DOSI
DEEP-OCEAN STEWARDSHIP INITIATIVE

POLICY BRIEF

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Activities in the twilight zone require a precautionary approach

A global survey led by the Deep-Ocean Stewardship Initiative (DOSI) Fisheries Working Group assessed expert knowledge of the twilight zone and revealed major science gaps that hinder evaluation of human impacts. These findings reinforce the urgent need for precautionary policies to guide decisions on whether, and if so how, human activities in this ecosystem should proceed.

Key messages

- **The ocean twilight zone (200-1,000 m)** supports global biodiversity, food webs, and climate regulation. Its animals provide prey for valuable fisheries, such as tunas, and contribute to carbon cycling and sequestration.
- **Expert consensus:** A global survey of 93 marine experts from 26 countries identified critical knowledge gaps in biomass, life history, energy budgets, and the resilience of mesopelagic fishes.
- **High uncertainty of human impacts:** 62-87% of experts judged our understanding of the effects of fishing, climate change, mining, and pollution as limited. The twilight zone is extremely difficult to study, and major gaps hinder evaluation of emerging pressures, including proposals for new fisheries targeting mesopelagic species, marine carbon dioxide removal, and deep-sea mining.
- **Policy status:** Current governance and management frameworks do not adequately account for the dynamic, poorly understood nature of twilight zone ecosystems, but can and should explicitly consider these habitats.
- **Precaution needed:** Governments may wish to consider adopting a precautionary approach that establishes robust environmental baselines, funds long-term research and monitoring, and fosters international collaboration to guide decisions on whether, and under what conditions, extractive activities in the twilight zone should proceed and be managed. This is essential to avoid long-term or irreversible harm to species, biodiversity, ecosystems, and important ecosystem services.

Ocean twilight zone ecosystems are deeply important

The ocean twilight (mesopelagic) zone is a vast pelagic habitat spanning depths between ~200-1,000 m, where it connects the sunlit surface waters to the deep ocean. It is home to diverse communities of fishes and other organisms (such as squids, crustaceans and jellyfishes), that play critical ecological roles. Mesopelagic fishes are key prey for economically valuable fisheries such as tuna, and for many threatened marine mammals and seabirds. Each night, the largest collective migration on Earth occurs as ocean twilight zone animals rise towards the surface to feed and descend back to depth before dawn to evade predation. This daily movement transports carbon from surface waters into the deep ocean, supporting global climate regulation, carbon sequestration into the deep, and nutrient cycling.

Despite the essential role of mesopelagic animals in vertically connecting the water column, interest in developing new mesopelagic fisheries for taxa such as Lanternfishes (family: Myctophidae) and Pearlsides (family: Sternoptychidae) is increasing, particularly for products such as fishmeal for use in the aquaculture and nutraceuticals industries. However, scientific knowledge of mesopelagic fish biomass, life history, and ecosystem resilience is limited, raising concerns about the feasibility of sustainable management. Exploiting mesopelagic resources with limited knowledge risks leading to poorly regulated fisheries that could disrupt climate regulation at a time when it is most needed and weaken the food webs supporting commercial fisheries, marine biodiversity, and threatened species.

Figure 1: *Sampling demonstrates the remarkable diversity and variety of life in the mesopelagic zone, including* Atolla *jellyfish, hatchetfishes, squids and pyrosomes (colonial tunicates), pictured from the California Current.*

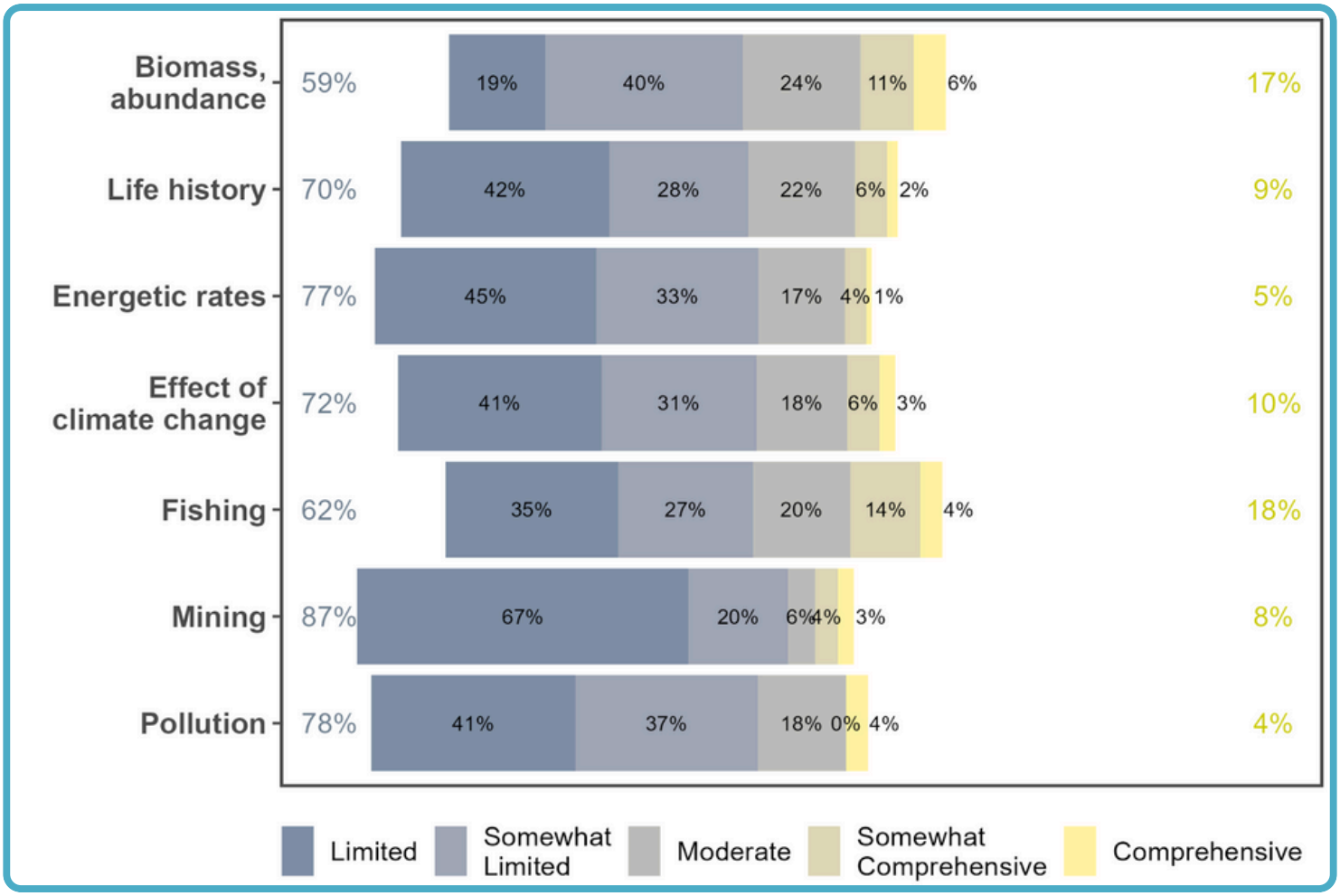

Figure 2: *Expert survey on the current state of knowledge for mesopelagic ecosystems. Responses were rated on a scale from one (Limited) to five (Comprehensive). Percentages show the share of respondents selecting each category, rounded to the nearest whole number. Most experts judged knowledge as limited across key topics, with only a small proportion viewing knowledge as comprehensive.*

Main findings

- **Scientific uncertainty:** Survey results highlight gaps in life history, energetic rates, and biomass estimates – knowledge which is essential for governance and management. Without information on these parameters, the ability to evaluate the impact and sustainability of fisheries and other human activities for mesopelagic species is limited.
- **Human impacts remain poorly understood:** Most experts reported insufficient understanding of the resilience of mesopelagic ecosystems to major stressors: fishing (62%), climate change (72%), mining (87%), and pollution (78%). These uncertainties impede effective risk assessment and policymaking.
- **Weaknesses in current governance:** 75% of experts judged the integration of science into policy as insufficient. Current legal frameworks, such as the UN Fish Stocks Agreement and the BBNJ Agreement, do not explicitly consider the mesopelagic zone, although both can and should be applied to it.
- **Uneven research coverage:** Research on mesopelagic ecosystems is concentrated in the Northern Hemisphere, leaving large portions of the Southern Hemisphere poorly studied. Moreover, a significant portion of the ocean twilight zone lies in the High Seas beyond national jurisdiction. These gaps create blind spots in global governance.

Recommendations

Without stronger policies, emerging pressures on the ocean twilight zone risk repeating the mistakes of past overfishing. Governments and international bodies now have an opportunity to consider the unknowns, invest in long-term research and monitoring, and ensure management decisions are reflective of the dynamic nature of these ecosystems and their key roles in global carbon cycling, sustaining economically valuable fisheries, and providing prey for threatened species.

Policy considerations

1. **Adopting a precautionary approach:** This could entail precautionary measures for mesopelagic fisheries development, such as delaying or tightly limiting new activities until a sound scientific basis for sustainable management is established in line with the provisions of the UN Fish Stocks Agreement and the BBNJ Agreement.
2. **Strengthening research and monitoring:** Investment in long-term baseline studies across diverse regions, supported by innovative tools such as autonomous vehicles, eDNA, and ocean observatories, could help fill the identified knowledge gaps.
3. **Integration into High Seas governance:** Twilight zone ecosystems could be explicitly considered in the implementation of the BBNJ Agreement, the measures adopted by regional fisheries management organisations (RFMOs), and the design of marine protected areas.
4. **Supporting international collaboration:** The promotion of equipment sharing, open-access data, and other measures for capacity building and technology transfer, particularly in underrepresented regions, would accelerate progress.
5. **Aligning with climate goals:** All management actions could aim to maintain or enhance carbon cycling services and ecosystem resilience in the mesopelagic zone, an approach embodied in the BBNJ Agreement and UNFCCC Ocean and Climate Change Dialogue.

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About DOSI

The Deep-Ocean Stewardship Initiative is a global network of experts that integrates science, technology, policy, law and economics to advise on ecosystem-based management of resource use in the deep ocean and strategies to maintain the integrity of deep-ocean ecosystems within and beyond national jurisdiction.

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Key reference

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