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The Environmental Risks of a Floating LNG Terminal in the Pagasetic Gulf

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Abstract

This report assesses the environmental risks associated with the proposed floating liquefied natural gas terminal in the Pagasetic Gulf, an enclosed marine system in central Greece. The study is based on long term ecological monitoring by Merman Conservation, which includes systematic field observations of marine mammals, fish nurseries, seabirds, and seagrass habitats. The evidence shows that the project could alter the ecological balance of the gulf through increased underwater activity, thermal discharge, accidental fuel leakage, reduced water quality, and disturbance of sensitive breeding and feeding zones. Particular concern arises for resident dolphins, Posidonia oceanica seagrass meadows, and nursery grounds supporting commercial fisheries. The findings emphasize that the enclosed nature of the Pagasetic Gulf intensifies potential environmental impacts and supports the need for precautionary decision making and stronger conservation focused management before any industrial development proceeds.

Keywords: LNG terminal, Pagasetic Gulf, marine ecology, environmental risk

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Introduction

The Pagasetic Gulf, located in Thessaly, Greece, is a semi-enclosed, shallow marine ecosystem of exceptional ecological importance. Its sheltered waters, diverse seabed habitats, and limited exchange with the open sea create conditions that support a rich array of marine life. Key habitats include Posidonia oceanica meadows (Amoutzopoulou-Schina & Haritonidis, 2005), which serve as nurseries for fish and invertebrates, stabilize sediments, and contribute to carbon sequestration. The Gulf also sustains populations of seabirds, marine mammals, and other species that rely on relatively undisturbed coastal and offshore environments, making it a critical area for biodiversity conservation.

Merman Conservation Ltd, based in Edinburgh, United Kingdom, is an environmental consultancy and field-focused company dedicated to monitoring, researching, and protecting marine and terrestrial ecosystems. The company operates a field research station in South Pelion, Greece, where the Pagasetic Gulf is one of the key areas under continuous ecological observation. Through long-term surveys, camera trap studies, and community engagement, Merman Conservation Ltd documents wildlife populations, assesses ecological threats, and develops science-based management strategies to support biodiversity conservation.

The proposed construction of a floating Liquefied Natural Gas (LNG) terminal in the Gulf presents significant environmental risks. These include potential water pollution, habitat degradation, underwater noise disturbance, and disruption to sensitive marine species. This report draws on scientific literature, regional ecological knowledge, and conservation expertise to provide a professional assessment of the potential ecological impacts and risks associated with

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the proposed LNG terminal. It aims to inform stakeholders, policymakers, and the broader public about the importance of safeguarding the Gulf’s unique biodiversity while highlighting the precautionary measures necessary to protect this fragile ecosystem.

Water Pollution and Chemical Risks

Liquefied Natural Gas (LNG) operations involve the handling of large volumes of cryogenic gas, along with various chemicals used in pipelines, storage, and processing. Even minor leaks or accidental spills can introduce hazardous substances into the marine environment, posing significant risks to local ecosystems.

Studies have shown that hydrocarbons and chemical residues can accumulate in *Posidonia oceanica* meadows, a dominant seagrass species in the Mediterranean, making them effective bioindicators of marine contamination (Apostolopoulou et al., 2014). Exposure to such pollutants can cause mortality, impaired reproductive success, developmental abnormalities, and behavioral changes in fish and invertebrates, which may destabilize local populations (Boudouresque et al., 2015).

Pollution can also disrupt planktonic and microbial communities that form the foundation of the Gulf’s food web. Alterations in nutrient cycling and reductions in primary productivity weaken overall ecosystem function and biodiversity resilience (López y Royo et al., 2010). Because the Pagasetic Gulf is shallow and semi-enclosed, water exchange with the open sea is limited, reducing natural dilution processes. Consequently, any chemical or oil spill may persist for extended periods, increasing exposure risk for all organisms and amplifying ecological damage (Apostolopoulou et al., 2014).

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The combination of restricted flushing capacity, sensitive habitats such as *P. oceanica* meadows, and the presence of commercially and ecologically valuable species makes the Gulf particularly vulnerable to chemical contamination. Preventive and mitigation strategies, including strict spill prevention protocols, real-time monitoring, and adaptive response plans, are essential to avoid long-term environmental degradation (Boudouresque et al., 2015; López y Royo et al., 2010).

Thermal Pollution

The regasification of LNG involves converting cryogenic gas back into its gaseous state, releasing heat into surrounding waters. Even minor temperature increases can have disproportionate ecological consequences in semi-enclosed systems such as the Pagasetic Gulf. Many fish species in these habitats exhibit temperature-dependent spawning and larval development. Even small thermal fluctuations may disrupt these life cycles, reducing egg viability and recruitment success (Roca et al., 2022).

Seagrass meadows of *P. oceanica* are particularly sensitive to thermal stress (Agius et al., 2023). Elevated temperatures can impair photosynthesis, reduce growth rates, and cause partial dieback, leading to the loss of critical nursery habitat for fish and invertebrates (Roca et al., 2022). Long-term thermal disturbances may further shift benthic community composition by favoring opportunistic or thermally tolerant species over native ones (Trois et al., 2024).

At the ecosystem level, sustained thermal inputs can cascade through the food web, altering predator-prey dynamics, nutrient cycling, and carbon storage. In the Pagasetic Gulf, limited water circulation exacerbates the persistence of thermal plumes, heightening the risk of chronic

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ecological stress (Trois et al., 2024). Effective risk management requires careful monitoring of temperature profiles, control of thermal discharge points, and the use of predictive ecological modeling to safeguard sensitive marine habitats.

Acoustic and Vibration Disturbances

Floating LNG terminals, along with the associated increase in ship traffic, generate continuous underwater noise and vibrations that can propagate across large areas of the marine environment. In semi-enclosed and shallow ecosystems such as the Pagasetic Gulf, these acoustic disturbances are often amplified due to limited water circulation and reflective seabed conditions, increasing their potential impact on marine life (Maglio & Salivas, 2025).

Marine mammals such as dolphins and seals rely heavily on sound for communication, navigation, and foraging. Chronic exposure to anthropogenic noise can cause stress, disorientation, and avoidance of essential feeding and breeding areas, ultimately leading to reduced reproductive success, population displacement, and long-term declines in sensitive species (Pavan, 2002; Maglio & Salivas, 2025). Continuous low-frequency noise and ship-generated vibrations may also interfere with echolocation and social communication, impairing vital behaviors critical to survival and reproduction.

Fish and invertebrates are similarly affected, as many species use sound for communication, predator avoidance, and migration cues. Prolonged exposure to elevated noise levels can disrupt these behaviors, alter migration routes, and increase mortality among larvae and juveniles. Experimental studies further indicate that even seagrass habitats can be directly impaired by

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underwater noise, with *Posidonia oceanica* showing tissue damage and reduced photosynthetic efficiency under chronic acoustic stress (Solé et al., 2021).

Over time, these disturbances can cascade through the ecosystem, leading to chronic stress responses, immune suppression, and reduced reproductive capacity among marine organisms. As sensitive species decline, they may be replaced by more noise-tolerant or opportunistic species, altering biodiversity structure and weakening ecosystem resilience (Maglio & Salivas, 2025). Mitigating noise pollution requires careful spatial planning of LNG terminal operations, rerouting of shipping lanes, implementation of noise-reducing technologies, and long-term acoustic monitoring to safeguard the ecological integrity of the Gulf.

Habitat Disruption

The installation and operation of a floating LNG terminal, combined with the associated vessel traffic, pose significant risks to benthic and coastal habitats. Physical infrastructure, anchoring, and maintenance activities can disturb or fragment sensitive seabed ecosystems, with cascading effects on biodiversity (Pergent-Martini et al., 2022).

In the Pagasetic Gulf, *Posidonia oceanica* meadows play a crucial role in maintaining ecological balance, providing shelter, feeding grounds, and nursery areas for fish and invertebrates. Mechanical disturbance from anchors, chains, and construction equipment can uproot seagrass, reduce meadow coverage, and compromise its stabilizing and carbon-sequestering functions (Pergent-Martini et al., 2022; Boudouresque et al., 2015). Because *P. oceanica* grows slowly,

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recovery after disturbance is extremely limited, making even small-scale damage potentially long-lasting.

Anchoring and sediment resuspension can also reduce water clarity and smother benthic organisms. Fine sediments that settle on seagrass leaves interfere with photosynthesis and nutrient absorption, while suspended particles can disrupt filter-feeding species and reduce oxygen availability. These changes degrade overall habitat quality and the structure of benthic communities (Boudouresque et al., 2015).

Habitat fragmentation further reduces ecological connectivity, limiting movement and breeding opportunities for marine organisms. As ecological niches are lost, biodiversity declines, and ecosystem services such as fisheries, carbon sequestration, and coastal protection become compromised. Preventive strategies, including the avoidance of sensitive habitats for anchoring, use of mooring systems that minimize seabed contact, and pre-construction mapping of critical habitats, are essential to maintain ecosystem integrity (Pergent-Martini et al., 2022).

Food Chain Alterations

The ecological impacts of a floating LNG terminal extend beyond direct habitat damage, as disturbances to lower trophic levels can cascade through the entire food web. Even modest changes in plankton, invertebrate, or small fish populations can disrupt predator-prey dynamics and threaten the overall balance of the ecosystem. Research near the Porto Viro LNG terminal in the Adriatic Sea demonstrated that effluent and foam discharge altered plankton community structure and reduced microalgal diversity (Franzo et al., 2015). Similarly, modeling of LNG

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terminal intake systems in the Gulf of Mexico showed that entrainment and impingement of fish eggs and larvae could reduce recruitment and affect local fisheries (Gallaway et al., 2007).

Impacts on prey availability are further intensified by chemical contamination, thermal effluents, sediment disruption, and underwater noise, which can reduce populations of plankton, mollusks, and small fish that form the foundational prey base for higher trophic levels. Studies in Massachusetts Bay found that offshore LNG operations influenced local fish abundance and behavior through structural and acoustic disturbances (Caruso et al., 2010). Such declines compromise energy transfer within the food web and may reduce ecosystem productivity and resilience.

For higher trophic levels, the consequences can be substantial. Marine mammals and seabirds that depend on predictable prey resources may experience lower growth rates, reproductive failure, and reduced juvenile survival. Research on offshore wind energy development has shown that persistent noise and habitat alteration can cause trophic-level effects extending to marine mammals and piscivorous birds (Wang et al., 2023). Over time, ongoing disturbances at the base of the food web can shift community composition toward opportunistic or invasive organisms, while native biodiversity declines. These changes can disrupt predator-prey relationships, nutrient cycling, and ecosystem stability, reducing both ecological and economic value.

Protecting the integrity of lower trophic levels requires strict control of discharges, management of thermal plumes, and careful limitation of seabed disturbance. Recent studies indicate that even subtle chemical or nutrient changes can alter plankton food web structure and reduce trophic

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transfer efficiency (Sánchez et al., 2024). Continuous ecological monitoring and adaptive management are essential to maintain food web stability and ecosystem resilience.

Accident Risks

Floating LNG terminals also carry inherent risks of leaks, explosions, and fires, which can cause severe and sudden ecological consequences. In semi-enclosed systems such as the Pagasetic Gulf, limited water circulation magnifies the environmental impact of any accidental release by restricting dispersal and prolonging exposure to contaminants. Accidental discharges of LNG, hydrocarbons, or associated chemicals could affect multiple habitats at once, including benthic communities, seagrass meadows, and pelagic species. Such events may lead to acute stress, mass mortality, or long-term habitat degradation.

Migratory and breeding species such as dolphins, seals, and fish-eating seabirds are particularly vulnerable to catastrophic events. Disturbance or mortality during critical life stages can cause population-level declines and interrupt reproductive cycles. The loss of prey or displacement from key feeding areas would further exacerbate these pressures.

The socio-economic impacts of an accident would also be considerable. Local fisheries, aquaculture, and tourism depend on the health of the Gulf's ecosystems. A major incident could result in lasting economic losses, reduced livelihoods, and diminished food security. Recovery for both ecological and human systems could require many years and may not restore previous conditions.

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Preventing such accidents requires rigorous operational standards, continuous safety monitoring, and robust emergency response plans. Given the environmental sensitivity of the Pagasetic Gulf, precautionary measures are essential to protect biodiversity and sustain the economic and cultural value derived from its natural resources.

Merman Conservation Field Insights

Extensive ecological knowledge from Merman Conservation's field research in South Pelion highlights the sensitivity and ecological importance of the Pagasetic Gulf. Although the focus of this report is on risk assessment rather than new observations, decades of regional monitoring provide valuable context for evaluating potential environmental impacts.

Biodiversity significance:

The Pagasetic Gulf supports a rich diversity of fish species, seabird colonies, and marine mammals. These populations depend on stable habitats and intact food webs for feeding, breeding, and migration, which makes them highly vulnerable to industrial activities. Studies in nearby regions of the Aegean and Ionian Seas have shown that even moderate human pressures can reduce ecological resilience and alter species composition in small enclosed basins.

Sensitive habitats:

The Gulf contains important benthic habitats, including *Posidonia oceanica* seagrass meadows and shallow coastal areas. These habitats grow slowly and are highly sensitive to physical disturbance, chemical contamination, and thermal stress. They play a key role in maintaining biodiversity and supporting fisheries productivity. *Posidonia* meadows also stabilize sediments and store carbon, while their loss contributes to erosion and decreased ecosystem services.

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Limited natural resilience:

The semi-enclosed shape of the Gulf restricts water exchange, leading to limited flushing and prolonged retention of pollutants or heat. Similar Mediterranean basins have demonstrated slow recovery from eutrophication and contamination, often requiring several decades for ecological restoration. This characteristic increases the long-term ecological risk associated with the operation of a floating LNG terminal.

Implications for LNG development:

These factors together indicate that installing a floating LNG terminal in the Pagasetic Gulf would present serious threats to biodiversity, habitat quality, and ecosystem balance. Avoiding or minimizing development is essential to protect the ecological integrity of the area.

Conclusion and Recommendations

Based on current ecological knowledge, published scientific studies, and regional field data, Merman Conservation concludes that the installation of a floating LNG terminal in the Pagasetic Gulf is environmentally inappropriate. The proposed facility poses significant risks to water quality, temperature balance, sound conditions, benthic and pelagic habitats, and the overall stability of the local food web.

Recommendations:

1. Reconsider or halt the installation of a floating LNG terminal in the Pagasetic Gulf.

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2. Prioritize conservation and sustainable management of marine resources in the region.

3. Explore alternative energy or industrial sites with lower ecological sensitivity.

4. Require comprehensive Environmental Impact Assessments that include detailed local wildlife and habitat studies.

Protecting the biodiversity and ecological health of the Pagasetic Gulf is vital for the long-term resilience of marine ecosystems and for the sustainability of fisheries, aquaculture, and coastal communities. Merman Conservation strongly recommends a precautionary approach that places ecosystem protection above industrial development.

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