition, up to USD 48 billion in LNG carrier investments could be written off as stranded assets by 2035. Notably, the projection of overcapacity persists even in high-carbon scenarios where fossil fuel consumption remains high enough to trigger 4°C of global warming, suggesting a structural misalignment between shipyard orders and realistic market absorption.[4]

Despite their scale and environmental footprint, LNG carriers occupy a persistent gap in environmental governance. A primary driver of this oversight is a formalistic interpretation of "project location." For instance, the Export-Import Bank of Korea (KEXIM), a major financier of the global LNG fleet, has maintained that LNG carrier projects are exempt from Environmental Impact Assessments (EIAs) because they lack a fixed geographical site as defined in the OECD Common Approaches. This rationale presents three significant analytical contradictions:

1. **Operational Consistency**: While mobile, LNG carriers follow well established shipping corridors and frequent specific terminals, creating predictable and recurring impacts on specific coastal and marine environments.[5]

2. **OECD Compliance**: The OECD Common Approaches explicitly reference "the locations to which [capital goods] are destined."[6] The ports, marine protected areas, and coastal communities these ships frequent fall squarely within this intended scope.

3. **Scope of Impact**: Current reliance on purely technical or safety standards fails to account for the broader ecological and climate implications, including:
   - Methane slip from dual-fuel marine engines;
   - Underwater noise pollution affecting marine mammals;
   - Ballast water discharge and the introduction of invasive species;
   - Collision risks in high-biodiversity coastal zones.

4 UCL Shipping and Oceans Research Group. (2025). USD 48 billion at risk of being written off as gas tanker orders soar by 300% in five years, new research shows.

5 Rodríguez, J. P., Klemm, K., Duarte, C. M., & Eguíluz, V. M. (2024). Shipping traffic through the Arctic Ocean: Spatial distribution, seasonal variation, and its dependence on the sea ice extent.

6 OECD. (2024). Recommendation on Common Approaches for Officially Supported Export Credits and Environmental and Social Due Diligence. OECD.

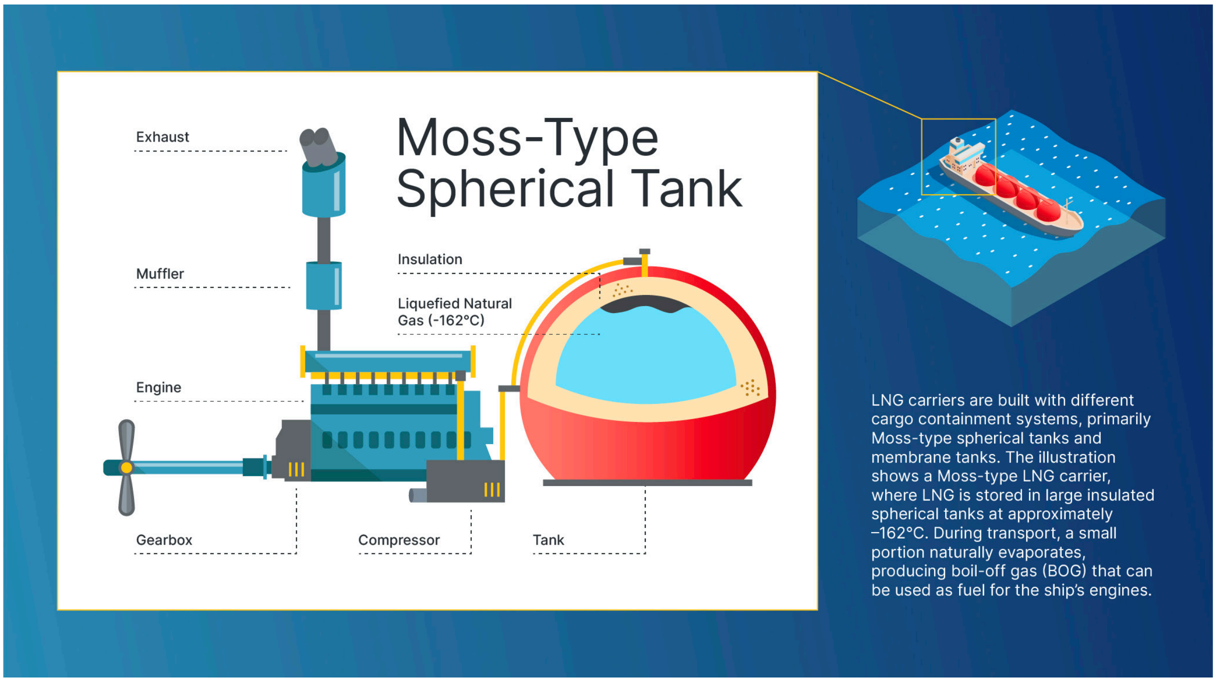
Report Objectives

This report provides a comprehensive assessment of the environmental and social impacts of LNG carriers. By synthesizing scientific literature, geospatial data (including AIS tracking), and frontline testimonies, the report aims to:

- Identify and quantify overlooked environmental and climate risks;
- Analyze the intersection of shipping routes with critical marine ecosystems and Indigenous territories;
- Evaluate case studies from Mozambique, the Philippines, the Gulf of Mexico, and East Asia;
- Provide a framework for regulatory and financial institutions to align LNG shipping oversight with climate and environmental integrity.

Inside the LNG Carrier & Lifecycle Emissions

Figure 2. What is LNG Carrier?



LNG carriers are not merely transport vessels; they are highly specialized, mobile gas infrastructures. Operating at cryogenic temperatures of –162°C, these ships manage natural evaporation known as boil-off gas through advanced insulation or re-liquefaction systems. A single modern carrier (174,000 m³) holds enough energy to power 45,000 North American homes for a year, making any operational failure a high-stakes environmental and climate event.[7]

Lifecycle Emissions from Shipbuilding

The environmental impact of an LNG carrier begins long before its first voyage. A 2024 cradle-to-grave study by Lloyd's Register on a 174,000 m³ LNGC found that approximately 79% of lifecycle emissions occur during vessel operations, the remaining emissions arise from upstream and pre-operational activities, demonstrating that environmental impacts begin well before a vessel enters service.[8] Despite this, these pre-operation emissions are systematically excluded from project-level EIAs.[9]

7 Riviera Maritime Media, *LNG shipping by numbers*, reports that a full load of 170,000 m³ (a representative size for modern LNG carriers) contains enough energy to heat 45,000 homes in North America for one year.

8 Lloyd's Register. (2024). From Cradle to Grave*: Emissions from an LNGC's Life Cycle*.

9 Ecochain. (2020). Environmental impact assessment (EIA): How is it different from life cycle assessment (LCA)?

The intensity of this embedded carbon is driven by the industry's heavy reliance on steel, which accounts for 75–85% of a vessel's lightweight mass.[10] Global shipyards consumed over 33 million tonnes of steel in 2021–2022, resulting in 72.2 million tonnes of CO_2 emissions.[11] For a modern 174,000 m^3 carrier, which typically has a deadweight exceeding 90,000 tonnes, this translates to tens of thousands of tonnes of high-strength structural steel.[12] Major shipbuilders in South Korea and China[13] primarily procure steel from coal-based blast furnaces (e.g., POSCO, Hyundai Steel), with emissions intensities around 2.0 tCO_2 per tonne of crude steel, consistent with reported values from major Korean producers such as POSCO.[14] By failing to account for these embedded emissions from the structural steel, significant upfront carbon debts remain unaddressed.

This accounting gap may increase the risk of these vessels becoming stranded assets as global carbon pricing and emissions disclosure requirements become more stringent. These embedded emissions add to operational emissions during the vessel's lifetime, including methane emissions associated with fuel use and boil-off gas management.

10 International Council on Clean Transportation (ICCT). (2024). Tracing the Steel Supply Chain of the Shipbuilding Industry.

11 ICCT. (2024). Tracing the Steel Supply Chain of the Shipbuilding Industry.

12 Gas Form B: Description of 174K LNG carrier MU LAN (Hull No. H1827A).

13 International Energy Agency (IEA). (2020). Iron and steel technology roadmap.

14 POSCO. (2023). Integrated Sustainability Report 2023. Pohang: POSCO Holdings.

Methane Slip and Engine Technology

The Methane Paradox: Energy Efficiency vs. Climate Impact

Over the past two decades, LNG carriers have largely moved away from older steam turbine engines toward newer dual-fuel, low-speed two-stroke engines. These modern engines are more fuel-efficient and were introduced to reduce fuel consumption and carbon dioxide emissions.[15]

However, this efficiency improvement comes with a significant drawback known as methane slip. Methane slip occurs when some methane fuel is not fully burned in the engine and is released directly into the atmosphere.[16] Because methane is a very powerful greenhouse gas — especially over the short term — even small leakage rates can have a large climate impact.

Given that methane's near-term warming potential is up to 80 times stronger[17] than CO_2, even a slip of 2–3% can offset the theoretical carbon savings of switching from oil to gas.[18] As a result, LNG carriers have become a major source of methane emissions within the shipping sector. In 2021, LNG tankers were responsible for 82% of shipping's methane emissions.[19]

Recent satellite-based analysis further corroborates the scale and spatial concentration of LNG carrier emissions. According to SkyTruth, LNG tankers emitted more than 50 million tonnes of CO_2 in 2024, accounting for approximately 4% of total global shipping emissions, while satellite imagery identified large methane plumes at multiple LNG terminals.[20]

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15 iMarine. (2024). Declining LNG freight rates accelerate retirement of steam turbine LNG carriers.

16 Biology Insights. (n.d.). What is methane slip and why does it matter?

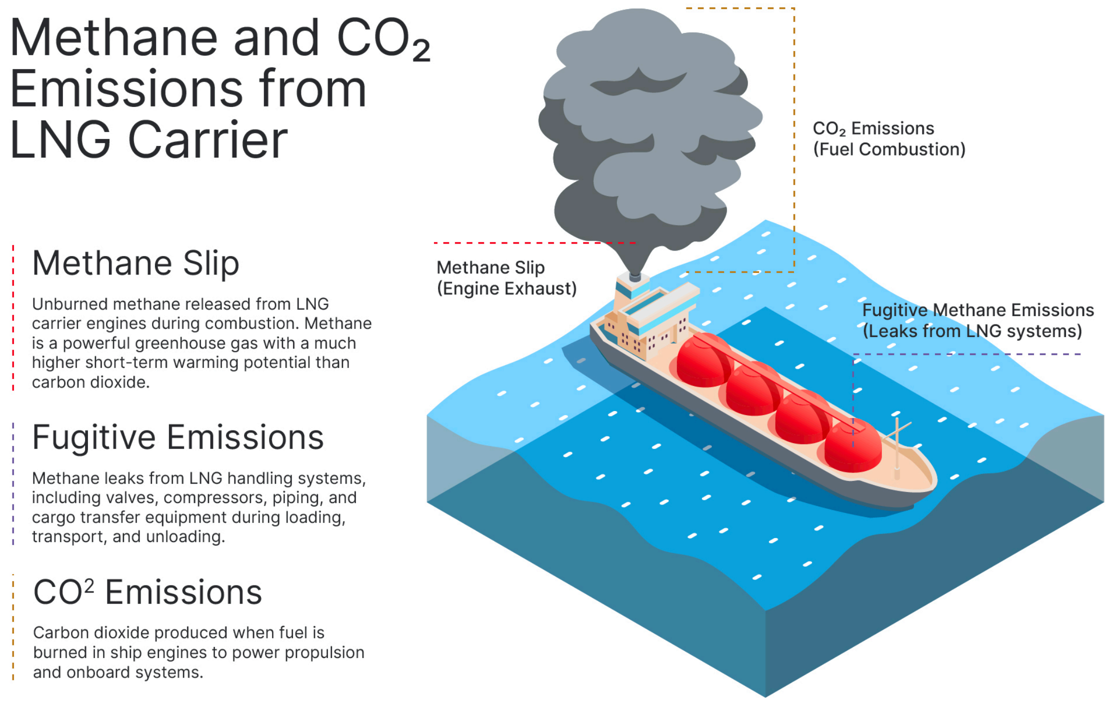
17 Sobanaa, M., Prathiviraj, R., Selvin, J., et al. (2024). A comprehensive review on methane's dual role: Effects in climate change and potential as a carbon-neutral energy source.

18 McCabe, S. J., Comer, B., Chen, Y., & Rutherford, D. (2023). Options for reducing methane emissions from LNG-fueled ships. International Council on Clean Transportation (ICCT).

19 International Council on Clean Transportation (ICCT), LNG Could Pull International Shipping Off Its Decarbonization Course (January 10, 2024).

20 SkyTruth, (2024). Satellite-based analysis of LNG tanker emissions and vessel traffic.

Figure 3. Cumulative emissions from LNG Carrier

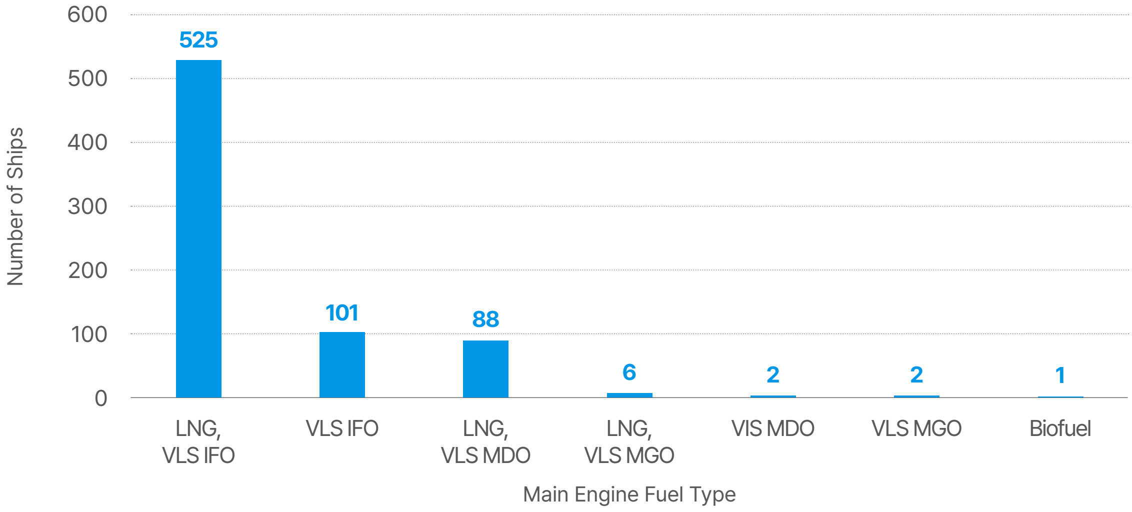


Current engine and fuel technology in the LNG carrier fleet

Current fleet data confirms a heavy reliance on high-emission technology. Over 525 vessels operate on dual-fuel LNG–VLSFO systems, and the fleet is dominated by 2-Stroke Dual-Fuel (Low Pressure) engines (239 vessels) known for elevated methane slip. These engines are widely used because they are efficient and cost-effective, but they are also known to have higher methane slip rates.

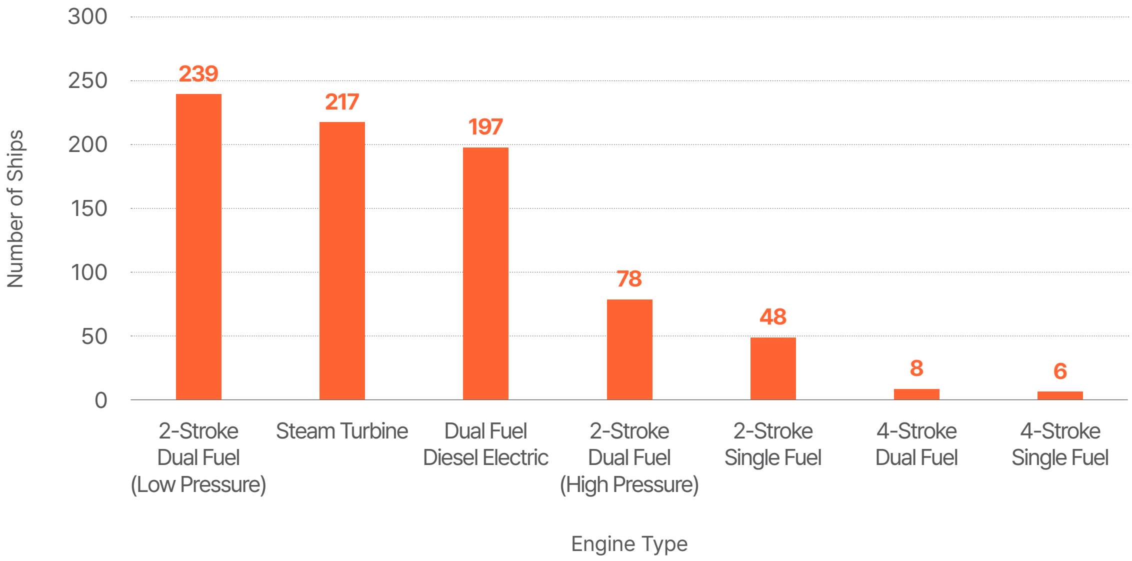
A smaller share of the fleet (78 vessels) — uses high-pressure dual-fuel engines, which significantly reduces methane slip. However, these engines introduce other environmental trade-offs, including higher emissions of nitrogen oxides (NOx) which can contribute to air pollution and nutrient loading in coastal waters.

Figure 4. Main Engine Fuel Type Distribution in LNG Carrier Fleet (Clarksons Research, World Fleet Register, 2025)



The figure shows that over 500 ships operate on dual-fuel LNG–VLSFO systems, confirming the sector's heavy reliance on fossil back-up fuels. Smaller fractions run exclusively on VLSFO or VLS MDO, with only negligible adoption of biofuels.

Figure 5. LNG Carrier Engine Types in Fleet (Clarksons Research, World Fleet Register, 2025)



The fleet is dominated by 2-Stroke Dual-Fuel (Low Pressure) engines (239 ships), followed by Steam Turbines (217) and Dual-Fuel Diesel Electric systems (197). High-pressure dual-fuel engines (78) and single-fuel units comprise the remainder.

Regulatory Pressure and Expected Diminishing Returns on LNG Carriers

As global regulations tighten, these technological choices will have a profound impact on vessel asset values. The implementation of the **EU Emissions Trading System (EU ETS)**, which will incorporate methane from 2026, alongside the **FuelEU Maritime** regulation, will impose escalating financial penalties on ships with high GHG intensity. For instance, vessels characterized by significant methane slip will face increased carbon levies and non-compliance fines, directly driving up operating expenses (OpEx).

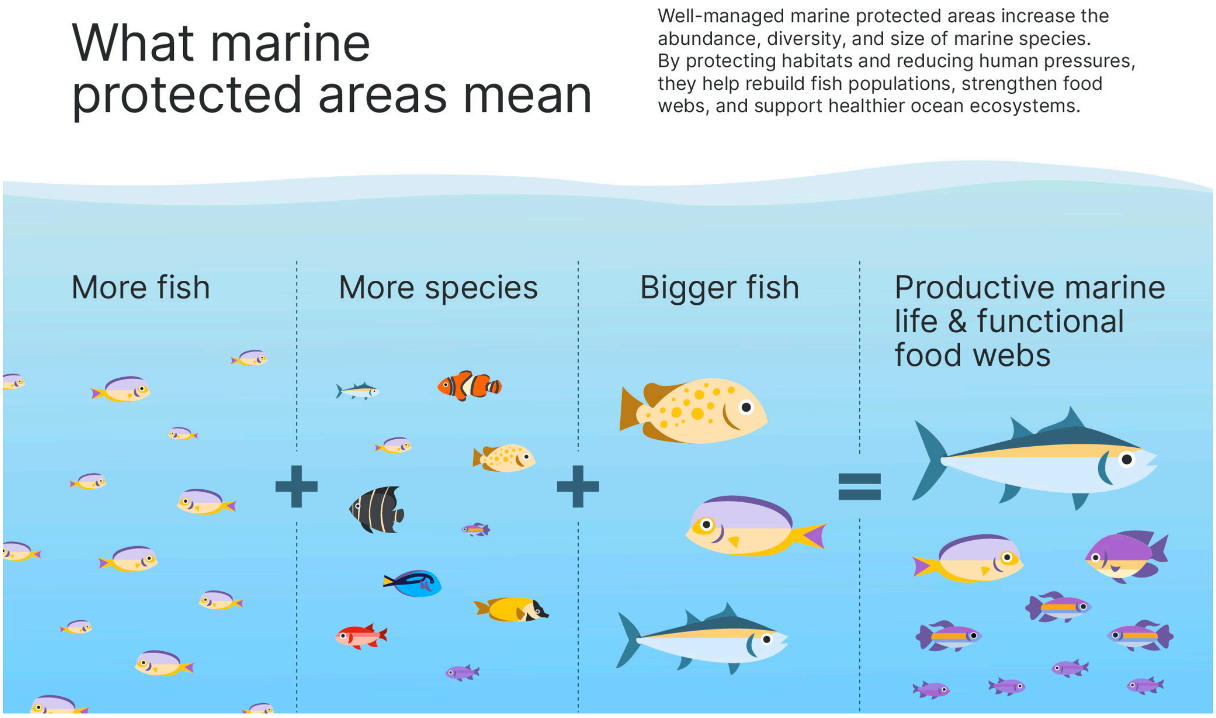
When coupled with the projected oversupply of 285 new ships on order, these rising regulatory costs are set to **sharply erode the expected returns and Net Present Value (NPV)** of the LNG fleet. Consequently, this structural shift increases the likelihood of asset impairment and early write-downs long before the end of their intended 30-year lifespans.

Table 1. Estimated LNG carrier emissions compared with China's annual greenhouse gas emissions (2023)

	# of ships	Emissions($GtCO_2e$)
LNGC In service	746	9,198
LNGC On order	285	3,514
Total LNGC	1031	12,712
China's annual GHG emissions 2023		15,944

Biodiversity & Marine Ecosystem Impacts

Figure 6. Introduction of Marine Protected Areas



Overview: cumulative impacts and regulatory blind spots

The expansion of the LNG carrier fleet places cumulative pressure on marine ecosystems, particularly in biodiversity hotspots and coastal corridors. These impacts arise from underwater noise, ballast water discharge and invasive species, and increased vessel traffic in sensitive areas.

Despite their scale and recurrence, these impacts are frequently excluded from project-level EIAs. EIAs for LNG projects often stop at onshore terminals, while the shipping phase is treated as mobile and therefore outside assessment scope. This creates a significant governance gap, especially in regions with marine protected areas, Indigenous fishing grounds, and critical habitats for marine mammals.

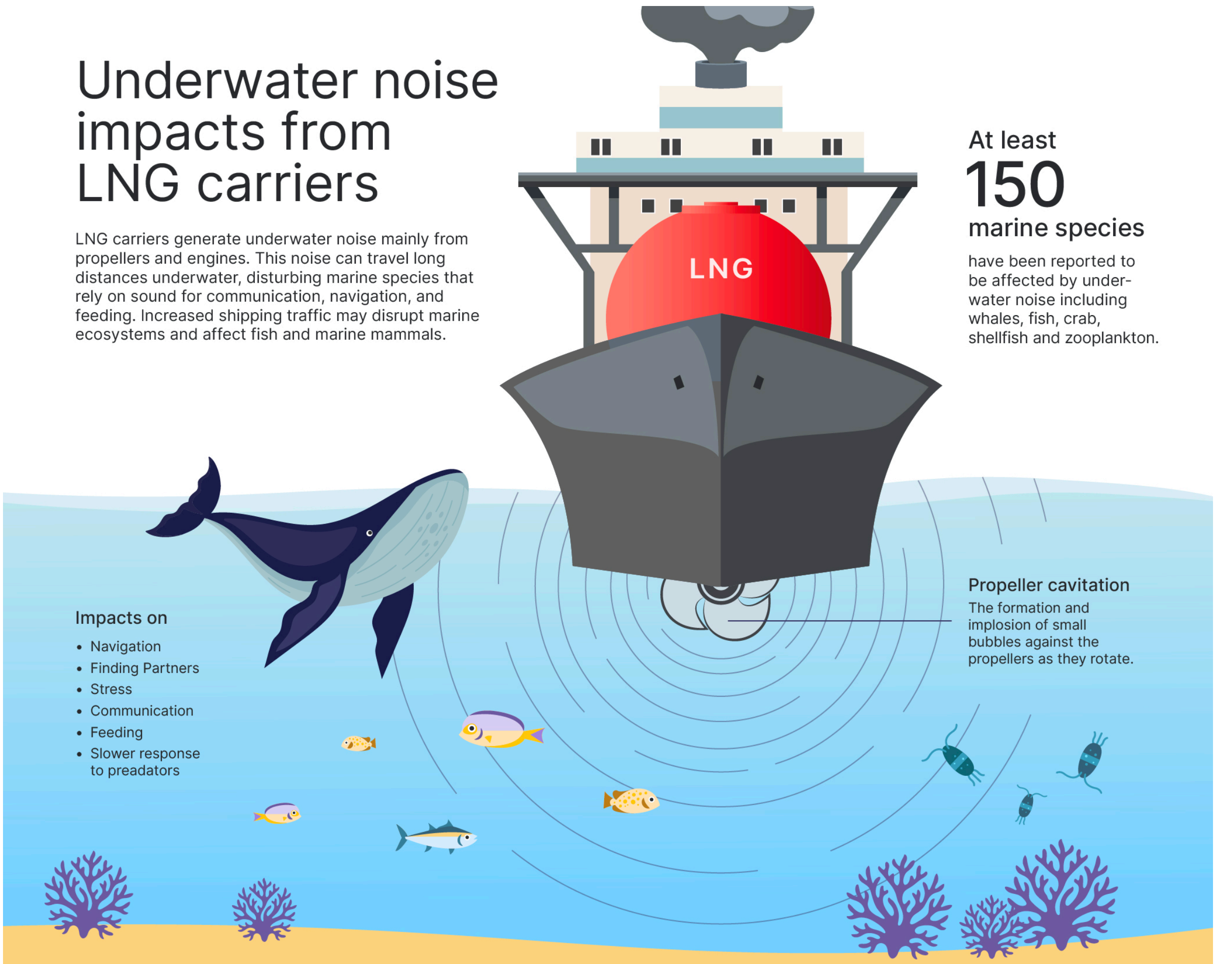
Underwater Noise Pollution

Sources and ecological relevance

Underwater noise from LNG carriers is generated primarily by propeller cavitation, engine machinery, and hull vibration.[21] LNG carriers are particularly disruptive in the low-frequency range (20–300 Hz), which overlaps with the communication, navigation, and foraging frequencies used by baleen whales and dolphins.[22]

Chronic exposure to low-frequency ship noise has been shown to interfere with marine mammals' ability to communicate, locate prey, and navigate. In biologically sensitive regions, this can lead to habitat displacement, increased stress, and reduced feeding efficiency.

Figure 7. Major sources and impacts of underwater noise from ships (Clean Arctic Alliance data, 2023)

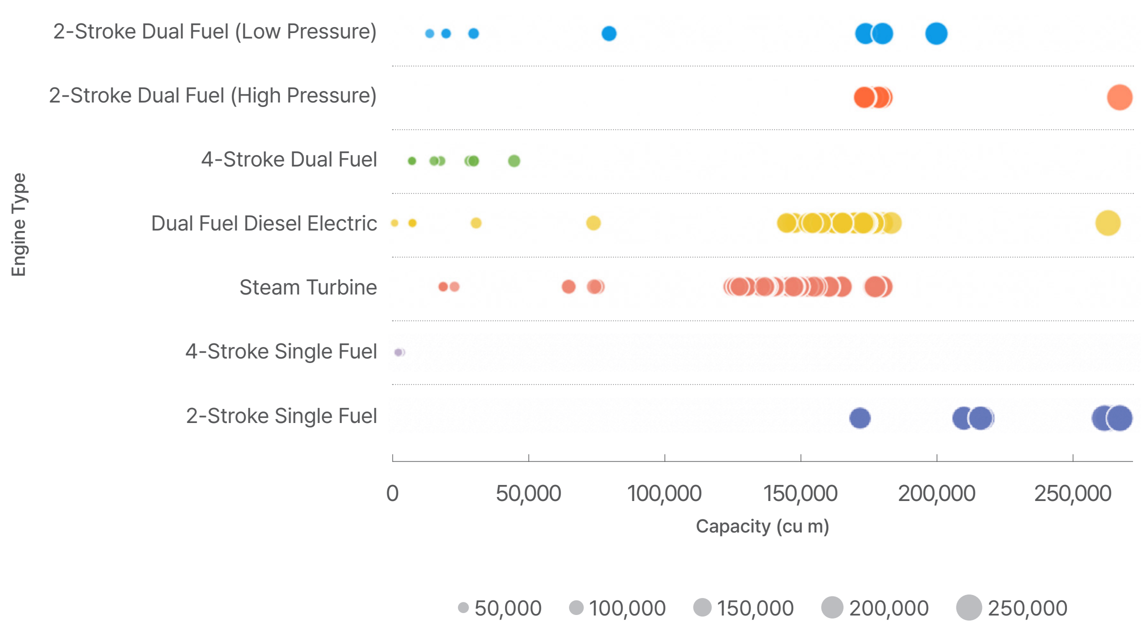


21 International Maritime Organization (IMO). (2025). Gap analysis of policies and recommendations for the mitigation of underwater radiated noise from shipping.

22 Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E., & Embling, C. B. (2019). The effects of ship noise on marine mammals — a review. *Frontiers in Marine Science*, 6, 606.

Technology choices and acoustic impacts

Figure 8. Capacity vs Engine Type of LNG Carriers(Clarksons Research, World Fleet Register, 2025)



Fleet data indicates a clear relationship between engine technology, vessel size, and acoustic impact:

- **Large Carriers (~174,000–180,000 m³)**
  - Predominantly powered by 2-stroke dual-fuel engines.
  - Low-pressure engines (X-DF), favored by Chinese yards, generate intense low-frequency noise, which propagates over long distances underwater.
  - High-pressure engines (ME-GI), common in Korean yards, reduce methane slip but produce sharper tonal noise and higher NOx emissions, creating different but still material environmental trade-offs.

- **Legacy Fleet**
  - Smaller or older vessels still utilize steam turbines or diesel-electric systems.
  - Steam turbines produce continuous vibrations affecting long-range cetacean communication over extended period.[23]

23 Riley, T., & Hollich, S. (2018). The Arctic: Anthropogenic Noise, Shipping, Impact on Marine Mammals, & Future Management.

From ecological impact to operational risk

Underwater noise is increasingly recognized not only as an environmental issue, but also as an operational and financial risk for shipping operators.

In regions such as British Columbia and the Gulf of California, authorities have introduced or are considering speed restrictions, routing measures, and exclusion zones to protect marine mammals.[24] While these measures aim to reduce ecological harm, they can also result in:

- Longer voyage times
- Reduced schedule reliability
- Higher fuel consumption per voyage
- Lower overall fleet utilization

For LNG carriers operating on tight delivery schedules and long-term charter assumptions, these disruptions can directly erode voyage efficiency and expected financial returns. As marine protection measures expand, especially in biodiversity hotspots, the mobility of LNG carriers — previously used to justify regulatory exclusion — may instead become a constraint on operations.

In addition to noise, LNG carriers rely on ballast water operations that can introduce non-indigenous species into coastal ecosystems. While the Ballast Water Management Convention sets technical standards, enforcement gaps and operational failures mean that invasive species risks remain material, particularly in enclosed seas and near sensitive coastal communities.

These impacts further contribute to cumulative ecological pressure and can trigger stricter port controls, inspections, and liability exposure for operators.

Ballast Water Discharge: The Enforcement Gap

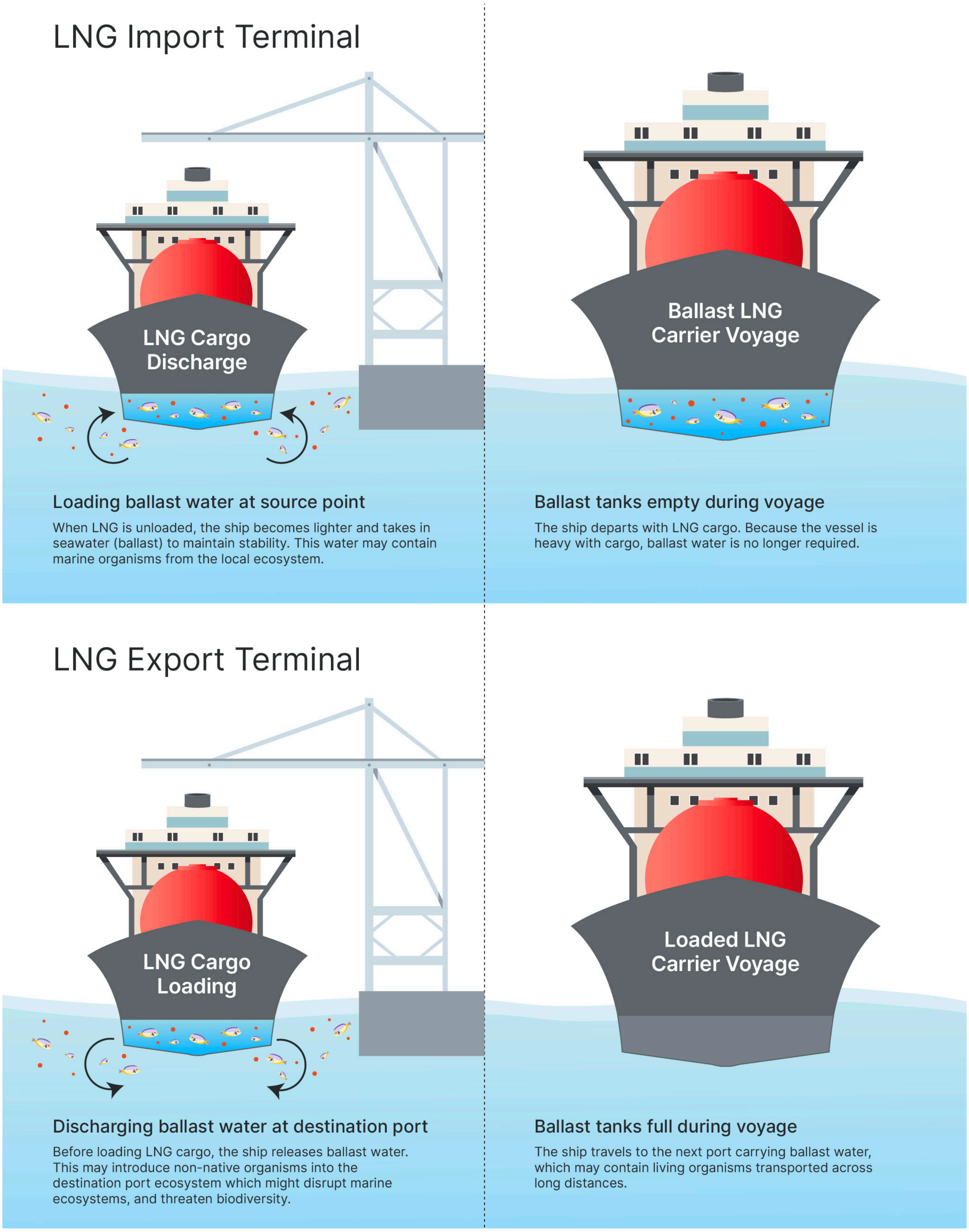
Why ballast water matters?

To maintain stability during cargo loading and unloading, LNG carriers must take in and release seawater, known as ballast water. As cargo is discharged at export terminals, ballast water is loaded; when cargo is loaded at import terminals, ballast water is discharged.

24 BIMCO. (2025, May 7). Whale protection measures in place from 1 May for parts of North America.

While this process is essential for vessel safety, it also creates a pathway for the transfer of marine organisms between regions. When ballast water taken up in one port is released in another, it can introduce non-indigenous species into local ecosystems, sometimes causing irreversible ecological damage.

Figure 9. Introduction of Ballast Water Discharge scheme



Regulatory framework and compliance gap

To address these risks, the Ballast Water Management Convention (BWMC) entered into force in 2017. The Convention requires ships to install Ballast Water Treatment Systems (BWTS) that meet the D-2 discharge standard, which limits the number of viable organisms released into the marine environment.[25]

However, Port State Control (PSC) inspection data shows a persistent gap between certification at delivery and actual performance during operation. Although vessels are certified as compliant when they enter service, inspections indicate that over 30% of BWTS fail to meet D-2 standards under real operating conditions.[26]

This gap highlights that compliance is not solely a technical issue, but also an operational and enforcement challenge.

Nature of non-compliance

PSC records show that non-compliance often involves:

- Inconsistent or incomplete record-keeping
- Discrepancies between ballast water logs and observed operations
- Insufficient crew training or familiarity with BWTS operation

While around 58% of non-compliance cases are classified as administrative[27], these documentation failures can conceal the continued discharge of untreated or improperly treated ballast water. As a result, invasive species risks persist despite formal compliance on paper.

Ecological and economic consequences: lessons from the Great Lakes

The consequences of unmanaged ballast water discharge are well documented in the U.S. Great Lakes, where invasive species such as zebra and quagga mussels were introduced through transoceanic shipping.

25 IMO Ballast Water Management Convention (official page)
26 Safety4Sea Editorial Team. (2024, November 26). Over 30% of ballast water treatment systems fail PSC inspections.
27 IIMS (2025) — One Third of Ballast Water Treatment Systems Fail PSC Inspections

Photo of quagga and zebra mussel infestation[28]

Since their introduction, these species have:

- Caused ecosystem disruption by filtering plankton, reducing food availability for native fish
- Contributed to the collapse of local fisheries and degraded habitat quality
- Imposed over USD 5 billion in economic costs, with more than USD 3 billion borne by power utilities due to clogged infrastructure

Implications for LNG carriers and financiers

The Great Lakes experience illustrates the latent liabilities associated with ballast water risks. As invasive species continue to generate significant ecological damage and economic costs — including projected annual damages exceeding USD 200 million in some U.S. states — regulatory scrutiny is increasing.[29]

For LNG carriers, this trend translates into:

- More frequent and rigorous PSC inspections
- Higher compliance and retrofit costs
- Greater exposure to litigation and port access restrictions
- Potential exclusion from ecologically sensitive regions

For shipowners and financiers, these factors increase operational uncertainty and downside risk, reducing expected fleet profitability and reinforcing the need to account for ballast water impacts in project-level risk assessments.

28 Photo By Bernie Azure, The Char-Koosta News referenced in Great Lakes Now. (2021). Cost of quagga and zebra mussel infestation

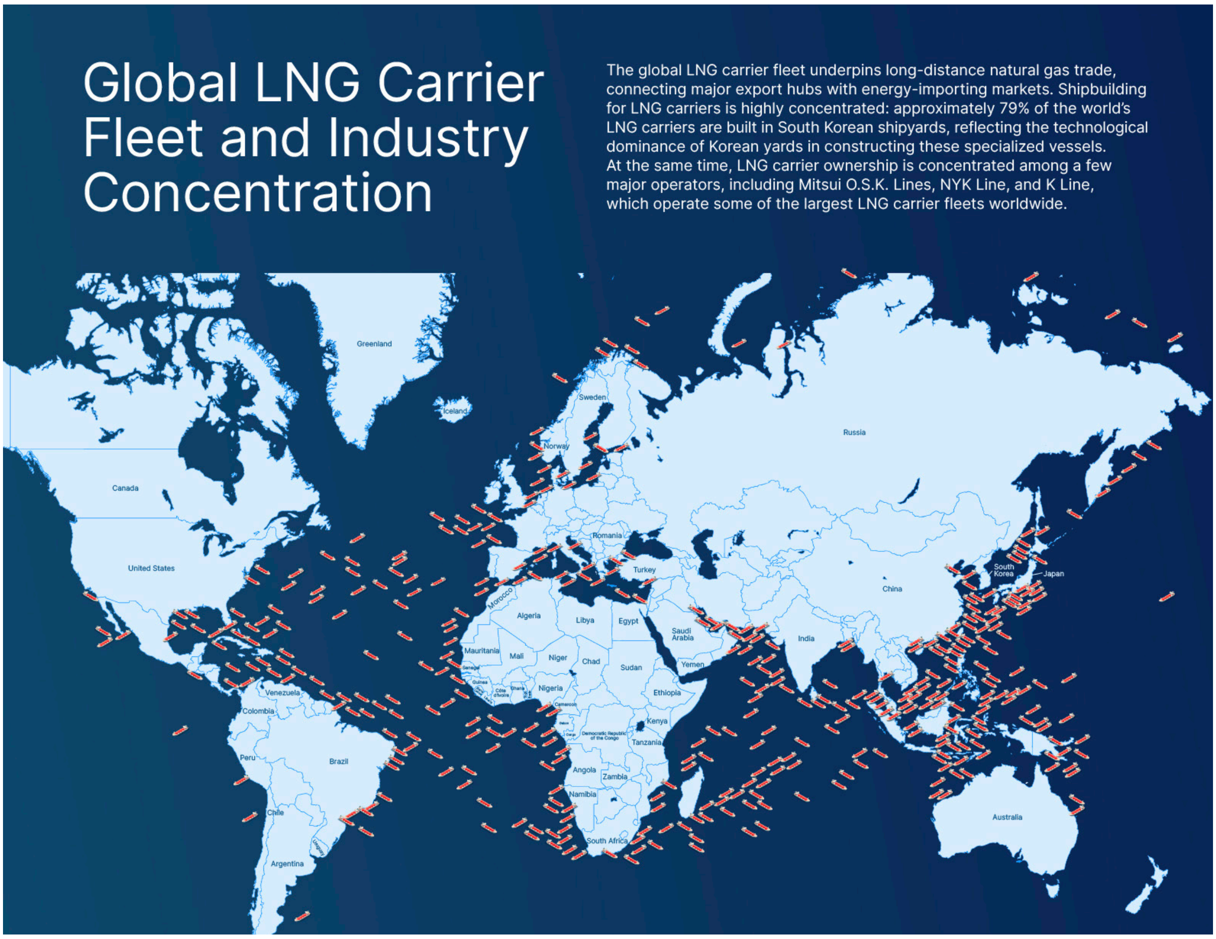
29 Great Lakes Now. (2021). Cost of quagga and zebra mussel infestation

Intersection of LNG Carrier Routes and Environmentally Vulnerable Regions

Global shipping patterns and exposure

LNG carriers are not isolated or location-neutral infrastructure. They operate as part of a global logistics system, connecting export hubs such as Qatar, the U.S. Gulf Coast, and Mozambique with major import terminals in Europe and East Asia.

Figure 10. Global LNG Carrier Fleet (Kpler, 2026)



In 2023 alone, approximately 500 LNG tankers collectively traveled over 77 million kilometers, a distance equivalent to the "Diamond Gas Rose" carrier circling the globe twice.[30] Mapping of vessel traffic shows that these movements are highly concentrated along a limited number of major shipping

30 SkyTruth. (2024, January 26). Mapping methane emissions from LNG vessels at sea.

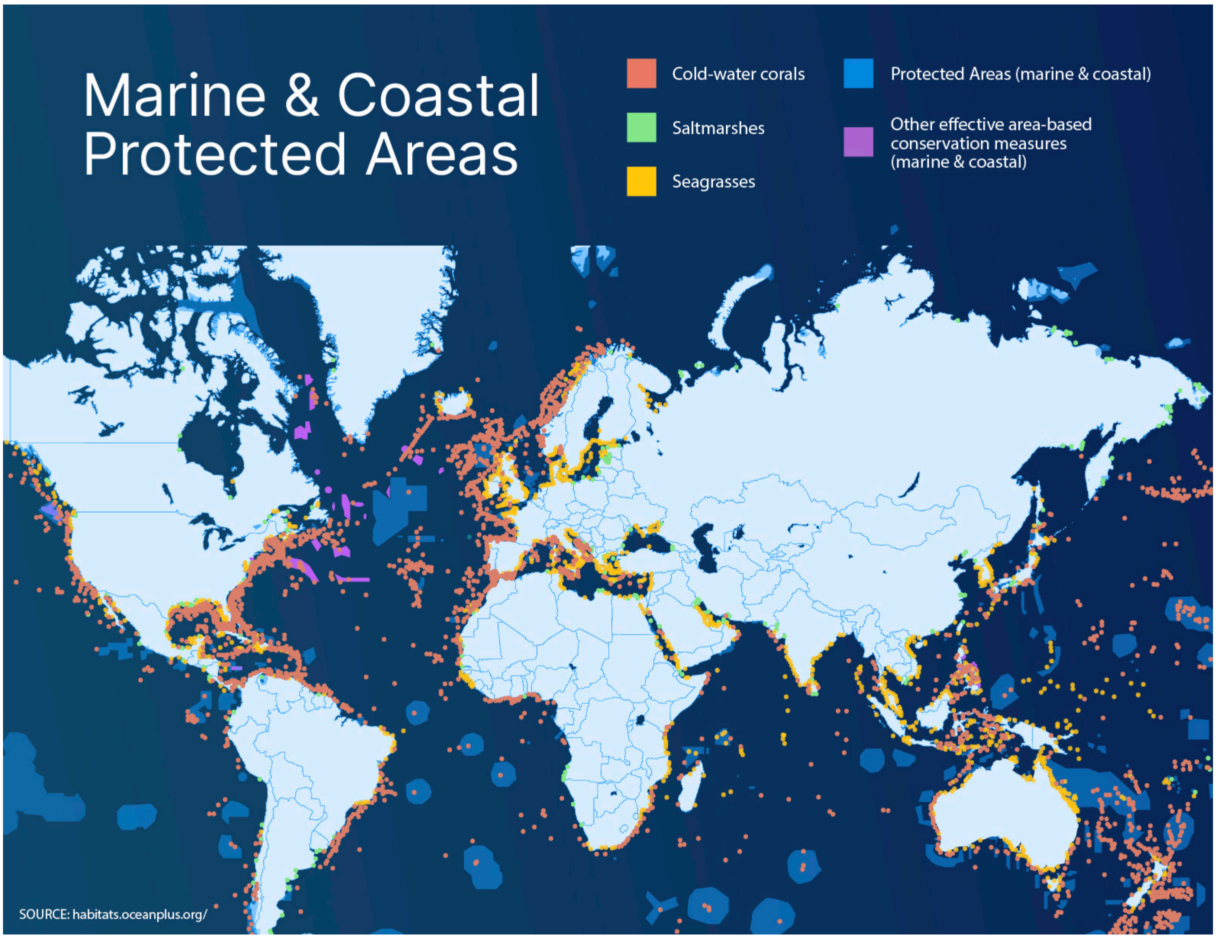
corridors, rather than being evenly distributed across oceans.[31]

As a result, LNG carrier traffic repeatedly intersects with some of the most environmentally sensitive marine regions in the world.

Concentration in ecological bottlenecks

LNG carriers predominantly transit biological bottlenecks-narrow or heavily trafficked marine corridors where ecological sensitivity and shipping density overlap. Many of these regions already face pressure from industrial activity, fisheries, and port development.

Figure 11. Location of Marine and Coastal Protected Areas worldwide



31 See Illustration 8.

Key examples include:

Region	Threatened Ecosystem	Impact Metric
Mozambique Channel	Whale breeding zones, coral reefs	Up to 20 carriers/week; >1,000 annual transits
Verde Island Passage (PH)	Coral Triangle, migratory fish routes	Threatens 1/3 of the world's whale/ dolphin species
Gulf of California (MX)	UNESCO-listed whale habitat	Route for proposed 600+ annual tanker transits
B.C. Coast (Canada)	Orca feeding grounds	Projected 610% traffic growth by 2040
Strait of Malacca	Mangroves, turtle nesting	High-density transit zone for East Asian markets

These regions are characterised by high biodiversity value, coastal livelihoods, and, in many cases, existing marine protection measures.

Figure 12. Intersection points of MPA's and LNG Carrier route

Tracking data from Kpler shows that the LNG carrier Diamond Gas Rose has travelled extensively between 2018 and 2025, covering long-distance international routes across multiple regions. During this period, the vessel repeatedly transited through marine areas of high ecological value, including recognized biodiversity-rich waters and sensitive marine corridors. These routes overlap with habitats critical for marine mammals and other vulnerable species, illustrating how routine LNG shipping activity intersects directly with areas of elevated environmental risk. The Diamond Gas Rose is cited here as a representative LNG carrier, selected to illustrate the scale of typical shipping operations, not for any particular significance.

Cumulative impacts along LNG shipping routes

The environmental impacts of LNG shipping are rarely the result of a single stressor. Instead, they arise from the interaction of multiple, overlapping pressures, including:

- Methane slip from vessel engines
- Chronic underwater noise affecting marine mammals
- Ballast water discharge and invasive species introduction
- Port dredging and navigational channel expansion

When these impacts occur repeatedly along the same routes and in the same ecosystems, their combined effect is greater than the sum of individual impacts.

This results in a systematic omission of cumulative effects, particularly in regions where LNG carrier traffic is both frequent and long-term.

Implications for regulation, operations, and asset utilization

From an investor and operator perspective, the absence of cumulative assessment represents a material blind spot.

As ecological stress in these regions intensifies, governments and regulators are increasingly expected to respond with:

- Speed restrictions
- Routing adjustments
- Seasonal exclusion zones
- Expanded marine protected areas

These measures, while aimed at environmental protection, can directly affect LNG carrier operations by:

- Increasing voyage duration
- Reducing schedule flexibility
- Limiting access to certain routes or ports

In this context, the mobility of LNG carriers—often cited as a reason for excluding them from EIAs—may instead become a source of operational vulnerability, leading to stranded routes, underutilized vessels, and diminished asset value over time.

Community and Human Rights Impacts

Overview: social impacts as material risk

The expansion of LNG shipping is not only a logistical or environmental issue; it has direct and indirect impacts on coastal communities and Indigenous peoples along LNG shipping routes. These impacts arise through the establishment of shipping exclusion zones, port expansion, increased maritime traffic, and cumulative environmental degradation affecting fisheries and access to coastal resources.

As these pressures intensify, community opposition, legal challenges, and security responses have increasingly translated into operational delays, cost overruns, reputational harm, and legal exposure. For investors and operators, social and human rights impacts therefore constitute a material operational and financial risk, rather than a peripheral concern.

Africa: Mozambique — The Cabo Delgado Coast and São Lazaro Bank

Photo taken in Mozambique (SFOC, 2026)

Context and route exposure

LNG carrier traffic serving Mozambique LNG (TotalEnergies) and Coral South FLNG (Eni) traverses the São Lazaro Bank,[32] a shallow, biodiverse shelf critical for coral ecosystems and whale migration. Shipping routes intersect directly with artisanal fishing grounds relied upon by coastal communities in Palma, Mocímboa da Praia, and surrounding areas.

Regulatory and assessment gaps

Both LNG projects excluded maritime shipping from their Environmental Impact Assessments (EIAs), despite the regular and high-frequency use of these routes. As a result, the cumulative impacts of shipping on marine ecosystems and local livelihoods were not formally assessed, nor were mitigation measures developed for fisheries access or community impacts linked to maritime operations.

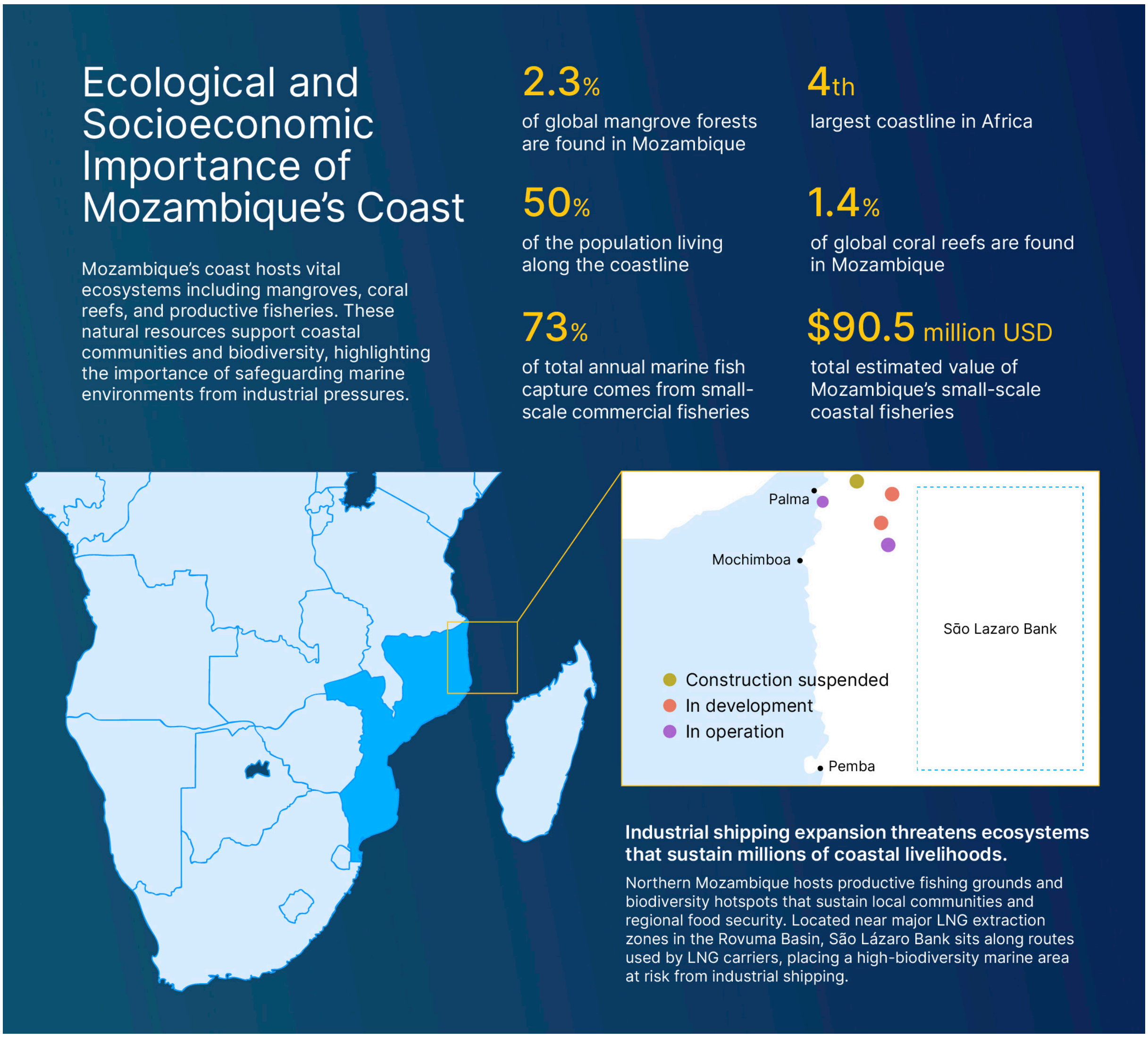
Operational and social impacts

Peak LNG carrier traffic of up to 20 vessels per week has intensified underwater noise, collision risk,[33] and ballast-water-related pressures in sensitive marine zones. Community members report declining fish catches and restricted access to traditional fishing areas, linked to port dredging and the enforcement of maritime "safety zones" around LNG facilities and shipping corridors.

32 Anadarko Mozambique Area 1, Lda. (2014). Environmental impact assessment for offshore drilling activities in Area 1, Rovuma Basin, Mozambique.

33 Engelbrecht CA, et al, (2025), 'True Risk: The environmental risks of deep-sea gas exploitation in the Rovuma Basin of Cabo Delgado, Mozambique'. Fair Finance Southern African and Justiça Ambiental!

Figure 13. Importance of Mozambique Coast



As artisanal fishing supports a majority of coastal livelihoods in northern Mozambique, these restrictions directly undermine household income, food security, and local economic stability.[34]

Security escalation, force majeure, and investor risk

The deterioration of social and security conditions in Cabo Delgado culminated in the March 2021 attack on Palma, after which TotalEnergies declared force majeure on Mozambique LNG and

34 Comia, H., Achia, S., & Machaieie, S. (2026). Artisan fishers' perception of climate change: A case study of Pemba district, Northern Mozambique.

suspended on-site operations.[35] The project remained halted for several years as insurgent violence continued to affect the region.[36]

By late 2025, TotalEnergies and partners had formally **ended the four-year freeze** on the USD 20 billion Mozambique LNG project as security conditions improved and resumed work under containment and security management protocols.[37]

Analyses indicate that the multi-year suspension and security dynamics have increased project cost exposure, with independent assessments citing upward cost pressures of at least USD 4.5 billion attributable to insurgency-related delays, disruption of work, and risk premiums required by contractors and financiers.[38]

Human rights concerns and security forces

Independent research and monitoring by policy institutes and civil society have documented credible allegations of human rights violations by Mozambican security forces deployed to protect LNG infrastructure, particularly in and around Palma after the 2021 attacks. Elements of these documented concerns include restrictions on civilian movement, detentions, and abuse of local residents in the context of military and police operations near project zones.[39]

Civil society groups, including Urgewald member organisations, have publicly urged the UN Office of the High Commissioner for Human Rights (OHCHR) to conduct an independent review of alleged violations linked to project security arrangements.[40]

Additionally, civil society reports submitted to financial watchdogs and investors have warned that unresolved human rights concerns constitute material governance and reputational risks, and that these concerns should be factored into project risk assessments by lenders and insurers.[41]

35 Reuters (2025). U.S. frees up almost $4.7 billion loan for TotalEnergies' Mozambique gas project, noting the project was paused in 2021 due to insurgent violence.

36 ISS Africa (2024). Terrorism takes its toll on Mozambique's gas revenue, estimating increased costs and revenue impacts linked to insurgent violence.

37 Energy News Africa (2025). TotalEnergies ends four-year freeze on the $20 billion Mozambique LNG project as security improves.

38 ISS Africa (2024). *Terrorism takes its toll on Mozambique's gas revenue*, estimating increased costs and revenue impacts linked to insurgent violence.; Energy in Africa (2025). *TotalEnergies force majeure Mozambique LNG*

39 Clingendael Institute (2023). Human rights violations by Mozambican security forces in the context of the Mozambique LNG project.

40 Urgewald (2023). Civil society urges the UN to investigate alleged human rights violations linked to Mozambique LNG.

41 BankTrack (2024). Civil society organisations condemn acceleration of gas projects in Mozambique, warning financiers of unresolved human rights and social risks.

In December 2025, media reporting documented that several UK and Dutch financial partners aligned with the project withdrew backing or publicly distanced themselves, explicitly citing concerns over security conditions and rights-related risk exposure as part of their decision calculus.[42]

Investor risk implications

For financiers and project partners, the Mozambique case illustrates how social, security, and human rights dynamics can escalate into material project risk. Multi-year suspensions, cost escalations, documented human rights concerns, and withdrawal of financial support demonstrate that community and security-related issues are not peripheral but central to long-term asset viability and financing outcomes for large-scale energy infrastructure.

ASEAN: Philippines — The Verde Island Passage (VIP)

Photo from Philstar. (2023). Verde Island Passage marine biodiversity [Alvin Simon/Protect VIP Network]

Ecological and community significance

The Verde Island Passage, often described as the "Amazon of the Oceans," is a global biodiversity hotspot and supports the livelihoods of thousands of small-scale fishers. It is also a designated Marine Protected Area intersected by major shipping lanes.

42 Le Monde (2025). TotalEnergies loses UK and Dutch backing for Mozambique gas project, citing security and human rights concerns.

Shipping-related risks and recent developments

Rapid expansion of LNG terminals and gas-fired power plants in Batangas has driven a sharp increase in tanker traffic through the passage, intensifying underwater noise, thermal discharge, and navigational pressure in ecologically sensitive waters.

Civil society organisations, including the Center for Energy, Ecology, and Development (CEED), have raised concerns that the absence of cumulative impact assessments for shipping poses an existential threat to both marine biodiversity and local livelihoods. In response to sustained legal and community opposition, several proposed LNG-related developments in the region have been delayed, modified, or cancelled, demonstrating the materialisation of social and environmental risk into project outcomes.

Comparable traffic intensification has been documented elsewhere in the Coral Triangle. Satellite-based vessel tracking published by SkyTruth shows a **dramatic increase in tanker traffic following the opening of an LNG terminal in Bali, Indonesia.** The data illustrate how LNG infrastructure development rapidly transforms regional shipping patterns, concentrating large-vessel movements in one of the world's most biologically diverse marine regions.[43]

The Coral Triangle supports over 75% of the world's coral species and underpins the livelihoods of millions of small-scale fishers.[44] The observed surge in tanker traffic following LNG terminal commissioning underscores the inadequacy of project-level Environmental Impact Assessments that exclude shipping activity, particularly in regions already under cumulative ecological stress.

- **Shipping Risk**: Rapid expansion of gas plants and LNG terminals in Batangas has triggered a surge in tanker traffic, leading to intensified underwater noise and thermal pollution. The Center for Energy, Ecology, and Development (CEED) has called this trend a "death sentence" for the region's biodiversity.[45]
- **Explosive Growth**: Vessel movements across the Coral Triangle are seeing "explosive growth," intersecting with Marine Protected Areas (MPAs) that sustain thousands of small-scale fishers. Without cumulative impact assessments, the region faces the irreversible loss of marine livelihoods.

43 SkyTruth. (2025, January 15). Visualizing the threats of fossil fuel expansion in the Coral Triangle.

44 Coral Triangle Initiative. (n.d.). Biodiversity in the Coral Triangle.

45 Center for Energy, Ecology, and Development (CEED). (2021, October 5). Locals, environmentalists seek termination of fossil gas projects, protection for Verde Island Passage

United States: Cameron Parish, Louisiana

The U.S. Gulf Coast, including Cameron Parish, Louisiana, hosts several of the world's largest LNG export terminals and associated shipping corridors, making it a focal point for cumulative industrial and maritime impacts.

Ecosystem degradation and fisheries impacts

Industrial dredging for LNG navigation channels and sustained tanker traffic have degraded estuarine ecosystems in southwest Louisiana, contributing to the decline of shrimp and crab populations that underpin local fisheries.[46]

Commercial fishers and coastal residents report that channel deepening, vessel wakes, and sediment resuspension have altered benthic habitats and fishing grounds, reducing catch reliability and increasing operating costs.[47]

Local fishing organizations, including Habitat Recovery Project (HRP) with the Fisherfamily Advisory Council for Tradition and Stewardship (FACTS) and For a Better Bayou (FABB), have documented reef burial, propeller wash damage, and gear loss linked to LNG vessel movements and dredging operations.[48]

Coastal erosion and land loss

In 2023, the National Oceanic and Atmospheric Administration (NOAA) confirmed that channel expansion and vessel traffic contribute to accelerated coastal erosion by increasing wave energy, shoreline scouring, and wetland loss in already vulnerable areas of coastal Louisiana.[49]

46 National Oceanic and Atmospheric Administration (NOAA). (2023). Underwater: Land loss in coastal Louisiana since 1932.

47 McKenna, P. (2025, September 7). Fishermen in southwest Louisiana say LNG terminals are to blame for shrimp harvest decline. Inside Climate News.

48 Habitat Recovery Project. (n.d.). The facts.

49 (NOAA). (2023). Underwater: Land loss in coastal Louisiana since 1932.

Photo provided by Habitat Recovery Project on Vessel-related shoreline erosion and infrastructure damage in coastal Louisiana

Gulf of California: Saguaro LNG and Whale Sanctuaries

Context and ecological significance

The proposed Saguaro LNG export project (Sonora, Mexico) would rely on LNG carrier traffic transiting the Gulf of California, a semi-enclosed sea internationally recognised for its exceptional marine biodiversity.[50] The region hosts 39% of the world's marine mammal species, including blue whales, fin whales, sperm whales, humpback whales, and the critically endangered vaquita porpoise, whose remaining population is estimated at fewer than 10 individuals.[51]

The Gulf is designated as a **UNESCO World Heritage Site**, often referred to as the "Aquarium of the World", reflecting its ecological productivity and global conservation importance.[52]

Shipping intensity and lethal route exposure

Based on the planned export capacity of up to 15 Mtpa, shipping demand analyses suggest that several hundred LNG carrier transits annually—potentially exceeding 600 transits under expanded

50 Cunningham, N. (2025, June 26). Saguaro LNG project in Mexico faces "major red flags."

51 UNESCO World Heritage Centre. Listing for the Gulf of California

52 UNESCO World Heritage Centre. Islands and protected areas of the Gulf of California

capacity scenarios—would be required to support full Saguaro LNG operations.[53] These voyages would pass directly through core whale migration corridors and feeding grounds, substantially increasing:

- Ship-strike risk, particularly for slow-moving baleen whales
- Chronic underwater noise exposure, overlapping with cetacean communication frequencies
- Cumulative stressors in an already constrained and semi-enclosed marine system

According to marine scientists cited by **Natural Resources Defense Council (NRDC)**, even moderate increases in large-vessel traffic in the Gulf materially elevate mortality risks for whales and dolphins, with impacts that are **non-linear and cumulative** rather than incremental.[54]

Acoustic impacts and habitat degradation

LNG carriers generate sustained low-frequency underwater noise (20–300 Hz), which propagates efficiently in deep, enclosed waters such as the Gulf of California. Scientific assessments referenced by NRDC and Mexican conservation organizations find that:

- Chronic noise disrupts foraging, navigation, mating, and calf-rearing
- Noise masking reduces the effective communication range of whales by up to 90% in high-traffic corridors
- Acoustic disturbance can lead to functional habitat loss, even in the absence of physical degradation

For the vaquita, which relies on acoustic cues for navigation and feeding, additional vessel noise compounds existing pressures from bycatch and habitat fragmentation.[55]

Legal challenges and regulatory risk

A coalition of Mexican and international NGOs has filed legal challenges against Saguaro LNG[56], urging Mexican authorities to revoke or suspend permits on the grounds that:

- Environmental assessments failed to evaluate cumulative shipping impacts
- Marine biodiversity risks were systematically underestimated
- Impacts on protected species and UNESCO-listed ecosystems were inadequately addressed

53 Institute for Energy Economics and Financial Analysis (IEEFA). (2025). Mexico Pacific Limited: Delays, turmoil, and permitting errors have stymied Mexico's largest LNG project.

54 IUCN Red List. Vaquita species.; NRDC. What Saguaro LNG Project Means for Marine Wildlife

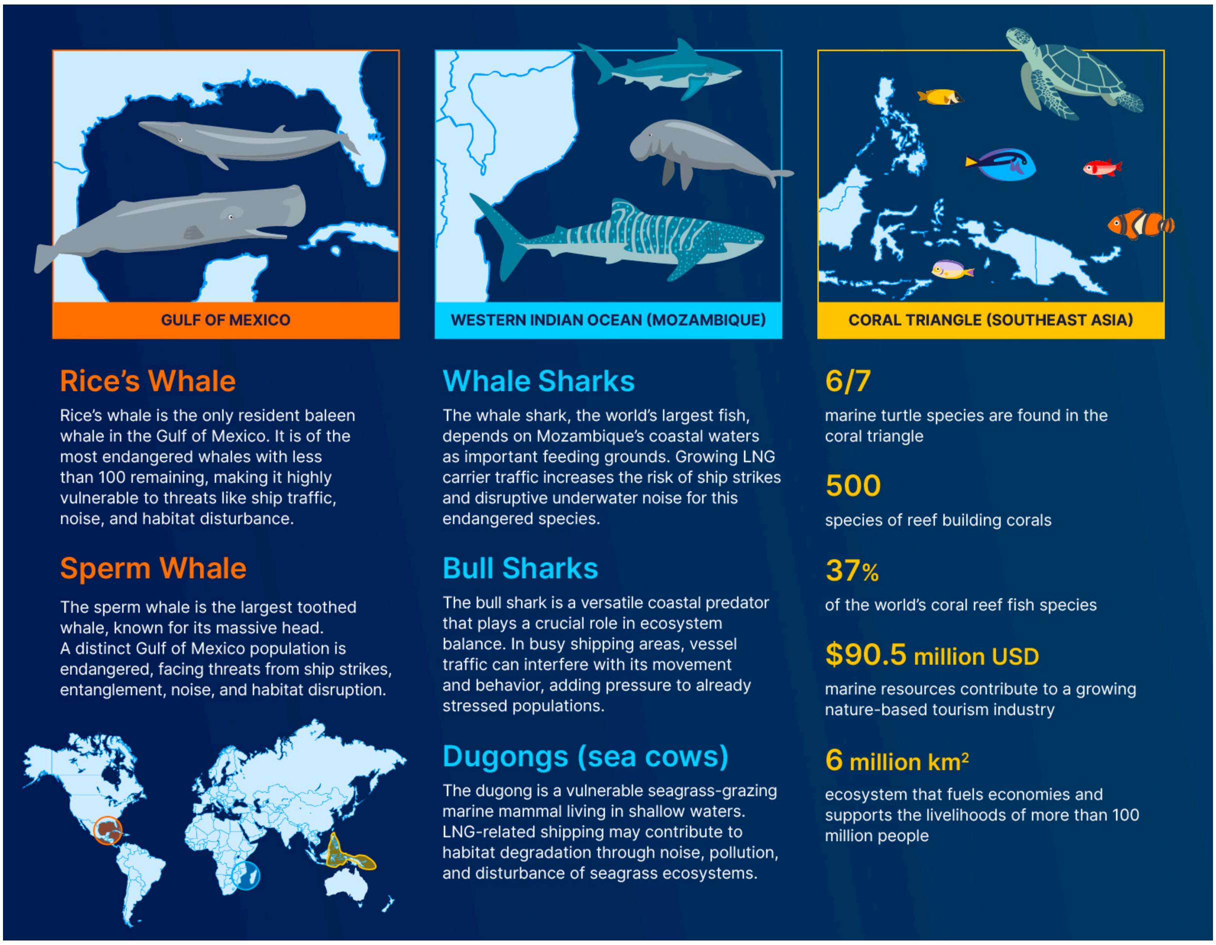
55 Rojas-Bracho, L., & Taylor, B. L. (2017). Phocoena sinus. The IUCN Red List of Threatened Species

56 Private Equity Shareholder Project. (2024). PE-backed LNG project marred with setbacks and community opposition

These cases remain active and represent a material permitting and schedule risk for project developers and associated shipping operators.

The Saguaro LNG case underscores the importance of assessing LNG shipping not as an isolated logistical function, but as an integral component of project-level environmental, social, and financial risk. In ecologically constrained regions such as the Gulf of California, cumulative shipping impacts represent a material consideration for asset valuation, insurance, and long-term fleet deployment.

Figure 14. Animal Habitat Map



Canada: British Columbia — LNG Canada and Orca Protection

In the Douglas Channel-part of the Haisla Nation's traditional territory, LNG Canada is projected to dramatically increase vessel traffic in sensitive fjord ecosystems.

- **Collision Risk**: Tanker calls are forecast to increase by 700% by 2030. WWF Canada warns that without robust mitigation, this could lead to 20 whale deaths (fin and humpback) per year.[57]
- **Acoustic Interference**: Increased vessel traffic contributes to underwater noise that interferes with whale communication and habitat use.
- **Lack of Transparency**: Proprietary monitoring plans by LNG Canada restrict independent validation, raising concerns over the efficacy of proposed mitigation.

57 World Wildlife Fund Canada. (2025, July 29). Fatal ship-strike risk from LNG tankers threatens great whales in BC's Great Bear Sea.

Financial Risk and Stranded Asset Exposure

Despite intensifying global decarbonization trends, public and private capital injection into the LNG shipping sector remains at historic highs. However, shifting market indicators and the evolving policy environment point toward significant structural financial risks for these assets.

- **Historic Highs in the Orderbook**: As of 2026, over 285 LNG carriers are under construction or on order a historic peak that likely exceeds the market's absorption capacity.
- **Asset Devaluation and Write-off Risk**: According to an analysis by the UCL Energy Institute and the Kuehne Climate Center, approximately $48 billion in LNG carrier investments face the risk of being written off as stranded assets by 2035 under a demand trajectory aligned with Paris Agreement climate goals.[58]
- **Profitability Decline from Structural Oversupply**: Deliveries scheduled between 2026 and 2027 will introduce new shipping capacity equivalent to roughly one-quarter of the existing global LNG fleet. This influx of supply serves as a direct catalyst for declining freight rates, reduced vessel utilization, and deteriorating profitability.
- **High Capital Intensity and Debt Exposure**: With construction costs reaching approximately $250 million per vessel, these high-value assets involve large-scale fleet-wide debt financing. This creates an immediate threat to the financial health of both shipowners and financiers during periods of market volatility.

Photo of Three Jumping Killer Whales from Pexels [Holger Wulschlaeger]

58 Kuehne Climate Center & UCL Energy Institute. (2025, September 22). USD 48 billion invested in LNG carriers could be written off by 2035.

Conclusion and Recommendations

The findings of this report indicate that LNG carriers cannot be considered suitable assets for a carbon-neutral transition. They generate significant, unquantified environmental and social costs, including methane slip, underwater noise, and ecological disruption from ballast water discharge. Specifically, formalistic interpretations based on the 'mobility' of these vessels have excluded them from Environmental Impact Assessments and climate disclosures, creating a critical information gap for regulators and investors alike.

Policy and Regulatory Recommendations

- **Align EIAs with existing international standards**: Apply the OECD Common Approaches, IFC Performance Standards, and Equator Principles to ensure that EIA for new gas projects include full lifecycle and transport-related impacts, including LNG carrier construction, operation, and decommissioning where vessels are integral to the project.
- **Strengthen methane regulation in shipping**: Enhance international and regional emission frameworks, including those under the IMO, by improving monitoring, reporting, and verification and tightening limits on methane slip from marine engines.
- **Protect environmentally sensitive marine areas**: Expand the use of established maritime management tools-such as routing measures, speed restrictions, and exclusion zones—in biodiversity hotspots and whale migration corridors.
- **Assess cumulative impacts along LNG shipping routes**: Apply cumulative impact assessment approaches, consistent with UNEP, CBD, and World Heritage guidance, that cover entire maritime transport routes.

Financial and Investment Recommendations

- **Review Capital Allocation**: Establish screening criteria that reflect the current supply-demand dynamics and the risk of oversupply in the LNG carrier market.
- **Redefine Green Taxonomies**: Exclude LNG carriers from green or transitional finance eligibility until their actual climate and ecological impacts are addressed.
- **Enhance Risk Assessment Criteria**: Integrate marine biodiversity protection and community rights as mandatory indicators within ESG ratings and investment due diligence processes.

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Solutions for Our Climate

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Design Nature Rhythm

Solutions for Our Climate(SFOC) is an independent policy research and advocacy group that aims to make emissions trajectories across Asia compatible with the Paris Agreement 1.5°C warming target.