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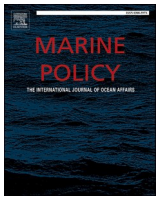

Science is not enough: The role of legitimacy in the governance of marine activities

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ABSTRACT

Several scientific programs are investigating the potential for the mesopelagic zone to provide food, fish meal, and nutraceutical supplements for human food systems. However, it is not clear whether fishing in the mesopelagic zone will be granted a social license to operate. Three analogous marine cases and three rounds of stakeholder engagement identified diverse perspectives about the pragmatic, moral, and cognitive legitimacy of human activity in the mesopelagic zone. Therefore, contestation about mesopelagic activities can be expected regardless of the state of scientific knowledge. This is because an activity's social license to operate is grounded not only in scientific fact, but also in notions of legitimacy. The consultations also show that, despite uncertainty, stakeholders are already employing strategies to support or challenge the legitimacy of mesopelagic fishing, even in this nascent stage. Including stakeholder deliberation alongside current science programs can improve policy advice processes by uncovering important perceptions of legitimacy at an early stage. New governance arrangements such as a multi-stakeholder council, can anticipate and facilitate contestation, envisioning more socially acceptable outcomes for the management of the mesopelagic zone.

1. Introduction

The Blue Economy is growing rapidly as economic activities in marine areas are either introduced or expanded [40,65,67]. Growing demand for seafood [13], recreation [31], transport [76], and energy [51,65] are driving expansion of fishing, tourism, shipping, and resource extraction, while technological advances make new activities feasible [30,57,81]. The acceptance of an emerging marine activity as sustainable, however, depends not only on a scientifically sound understanding of its technical and economic feasibility or its environmental impacts. Crucially, the sustainability of marine activities also depends on the willingness of society to accept the activity as legitimate and thereby grant it a social license to operate [88]. Meanwhile, public debates have questioned the ethics of established fishing (see [29] on bottom trawling and [61] on pelagic fishing) and aquaculture (see [28] on salmon farming). Examples of contests around the legitimacy of new marine activities include deep-sea mining [20,37], reduction fisheries for fish meal and fish oil [10,36], and electric pulse trawling [17,30].

Human marine activity is also expanding into the mesopelagic zone, the oceanic layer between 200 m and 1000 m depth. This ecosystem is home to vast communities of crustaceans, cephalopods, and micronekton such as lanternfishes (*Myctophidae*) and pearlsides (*Maurolicus*) [81], organisms which are potentially interesting for food, fish meal, and high-value supplements of Omega-3 [79]. Estimates have shown that the mesopelagic zone contains a very large biomass [81] and as such there have been several attempts at mesopelagic fishing since the 1960s worldwide [26,68,89]. So far, none of these efforts have been consistent or profitable [66,70,82], but this does not preclude the future availability of technologies or circumstances that enable an economically viable mesopelagic fishery.

At present, scientists are the stakeholders with the most interest in the mesopelagic zone. Large scientific programs such as the European Union-funded MEESO [55] and SUMMER [84] projects and the Woods Hole Oceanographic Institution's Ocean Twilight Zone Project [86] aim to develop a knowledge base about the mesopelagic zone, bringing about a surge of scientific projects and publications in recent years [78]. In many cases, this scientific work calls for yet more research to understand the ecosystem and any potential impacts of exploitation, explicitly framing this knowledge as being necessary for governance [33,39,54]. As a result, the public debate on human activity in the

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mesopelagic zone often invokes the quality and availability of scientific knowledge as a reason to apply a precautionary approach [6,69,73,81].

However, a narrow focus on resolving uncertainties to do with the natural system overlooks the complex social and political side of fisheries management. While scientists may presently be the de facto governors of the mesopelagic zone [78], other social and political actors will inevitably become involved if human activity in this ecosystem occurs. The range of issues that will be contested will expand from scientific debate to include social, ethical, cultural, and political concerns [56,92]. These concerns can be a significant source of uncertainty as stakeholders take strategic action to secure the legitimacy of their preferred outcomes. Scholars have therefore employed the concept of the social license to operate to better understand how stakeholder concerns are negotiated during the governance of various activities, using it to explain why some technically and economically viable activities are made untenable by social contestation [71].

As interest in the mesopelagic zone continues to grow, questions about how it will be governed and whether and how mesopelagic fishing might obtain a social license to operate become relevant. This article aims to understand what present stakeholder perspectives are in order to anticipate future contestation about mesopelagic zone activities. The following section outlines a framework for understanding legitimacy as the foundation of a social license to operate. The Method section outlines how this framework has been applied to three illustrative examples (deep-sea mining, reduction fisheries, and pulse fishing) and to stakeholder perspectives about the mesopelagic zone. Because mesopelagic zone activities are not widespread or concrete, the illustrative examples are instructive for understanding how legitimacy operates in contemporary marine governance settings. The analysis presented in the Results section draws on both the examples and the stakeholder perspectives to show that the social license to operate of mesopelagic fishing will be contested irrespective of its scientific assessment. In addition, analysis of the stakeholder perspectives also identifies the strategies that are already being employed to either build or challenge the legitimacy of fishing in the mesopelagic zone, even in this nascent stage. The Discussion section argues that contestation is grounded not only in scientific uncertainties, but also in competing notions of legitimacy based on interests, values and worldviews. Understanding the social license to operate of mesopelagic zone activities therefore requires moving beyond the present scientific focus on resolving uncertainty about the potential impacts of future activities on natural systems. In addition to a scientific knowledge base, it is necessary to understand the role of various types of legitimacy claims in determining social acceptability. The article closes by introducing principles to guide the anticipatory governance of the mesopelagic zone.

2. Social license to operate and legitimacy

The concept of a social license to operate has emerged in response to increased public contestation over resource extraction activities. An activity's social license to operate is generally defined as "ongoing acceptance and approval from local communities and other stakeholders" [50,71]. Increases in public contestation are the result of the shift from government to governance [45,71,91]. Governance refers here to "the whole of public as well as private interactions taken to solve societal problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them ([44], p. 17). As part of this shift, governmental and legal solutions to solving increasingly complex sustainability problems are seen as insufficient and participation of private parties and civil society has increased [71,90].

A legal license for resource extraction activities granted by the government is therefore no a guarantee that an activity is accepted. Even when a legal license has been approved, a lack of social license from communities and other societal stakeholders can result in delays or in the legal license being suspended or revoked [50,80,91]. Unlike a legal license, a social license to operate is intangible and is continuously negotiated by many parties, including those who perform the activity, those who regulate it, and local communities and other stakeholders [20]. A key assumption in the social license to operate literature is that legitimacy is crucial for first achieving and then keeping a social license [24]. However, SLO remains closely tied to a legal license (and thus the governance of resource extraction) because economic actors need to meet both legal and stakeholder requirements as well as government agendas [5]. The legitimacy of resource extraction is then an outcome of a complex dynamic between legal, political and social licenses [50,80,91].

Yet legitimacy is a multifaceted term that requires reconceptualization if it is to be useful to understanding its role in social license to operate processes specifically and natural resource governance more generally [56,80]. Stakeholders are concerned about more than the social, economic and/or environmental impacts of marine activities that might affect their own individual needs and interests [37,92]. Importantly, values and worldviews also matter for stakeholder perceptions of legitimacy [24,83].

Recent studies have therefore called for a reconceptualization of the concept of legitimacy to better relate stakeholder concerns to decision making around resource extraction developments [56,80]. Specifically, it is necessary to consider how values and worldviews relate to stakeholder perceptions of how marine activities might impact their own desires and interests [56,92]. This study therefore draws from Suchman [83], who defined legitimacy as a "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions" ([83], p. 574). The application of this framework in environmental governance (e.g. [11]) and specific marine cases (e.g. [15]) demonstrates its usefulness for understanding how socially constructed legitimacies can steer governance outcomes [24].

Suchman's framework makes a distinction between three types of legitimacy: pragmatic, moral and cognitive. First, *pragmatic legitimacy* rests on the self-interested calculation of an organization or activity's most immediate audience ([83], p. 578). In other words, stakeholders may deem an activity pragmatically legitimate if it matches with their own interest(s). Organizations seek this legitimacy by looking for ways to find common interests with more influential stakeholders or to compensate stakeholders whose self-interest is being compromised. Second, *moral legitimacy* exists when social actors deem the activities of a business to be the right thing to do ([83], p. 579). Stakeholders may deem an activity to be morally legitimate if it contributes to something that is valued by the relevant society, such as societal welfare. However, if the societal values held by stakeholders differ, then contestation about whether an activity is morally legitimate can arise. Finally, *cognitive legitimacy* refers to organizations or their activities being seen as legitimate because they are "necessary and inevitable based on some taken-for-granted cultural account" ([83], p. 582). An activity may be deemed to be cognitively legitimate when its alternatives are unthinkable. This type of legitimacy thus relies on social comprehensibility, or the extent to which the organization or its activity adheres to larger existing belief systems or practices. By analysing legitimacy in this more nuanced way, it is possible to better anticipate how a social license to operate might be established or challenged.

Legitimacy, however, is not a neutral and self-evident property of an activity. Rather, it is established or challenged by actors who wish to influence the activity's social license to operate. Suchman [83] therefore offers a typology of legitimation strategies, through which actors and organisations gain, maintain, and repair the various types of legitimacy outlined above. Today, human involvement in the mesopelagic zone is mostly regarded as an anticipated or potential activity, and for the purposes of this analysis this study confines the theoretical framework to strategies of gaining legitimacy. Organisations can gain pragmatic legitimacy by meeting the instrumental demands of stakeholders, such as by providing a desired product ([83], p. 587). Moral legitimacy can be

gained by conforming to altruistic ideals, and organisations can build this type of legitimacy by showcasing socially acceptable outcomes of their activities ([83], p. 588). Cognitive legitimacy can be gained by conforming to established models and standards, such as by mimicking existing institutions or by professionalising and codifying an activity alongside other established activities ([83], p. 589). Identifying where, by whom, and to what end these strategies are being employed can help anticipate contestation, even in nascent activities.

3. Methods

Studying present and future perceptions of the mesopelagic zone is complicated by several characteristics. First, mesopelagic fishing is not presently performed at a significant commercial scale, is relatively understudied, and has a small network of stakeholders. Second, most people rarely have a chance to interact directly with this novel and remote ecosystem because doing so requires technologies such as boats, submarines, and other specialised hardware. As a result, the general public can be apathetic or fearful towards the deep ocean [38,41]. This does not mean that the public does not care about the deep ocean [3], but their perceptions are always mediated by the small community of scientists, interest groups and fishers who interact with it. Third, the need for large vessels and specialised equipment such as echosounders, nets, and submersible vehicles can incentivise science and industry to cooperate. As a result, complex social interactions between science and industry arise as these groups of actors collaborate to engineer the innovative technology needed to facilitate engagement with the sea, particularly in the deep pelagic waters. While industry-science collaborations can be perceived to threaten the credibility of science (e.g., the debate in Kraan et al. [46] and Le Manach et al. [49]), they can improve perceptions of legitimacy for both parties [14]. Finally, the mesopelagic zone spans a complicated regulatory landscape with local, regional, and international agreements, most of which are still in development. Sovereignty and international cooperation will therefore be key issues shaping stakeholder perceptions.

In order to overcome the challenges outlined above, we combine two approaches to gather insights on stakeholder perspectives on the legitimacy of mesopelagic fishing. First, we examine three analogous examples of marine activities comparable to mesopelagic fishing to identify the legitimacy types and legitimation strategies of stakeholders employed in those cases. Second we identified stakeholder perceptions (structured by legitimacy type) and legitimation strategies of stakeholders currently involved in discussing (potential) mesopelagic fishing. For each approach different methods have been used which are described in the following sections. The figure below summarises the research design employed in this study. Fig. 1

3.1. Three analogous examples: deep-sea mining, reduction fisheries, and pulse fishing

The three analogous examples purposively selected were: deep sea mining, reduction fisheries, and pulse fishing. These examples are suitable for a comparative analysis because they share several important characteristics with mesopelagic fishing and have varying levels of implementation and status when it comes to their social license (see Table 1). While it is not possible to predict whether or not mesopelagic fishing might ultimately become socially acceptable, theorising from the illustrative examples can anticipate the types of contestation that will occur and identify how stakeholders build or challenge legitimacy.

Literature and document review (including news items and position papers) was performed to analyse the legitimation strategies and legitimacy types in each of the three analogous examples according to Suchman's [83] framework. Box 1. Illustrative Examples provides more information about each of the analogous activities.

3.2. Stakeholder engagement for the mesopelagic zone

Focus groups, document analysis, and participant observations were used to identify stakeholder perceptions and legitimation strategies. We define stakeholder as individuals or representatives of organisations that

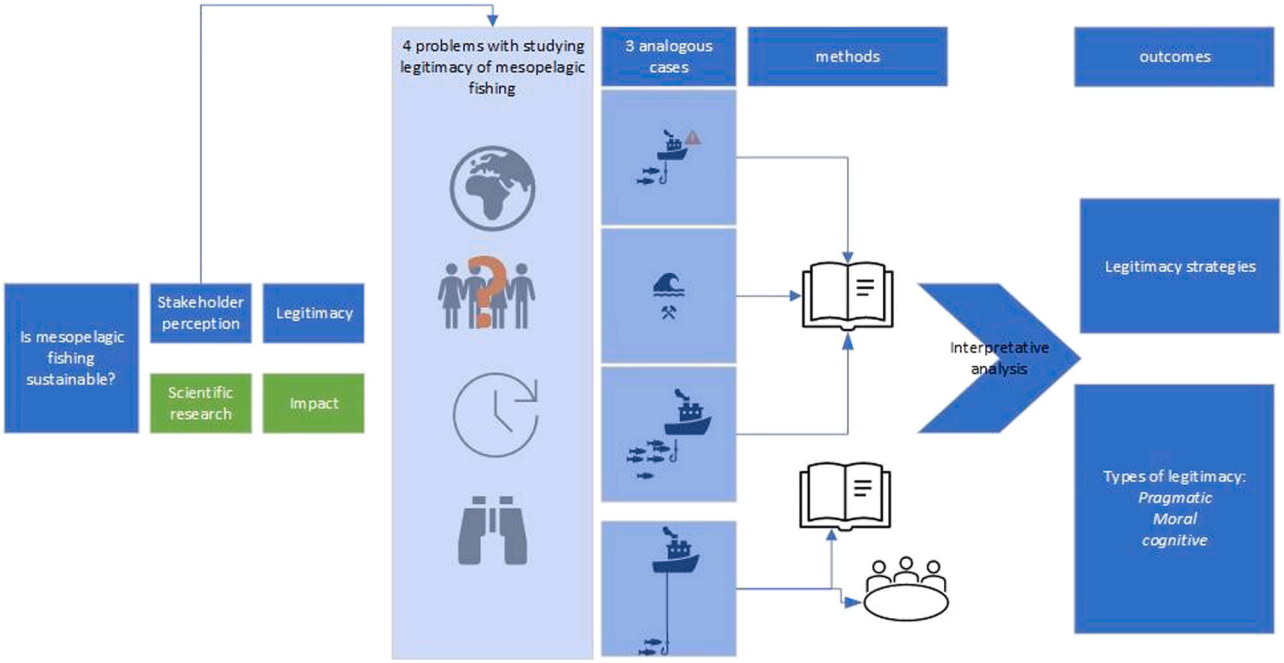

Fig. 1. Research design of the study, showing that to understand whether mesopelagic fishing in future might be deemed sustainable, it is important to understand its impact via scientific research but also assess the legitimacy in the eyes of stakeholders (the social licence to operate). As identifying mesopelagic stakeholders is complicated due to 4 identified problems (multiple jurisdictions including high seas; a small and partly still unknown group of stakeholders, a future activity and far away at sea) the study includes an analysis of legitimacy in three analogous cases (pulse fishing, deep sea mining and reduction fisheries). Via document analysis, focused groups, participant observation and interpretative analysis the outcomes show the legitimising strategies and the different types of legitimacy identified.

Table 1
Characteristics of mesopelagic fishing and related examples.

Characteristics	Mesopelagic fishing	Deep-sea mining	Reduction fisheries	Pulse fishing
Leverages technological innovation	X	X	X	X
Extracts fish for human food systems	X		X	X
Difficult to engage public stakeholders	X	X	X	
Science and industry collaborate	X	X	X	X
Novel and remote ecosystem	X	X		
Possible in international waters	X	X	X	
Level of implementation	Pilot phase	Pilot phase	Established	Banned
Status of social license to operate	Contestation emerging	Contested	Mostly accepted	Not accepted

(perceive to) have a stake in present or future mesopelagic fishing activity, such as actors from the fishing industry, NGOs, policy makers and scientists. Three focus groups aimed to 1) understand stakeholder questions and concerns about mesopelagic fishing, and 2) elicit stakeholder understandings of the feasibility and potential extreme outcomes of human activity in the mesopelagic zone, and 3) determine whether the modelling undertaken in the MEESO project was aligned with questions held by the stakeholders. These focus groups were held online in March 2021, September 2021 and June 2022 in the context of the H2020 MEESO project. Stakeholders included fishers, processors, gear manufacturers, scientists, European policy officers, NGO representatives, and students. The stakeholders were identified through the networks of the MEESO project and through snowball sampling [9]. As mesopelagic fishing is a relatively new activity, the pool of people knowledgeable about it is small. At the same time, the focus of the MEESO project was European, limiting the potential involvement of policy makers and industry. Nevertheless, approximately 100 people were engaged from 13 different countries (Norway, Iceland, Ireland, Denmark, Spain, Marshall Islands, Papua New Guinea, Fiji, Ecuador: Galapagos Islands, United States, Canada, the Netherlands, Sweden), with some stakeholders attending multiple workshops. The fisheries stakeholders were all from European countries (Norway, Iceland, Ireland, Denmark and Spain). The focus group workshops were held online and employed structured virtual workboards to systematically elicit and record the responses from the stakeholders. More detail about the stakeholder engagement methods and outcomes can be found in the relevant MEESO project reports [47,48,77].

Legitimation strategies were observed during the stakeholder engagements, document analyses and during other stakeholder interactions over the duration of the MEESO project. Citations are provided when stakeholder perspectives are evident in published material. In all other cases, the stakeholder perceptions are reported as a combination of evidence-based arguments, uncertainties, and personal reasonings about the mesopelagic zone and as such are presented anonymously and without citations. In order to theorise about the future acceptability of mesopelagic fishing and the legitimation strategies that are being employed, the analysis posits a false dichotomy between mesopelagic fishing and conservation (as presented in Table 2). These are by no means the only two outcomes for the mesopelagic zone, nor are they incompatible. Rather, the two desired outcomes are explored in order to highlight the debates about legitimacy that are already evident in the management of the mesopelagic zone.

4. Results

The analogous examples of deep-sea mining, reduction fisheries and pulse fishing illustrate that science-based processes are not sufficient to resolve stakeholder conflicts that play out on the grounds of interests (pragmatic legitimacy) (see Section 4.1), values (moral legitimacy) (see Section 4.2) and worldview (cognitive legitimacy) (see Section 4.3). The stakeholder consultations indicate that contestation about human activity in the mesopelagic zone will proceed similarly. The results also show that, while conversations about mesopelagic fishing remain hypothetical in nature, various anticipatory legitimation strategies are already active.

Box 1
Illustrative Examples.

Deep-sea mining refers to the extraction of minerals and metals from the deep ocean substrate using underwater mining techniques, made possible by advancements in engineering and technology. Underwater mines in the high seas are being prospected as potential sources to meet demand for minerals and metals including diamonds, phosphor, nickel and cobalt [58]. Since 2014, the Parties to the International Seabed Authority are negotiating the Mining Code to regulate the prospecting, exploration and exploitation of minerals in the international seabed area. Some contest deep sea mining due to the permanence of damage caused to the sea floor, and the life that inhabits it [1,58].

Main countries involved: International waters and some interested countries, including Nauru, Tonga, China, Russia, South Korea and the UK.

Reduction fisheries are industrial fisheries that catch small pelagic fish (e.g., Peruvian anchoveta, blue whiting, and herring) and process them into fish meal and fish oil. In 2020, 16 of the 90 million tonnes of wild capture fish were directed for this purpose [19]. The majority of fishmeal and fish oil are used in aquaculture, which today equals wild capture fisheries in terms of volume production [19]. In the past, reduction fisheries have also been used to produce feed for pig and poultry farming [19]. Some contest that reduction fisheries are unsustainable and that these species could be left at sea as forage fish for other commercial species or be caught for direct human consumption [10,36,85].

Main countries involved [10]: Peru, Chile, Norway, Japan, United States, South Africa, China, Denmark, Iceland, and Thailand.

Pulse fishing uses electricity to catch sole (*Solea solea*), a high-value flatfish species. The technique was developed as a means to reduce the impact of conventional beam trawling for flatfish, which is criticised for its impact on the seafloor, bycatch and fuel consumption [34]. Between 2006 and 2021, pulse fishing was allowed in the southern North Sea by way of an EU derogation to the legal ban on electric fishing. The use of pulse gear has been heavily contested [17,30], with concerns for the welfare of the target species and the ecosystem as well as political contest about its legality.

Main country involved: The Netherlands.

Table 2
Strategies that have been employed to build the legitimacy of either fishing or conservation in the mesopelagic zone, using [83] typology of legitimation strategies.

Type of legitimacy	Activity	Strategies to build legitimacy of mesopelagic fishing	Strategies to build the legitimacy of conservation of the mesopelagic zone
Pragmatic	Conform to demands	Frame mesopelagic fish as valuable raw material	Frame the mesopelagic zone as crucial for global climate regulation and supporting existing commercial fish stocks; question the need for mesopelagic resources by pointing to alternative sources of fishmeal
	Select markets	Connect mesopelagic catches to fishmeal and fish oil market	Connect the mesopelagic zone on the agenda of NGOs that already deal with ocean conservation, fisheries management and the animal welfare
	Advertise	Show products made with mesopelagic fish as appealing and valuable to feed producers and users, or as products available directly to consumers	Show that fish meal and oil demands are being supplied sufficiently by existing activities and that mesopelagic fishing is therefore unnecessary
Moral	Conform to ideals	Associate mesopelagic fishing with feeding a growing human population and developing sustainable food systems	Associate mesopelagic fishing with ongoing debates about global inequality, encroachment of industrial activity, and unsustainable resource use
	Select domain	Position fishing the mesopelagic zone as a potential solution for human food security	Position mesopelagic fishing as incompatible with animal welfare, climate change action, and preserving pristine ecosystems
	Persuade	Argue that fishing in the mesopelagic zone is an economically viable and environmentally sustainable source of food that can reduce pressure on other marine ecosystems	Argue that fishing in the mesopelagic zone jeopardises the stability of food webs and carbon cycles that support present human life
Cognitive	Conform to models	Apply existing fisheries management models to mesopelagic fishing by calculating e.g. maximum sustainable yield, spawning stock biomass, total allowable catch.	Apply existing conservation measures to the mesopelagic zone such as marine protected areas and moratoria.
	Select labels	Qualify mesopelagic fishing for Marine Stewardship Council consumer certification	Qualify the mesopelagic zone for inclusion in ongoing protection campaigns, such as 30 ×30 from the UN
	Institutionalise	Establish regional fisheries management organisations that	Establish international agreements to
		resemble those that exist for other species groups	monitor and conserve the mesopelagic zone and its ecosystems

4.1. Contests about pragmatic legitimacy

Pragmatic legitimacy refers to the validity of an activity from the perspective of a self-interested party [83]. In each of the three illustrative examples, the marine activity is quite obviously deemed legitimate by the actors that (wish to) perform and profit from the extractive activity. Downstream users or consumers of these resources also lend pragmatic legitimacy to the activities: deep-sea mining is legitimated by those who (would) purchase the minerals to produce electronics, reduction fisheries are legitimated by those who purchase fish meal to feed aquaculture, and pulse fishing was legitimated by wholesalers who purchased the catch from vessels that employed the gear. These actors also foster the pragmatic legitimacy of their activity in the view of others by highlighting the value of their product in terms of how it contributes to human wellbeing through food or raw materials, economic value, and employment.

In each of these cases, however, the pragmatic legitimacy of the activity was challenged by other marine ecosystem users with conflicting interests. For example, the interests of deep-sea miners are at odds with the interests of fishers whose stock is potentially affected by sediment plumes [2,37]. In this way, deep-sea mining is seen as pragmatically legitimate by the miners, but not by this group of fishers. In the example of reduction fisheries, some have pointed to the competition between reduction fisheries and artisanal fisheries [75,85]. In these cases, actors build or challenge the pragmatic legitimacy of an activity by highlighting the relationships between the interests of different stakeholder parties.

In the same way, mesopelagic fishing is deemed pragmatically legitimate by fishers, gear manufacturers, fishmeal producers, the aquaculture sector, nutraceutical sector, and scientists, whose interests would all be served by the activity. Stakeholders reported that the most likely use of mesopelagic fish would be in the production of fish meal and fish oil, rather than direct human consumption. As a result, mesopelagic fishing may be deemed pragmatically legitimate by the fishers who perform and profit from mesopelagic fishing, fishing gear manufacturers, fish meal and fish oil processors who purchase the raw materials, and the industries that purchase and use these products. Actors from the nutraceutical industry may also deem it a legitimate source of nutrient-rich raw materials. Finally, some scientists also see mesopelagic fishing as pragmatically legitimate for their own research agenda: the need for management-relevant knowledge could provide grants for further research and industry partnerships can deliver data. During the stakeholder workshops, scientists argued that a better understanding of the mesopelagic zone could be gained through experimental fishing. Scientists are presently the largest group with pragmatic interest in the ecosystem due to the proliferation of scientific programs that provide employment and personal fulfilment.

Several strategies to gain pragmatic legitimacy can already be observed in the mesopelagic zone (summarised in Table 2). First, the development of informal coalitions involving processors, fish feed producers, and aquaculture firms aligns the interests of several actors, bolstering the pragmatic legitimacy of mesopelagic fishing. As a concrete illustration, fishing industry actors are willing to collaborate with scientists and fish meal producers, delivering catch samples from experimental mesopelagic fishing to assess the feasibility of developing commercially valuable products. This collaborative approach fosters a

shared interest in the activity, establishing pragmatic legitimacy. In order to strategically enhance the pragmatic legitimacy of mesopelagic fishing to consumers, actors can perform targeted market selection and direct advertising. Products based on *Myctophidae* or *Maurolicus* are yet to be marketed as such, but blue whiting (*Micromesistius poutassou*), a larger mesopelagic species, has a well-established fishery whose catch is processed into, among others, weight control supplements [64]. *Maurolicus* is shown to have similar potential use as an ingredient for health supplements [32].

However, as in the examples of deep-sea mining and reduction fisheries, competing ideas about the pragmatic legitimacy of mesopelagic fishing will emerge when user interests conflict. Stakeholders are already concerned that mesopelagic fishing may disrupt other ecosystem functions, such as supporting commercially important species like tuna or swordfish. This competition could lead to conflicts in pragmatic legitimacy between user groups. Other industries that are presently part of fish meal and fish oil production value chains may also challenge the pragmatic legitimacy of the activity if it competes with their market position. Furthermore, some stakeholders argue that the mesopelagic zone plays a crucial carbon sequestration function and, from this standpoint, it is in every human's interest to preserve the mesopelagic zone so that it might continue to regulate the global carbon system. During the stakeholder workshops, some argued that the carbon sequestration function of the mesopelagic zone should be valued just as much as its potential to provide fish for food.

In light of these competing interests, stakeholders employ a number of strategies to challenge the pragmatic legitimacy of mesopelagic fishing. One example of this is the Metro Pelagic campaign [4], where images emphasizing the remarkable qualities of mesopelagic animals were exhibited in metro stations in Bilbao, Spain. Subsequent blogs about the exhibition leveraged this public interest to argue for the continued study of the ecosystem [21], which is in the pragmatic interest of the scientists behind the campaign. Another legitimation strategy is the expansion of NGO campaigns to include the mesopelagic zone in existing conservation, biodiversity, and climate campaigns (e.g. [8]). Scientific articles that argue that mesopelagic fishing would disrupt climate regulation services and other commercial fisheries can be strategically used to challenge the pragmatic legitimacy of mesopelagic fishing by alerting other stakeholders to threats to their interests (e.g. [6]). Each of these strategies relies on advertising directly to parties who would otherwise be unaware of mesopelagic fishing. Thus while mesopelagic fishing is not presently undertaken at a large scale, the stakeholder consultations and illustrative examples show that the activity can be deemed pragmatically legitimate to the group that it serves, but illegitimate to the group whose interests are or may be threatened.

4.2. Contests about moral legitimacy

Moral legitimacy refers to the legitimacy of an activity with regards to how much it is positively viewed by its social environment, upholding a collective good rather than individual self-interest [83]. In each of the three illustrative examples the moral legitimacy of the contested activity can be argued by pointing to how these extracted resources contribute to a collectively valued cause such as food security or addressing climate change. For example, reduction fisheries can be legitimised by highlighting its importance for nutritional health, with small pelagic fish being a valuable source of unsaturated marine fatty acids in aquaculture feed and health supplements [19]. Deep-sea mining can be morally legitimised by referring to the urgency of the climate crisis and the need for minerals to produce renewable energy technologies [1,43,57]. Similarly, pulse fishing made claims to moral legitimacy by pointing to the gear's improved selectivity, reducing bycatch of undersized and undesired fish and benthic organisms, as well as its reduction in CO2 emissions when compared to traditional beam trawling [72].

However, ideas about the moral legitimacy of an activity can also lead to contestation, even with the same moral goal in mind. For example, reduction fisheries are seen as immoral by those who argue that redirecting catches to aquaculture reduces access to quality food for poor communities, threatening food security [10,85] but can be seen as socially or economically beneficial depending on the context [93]. Contestation can also occur when a single activity has several moral consequences. For example, a parliamentary motion by supporters of pulse fishing argued that the technique supported food security while reducing carbon emissions, which were both morally sanctioned objectives [60]. Conversely, pulse fishing opponents connected it to morally unacceptable outcomes by arguing that the activity damaged vulnerable ecosystems and was cruel to animals [49]. In these analogous marine activities, actors therefore build or challenge the moral legitimacy of an activity by connecting it to wider societally upheld goals and values.

The stakeholder consultation workshops showed that human activity in the mesopelagic zone invokes similar moral dilemmas that could lead to future contestation. Some have argued that mismanagement of the mesopelagic zone could have profound moral consequences because of its importance to both the carbon cycle and food webs, which are crucial for supporting human life [94]. By contrast, fishing in the mesopelagic zone can be presented as morally legitimate if it is tied to socially valued goals, such as food security. During the consultation workshops, a scientist argued that fish contain many nutrients, fats and proteins which are needed by humans and therefore mesopelagic fishing should not be ruled out before testing its sustainability, appealing to the moral legitimacy of providing nutrition to humans. In published literature, scientific stakeholders have attempted to quantify the potential for harvests in the mesopelagic zone and outline potentially significant contributions to food security ([33,81]). Even with caveats, academic exercises such as these can lend legitimacy for mesopelagic fishing by connecting it to the morally justified goal of food security. In a link with one of the case studies, some stakeholders position mesopelagic fishing as a solution to a moral problem caused by reduction fisheries, namely that reduction fisheries redirect fish that are suitable for human consumption to the aquaculture industry, threatening food security of poor rural communities [85]. If mesopelagic fish are not suitable for human consumption, but are suitable for reduction into fishmeal, the moral legitimacy of mesopelagic fishing can be established by persuading others that it would relieve fishing pressure on other edible fish that are currently caught for the reduction industry.

During the stakeholder consultations, the moral legitimacy of mesopelagic activities was challenged on the grounds of ideals such as animal welfare and global equality. Fishing in the mesopelagic zone would kill billions of organisms both intentionally (as the target species) and unintentionally (as bycatch), which leads some stakeholders to challenge the moral legitimacy of the activity on the grounds of animal welfare. In another example, some stakeholders expect that, because of its capital-intensive nature, mesopelagic fishing would only benefit large companies from wealthy countries, further exacerbating global inequalities in use and access of the ocean. One stakeholder questioned whether mesopelagic fish catches will be used to improve food security, or whether in actuality it would exacerbate inequalities between nations. With this argument, the socially sanctioned objective of equitable benefits from shared marine resources is used to challenge the moral legitimacy of mesopelagic fishing.

4.3. Contests about cognitive legitimacy

Cognitive legitimacy refers to the embeddedness of an activity in the worldview of the society, to the extent that alternatives are difficult to imagine [83]. In each of the three illustrative cases, the marine activity can be perceived as cognitively legitimate because it is embedded in existing practices. Deep-sea mining is a technologically enhanced extension of – and by some even seen as a more sustainable alternative to – terrestrial mining [43,57]. Reduction fisheries are part of existing industrialised and globalised value chains of seafood and food

processing [19]. Pulse fishing is an innovation upon the existing fishing technique of beam trawling [30]. In this way, the activities all gained cognitive legitimacy with some stakeholder groups because of their embeddedness in and similarity to activities that came before them.

However, contestation can occur when actors have different worldviews and therefore different ideas about the cognitive legitimacy of an activity. For example, while pulse fishing technology was seen as legitimate to those who accepted conventional beam trawling, other actors saw bottom trawling in any form as destructive and unnecessary and therefore opposed pulse fishing [49]. Alternatively, actors can challenge cognitive legitimacy by emphasising an activity's novelty: deep-sea mining is not like terrestrial mining because of the unique underwater environment [1,57,58]; reduction fisheries artificially support piscivorous aquaculture [10]; and pulse fishing gear will inhumanely kill fish by 'electrocution' [7].

Following Suchman [83], actors can establish the cognitive legitimacy of an activity by connecting it to existing developments, institutions, and models. Pulse fishing actors can emphasise the gear's novel improvements when compared to the established practice of tickler chain beam trawling [59]. Reduction fisheries and pulse fishing actors can embed the cognitive legitimacy of their activity by connecting to existing fisheries sustainability models, such as by seeking MSC certification or internal standardisation [52,53,62]. Similarly, deep-sea mining actors can build cognitive legitimacy by associating with institutions, establishing regulatory standards through the International Seabed Authority [37,87].

While stakeholders did not consciously express their perspectives in the language of Suchman's legitimacy framework, contests about cognitive legitimacy were present during the consultations. First, fishing is an established global practice, and therefore some stakeholders see mesopelagic fishing simply as an extension of this legitimate activity. It is cognitively legitimate because it is the familiar activity of fishing, only facilitated by the availability of new technologies and the 'discovery' of fish resources in deeper waters. Extending this, some stakeholders see a need to establish stock distribution and abundance estimates, which are essential for estimating a maximum sustainable yield (MSY) for mesopelagic fish. The use of MSY in the management of other fisheries is seen as a legitimate practice. By producing similar calculations for mesopelagic fishing, stakeholders build the cognitive legitimacy of the activity by associating it with already-accepted activities. Those who advocate for a precautionary approach to managing activity in the mesopelagic zone are similarly embedding it within existing human-marine interactions: during the consultation workshops, stakeholders proposed applying a precautionary approach until MSY can be established, thereby lending mesopelagic fishing cognitive legitimacy through its association with existing fisheries management approaches.

Thus the cognitive legitimacy of mesopelagic fishing can be gained by embedding it in recognised institutions, practices and models. For example, establishing a mesopelagic zone regional fisheries management organisation (RFMO) has been recommended as a useful governance instrument [94]. Whether it is the intention or not, establishing a mesopelagic RFMO would associate new mesopelagic zone fishing activity with existing conventions around fishing in other ecosystems, thereby lending it cognitive legitimacy. In a similar way, scientific projects such as MEESO aim to assess the viability of fishing in the mesopelagic zone. In doing so, they may be (inadvertently) lending cognitive legitimacy to mesopelagic zone fishing by associating it with existing accepted management tools such as spatial distribution models and MSY assessments [35]. In other words, employing present fisheries management tools and techniques in this new and uncertain ecosystem can afford cognitive legitimacy to the new activity of mesopelagic fishing.

However, as with deep-sea mining, reduction fisheries, and pulse fishing, human activity in the mesopelagic zone will see contestation about its cognitive legitimacy according to stakeholder worldviews. A vegetarian or vegan worldview holds that humans do not need to rely on animals as food, and therefore does not accept the legitimacy of eating any wild or aquaculture fish, let alone those from the mesopelagic zone. Similarly, some groups see the mesopelagic zone as a pristine wilderness that is threatened by destructive human activity. From this perspective, existing attempts to regulate and manage fisheries has failed to protect wildlife in existing cases, so it is expected to fail in the new activity in the mesopelagic zone as well. Furthermore, some stakeholders may challenge the cognitive legitimacy of mesopelagic fishing by focusing on how existing seafood systems can be made less wasteful, rather than how fishing activity can be expanded. One stakeholder questioned whether expanding food production through mesopelagic fishing was justified, proposing that reducing waste in current practices might be a more effective approach. In these ways, the cognitive legitimacy of human activity in the mesopelagic zone is already being formed and debated.

Finally, actors that wish to challenge the cognitive legitimacy of mesopelagic fishing can embed or include the mesopelagic zone in existing marine conservation frameworks. Including the mesopelagic zone in ongoing calls for conservation such as the UN's 30×30 campaign [12,74] can make marine protected areas in the mesopelagic zone cognitively legitimate. The conservation of the mesopelagic zone can be further institutionalised within the *United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction* (known as the BBNJ agreement). As Suchman [83] argues, the cognitive legitimacy of an activity relies on its embeddedness in existing institutions, and the BBNJ agreement will require an institutional framework of commissions, financial mechanisms, and coordination bodies [25]. Those who wish to establish cognitive legitimacy for conservation can do so by associating the mesopelagic zone with these activities.

5. Discussion

The social license to operate of mesopelagic fishing will depend not only on verifiable facts, such as economic and ecological viability, but also on how the activity relates to stakeholder interests (pragmatic legitimacy), supports societal values (moral legitimacy), and conforms with existing narratives and institutions (cognitive legitimacy). As contests about mesopelagic fishing play out, actors can be expected to adopt single or nested legitimation strategies at the pragmatic, moral and cognitive levels. As a result, any social acceptance or science communication campaign that relies exclusively on conveying facts is unlikely to influence the social license to operate of mesopelagic fishing. To be effective, bids for gaining or challenging legitimacy must engage with interests, values, and worldviews.

While social media and alternative sources of information may one day be home to alternate views about the mesopelagic zone, scientists are presently the de facto governors of the mesopelagic zone [78]. drawing on both past cases and present developments to speculate about a future for mesopelagic fishing [22,68]. The results presented above illustrate that some scientific work lends cognitive legitimacy to fishing in the mesopelagic zone by associating it with present fisheries management strategies. Examples of this include calculating maximum sustainable yields and determining stock biomass as called for in Standal & Grimaldo (2020). Simultaneously, other scientific work frames the mesopelagic zone as a crucial part of global carbon systems, calling for more quantification [54] and inclusion in existing carbon accounting frameworks [39]. However, as the illustrative examples presented above show, this authoritative role of science could diminish as other stakeholders become involved in discussions about the legitimacy of human activities in the mesopelagic zone. Private actors in the fishing and processing industries, environmental NGOs such as the Deep Sea Conservation Coalition [16] and unions of scientists such as Deep Ocean Stewardship Initiative [18] are already employing legitimation strategies for their preferred outcome for the mesopelagic zone.

However, decisions about whether or not mesopelagic zone activities will go ahead will be informed by science, but are ultimately political in

nature. As a result, attempts to govern activity in the mesopelagic zone must go beyond developing a knowledge base to also find ways to facilitate contestation and negotiation for the inevitable trade-offs that need to be made between conflicting perspectives about legitimacy. As observed in the illustrative examples, stakeholders will debate scientific facts, but they will also challenge one another on the basis of interests, values and worldviews. The pulse fishing example shows that an activity can be banned in spite of scientific consensus about its impact [17]. In the case of the mesopelagic zone, scientific uncertainty remains high [81] but the need for decisions will arise quickly if fishing industry actors find mesopelagic fishing to be economically viable. Although a scientific consensus has not yet been reached, the results show that both fishing and conservation in the mesopelagic zone are already deemed pragmatically, morally, and cognitively legitimate by different stakeholder groups.

Furthermore 'nested' legitimacy claims can reflect a combination of interests, values and worldviews and are not easily rebutted by scientific fact alone. In the mesopelagic case, legitimising claims that it provides meaningful livelihoods (pragmatic legitimacy), contributes to food security (moral legitimacy), and can fit within existing management and certification frameworks (cognitive legitimacy) can all be upheld by the same actors. At the same time, however, other actors may similarly build a delegitimising argument that the mesopelagic zone supports other valuable commercial fisheries (pragmatic), stabilises vulnerable climate systems (moral), and falls under existing targets and agreements for ocean conservation (cognitive legitimacy). Because both of these positions can already be supported with scientific sources, the contest between them is unlikely to be resolved by the production of more scientific knowledge about the mesopelagic system. As a result, policymaking about the mesopelagic zone cannot rely solely on seeking more scientific certainty, but requires negotiation about trade-offs between different interests, values, and worldviews.

The meaningful participation of a diverse set of actors should therefore be part of mesopelagic zone policy formulation processes. While stakeholder participation in environmental governance should not be seen as a panacea, good stakeholder representation, communication, and power-sharing can improve outcomes [63]. In mesopelagic zone governance, there are several areas where stakeholder engagement can help to both anticipate and deal with the contestation to come. First, this article shows that stakeholders already have diverging ideas about whether or not fishing in the mesopelagic zone is a socially acceptable activity. Without professionally facilitated contestation processes, these actors will remain isolated from one another. The example of pulse fishing showed that this can create 'shock' opposition when the two groups finally confront one another in the policy arena. Second, it is unlikely that scientific certainty will be achieved in time for political decisions to be made. The deep-sea mining example shows that there can be a rush to produce regulations once activity begins, which can threaten the legitimacy of the governance system [37]. Third, common cost-benefit and risk analyses more easily identify the interests (pragmatic legitimacy) of economic actors when evaluating the impacts of policymaking, but easily overlook more complex values (moral legitimacy) such as nutrition and food sovereignty [27]. This may explain the persistent social license to operate of international reduction fisheries activities despite community opposition.

Importantly, scientists are also stakeholders in marine management. They both affect and are affected by legitimation strategies. Bringing marine scientists into contact with the concerns of other stakeholders can therefore help adjust the scientific agenda to more properly address stakeholder needs. In the pulse fishing case, the science agenda was formulated mostly by natural scientists and focused on evaluating the biological and ecological impacts of the new gear, whereas stakeholders were also interested in social impacts and governance questions [17]. For the mesopelagic zone, stakeholder concerns about food web interactions or carbon sequestration function may readily be taken up for further research by scientific bodies. Questions about the distribution of social goods that may come from mesopelagic fishing or carbon sequestration, which so far remain understudied in the scientific literature [78], should be explored with as much attention. Incorporating an understanding of legitimacy into the study of marine resources can facilitate a governance approach that is anticipatory rather than reactionary.

Contestation about the mesopelagic zone should therefore not just be expected by policymakers, but should be invited as part of the governance process. Trained facilitators and social scientists can effectively produce insights into the interests, values, and worldviews at play in marine management debates. In this way, scientific funding bodies can adapt their research agendas to properly inform the debates and trade-offs to come in the political arena. Marine management actors can move away from a governance approach that focuses solely on resolving technical uncertainties and instead incorporate social acceptance from an activity's early stages. To support this ambition, we summarise four well-established principles for designing stakeholder deliberations that can inform the anticipatory governance of the mesopelagic zone:

1) **Consult early, consult often.** Stakeholder engagements should begin during the problem definition phase of research programs, and should continue regularly as the scientific work progresses. As demonstrated here, engaging with an extended peer community [23] can help to understand the foundations of an activity's social license to operate long before activities start.
2) **Take stakeholder perspectives seriously.** Competing claims to legitimacy based on interests, values and worldviews should be considered even when they are irreconcilable with one another. Stakeholder perspectives that are grounded in these forms of legitimacy can have power in political arenas, even if they are not supported by scientific work. This aligns with research that has shown that emotions and values are key drivers of public responses to human activity in remote ecosystems [41].
3) **Maintain the rigour of scientific advice.** While scientists and scientific bodies may also be stakeholders in the mesopelagic zone governance arena, it is crucial to maintain the independent mechanisms for critique, rigour, and peer review processes that make scientific analysis so valuable for informing political debates. The systems and practices of science should endeavour to mitigate the influence of individual interests, values, and worldviews within scientific knowledge production.
4) **Social and political sciences are essential.** While natural scientists are trained in methodologies and theories that help create meaning from our natural surroundings, social and political scientists are sensitive to methodologies, theories and concepts that can guide understanding of the social world. They should therefore play a central role in designing and facilitating stakeholder deliberations about the use and management of the natural world.

One example of how these principles might be applied is in the formation of a Mesopelagic Council. This Council would gather key stakeholders in a round-table format to discuss the future of the mesopelagic zone. Key stakeholders include representatives from science, marine industries, policy-makers at national and international levels, and non-governmental organisations on equal footing with artists, ethicists, youth representatives, and activists. A Mesopelagic Council would not replace existing deep-sea governance institutions or frameworks such as RFMOs, the International Seabed Authority, or the BBNJ agreement. Rather, a Mesopelagic Council would provide a forum that is free from the cognitive legitimacy issues that may arise by being embedded within existing institutions.

In order to facilitate anticipatory discussions about the just and sustainable management of the mesopelagic zone, a Mesopelagic Council would not take fishing or any other human activity as a given, but would rather allow open deliberation about what and who the mesopelagic zone is for. In accordance with the first principle above, this

deliberation would be most effectively held before commercial fishing licenses are granted or other human activity begins. In accordance with the second principle above, diverse stakeholder perspectives would be included and considered. Scientific institutions have attempted to engage the public about the mesopelagic zone, such as through the Metro Pelagic campaign discussed above [4], or Woods Hole Oceanographic Institution's 'Keep it Weird' campaign [42], but these are outreach projects with the aim of shaping stakeholder perceptions, rather than understanding them. In accordance with the third principle above, the Council's scientific stakeholders would be invited to participate and contribute their current understanding of the mesopelagic zone. Importantly, however, scientific actors would also be encouraged to formulate future research agendas that are informed by the concerns of other members of the Council, so that scientific work can better inform the management of trade-offs between competing claims to legitimacy. By designing and facilitating deliberations of the Mesopelagic Council in a way that is sensitive to notions of legitimacy (as suggested in the fourth principle above), stakeholder contests can be understood and taken into account in management measures and research agendas. In this way, the social license to operate of mesopelagic zone activities can be understood as it evolves, not just in retrospect.

6. Conclusion

The social license to operate of mesopelagic fishing will be contested irrespective of its scientific assessment because these contests are grounded in competing notions of legitimacy, not debates about scientific fact. Close study of stakeholder notions of legitimacy can anticipate the types of contestation that may arise as a result of human activity in the mesopelagic zone before it begins. Although mesopelagic fishing is presently not practiced at any significant commercial scale, it is already evident that stakeholder concerns about food security, conservation, carbon sequestration, food web interactions, market dynamics, animal welfare, certification and management are all likely to arise should the activity go ahead. Furthermore, actors are already taking legitimising actions to support or oppose human activity in the mesopelagic zone, long before scientific consensus can be achieved. Scholars of other marine governance cases can apply this anticipatory approach to understand present and emerging stakeholder conflicts, especially in cases where scientific uncertainty is high.

CRediT authorship contribution statement

Amanda Schadeberg: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Judith van Leeuwen:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Rolf Groeneveld:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Conceptualization. **Marloes Kraan:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization.

Declaration of Competing Interest

The authors declare no competing interests.

Data availability

The data that has been used is confidential.

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