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Further Development of the Law of the Sea Convention in the Anthropocene Era: The Case of Anthropogenic Underwater Noise

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Abstract: Anthropogenic underwater noise (AUN) is a growing concern for governments and international institutions around the world. This emerging issue signifies a rapid environmental change and raises questions about the applicability and effectiveness of current instruments. A key question to be addressed is whether the United Nations Convention on the Law of the Sea (UNCLOS) can address the challenges posed by AUN. While AUN is not explicitly mentioned in the UNCLOS, this article argues that some of its provisions are applicable to the problem. Part XII of the UNCLOS is proposed as a governing framework for protecting the marine environment from AUN. As a result, several options are presented to strengthen the regulation of AUN under the UNCLOS, including the adoption of a new implementing agreement, addressing AUN through the existing implementation agreement, and regulating through the rules of references.

Keywords: Anthropocene era; UNCLOS; marine environmental protection; anthropogenic underwater noise; ocean governance; marine pollution

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1. Introduction

We currently live in the Anthropocene era, a complex period characterized by extensive anthropogenic activity, although its magnitude and starting point remain subject to serious debate [1]. The term "Anthropocene" refers to human-dominated activities (anthropogenic activities) that have significantly influenced global environmental changes, such as climate change, biodiversity loss, resource limitations, and waste production [2]. Anthropogenic activities are now global and the primary cause of contemporary environmental changes [3]. Consequently, they have rapidly and significantly impacted the Earth's climate, land, oceans, and biosphere.

The oceans, with their abundant living and non-living resources, play a vital role in supporting human well-being. However, increasing attention has been drawn to the ability of the oceans to sustain human well-being and the decline in marine life due to anthropogenic pressures. Human activities have affected ocean ecosystems and resources on a global scale, including overexploitation of the oceans for food and energy production, tourism, and transportation, as well as land-based activities such as atmospheric emissions and waste discharge [4]. As a result, marine ecosystems worldwide face multiple threats, including declining biodiversity, collapsing fish stocks, increasing habitat destruction, pollution, and population growth. These significant anthropogenic pressures require urgent action to enhance the protection of the marine environment in the current Anthropocene era and highlight the need for progressive development of marine environmental law and policy.

This article explores how the United Nations Convention on the Law of the Sea (UNCLOS) [5], the most important source of modern law of the sea, can be developed to address current marine environmental problems. Specifically, this article provides a critical analysis of the UNCLOS's capacity to facilitate the necessary systemic marine

environmental changes caused by anthropogenic underwater noise (AUN). A crucial question to be addressed is: "Can the challenges posed by anthropogenic underwater noise be resolved by the UNCLOS?" This article also examines the institutional arrangements and their response to the issue of AUN.

2. The Nature of Anthropogenic Underwater Noise

As discussed above, the world's oceans today are facing an environmental problem caused by several forms of anthropogenic pollution. Among these, AUN is classified as anthropogenic pollution in marine environments that can have detrimental effects on a variety of marine organisms, including whales, cetaceans, fish, and invertebrates [6]. Therefore, regulation and management of this problem are essential to protect the marine environment. Given the complexity of the problem, understanding the nature of AUN is fundamental to strengthening the regulatory framework for protecting the marine environment against this problem.

Sound plays many significant roles in the marine environment, including detecting predators and prey, communication, and navigation for various marine animals [7]. The term "acoustic" is sometimes used interchangeably with "sound" [8]. In addition, the term "soundscape" is used by scholars to describe the diverse array of sounds, including those of biological, geophysical, and anthropogenic origin, that arise from a particular landscape and vary over time and space, and offer information into critical ecosystem functions and human activities [9].

Underwater sound can occur naturally due to the physical environment, such as through wind, waves, rain, tidal actions, ice, and earthquakes (geophony) [10], and the activities of non-human organisms such as fish, marine mammals, and invertebrates (biophony) [10]. Sound can also be unintentionally or intentionally introduced by human activities such as shipping, seismic surveys, marine construction, and sonar technology (anthrophony) [10]. Seismic survey activities are categorized as anthrophony and are intentionally introduced into the marine environment. On the other hand, shipping, marine construction, and dredging are categorized as anthrophony and are unintentionally introduced into the marine environment.

Anthrophony can also be further classified into two categories: impulsive or temporary sounds, and non-impulsive or continuous sounds. Impulsive or temporary sounds have a short duration, high intensity, and a significant change in amplitude over a short period. They can be single events or repetitive, and examples include explosions, airgun discharges, sonar, and pile driving. On the other hand, non-impulsive or continuous sounds have a relatively constant sound level and are typically of lower intensity. For example, continuous sounds in the marine environment include those produced by ship propellers, industrial activities such as drilling and dredging, and renewable energy operations [6].

The term "noise" is defined as "undesired sound" [11] or "a type of unwanted sound for the receiver that interferes with the detection of other sounds of interest" [12]. Therefore, a particular sound can be considered noise to the receiver if it is unwanted. Wenz has classified four basic categories of underwater noise in the context of the sonar process, including radiated noise, self-noise, ambient noise, and reverberation noise [13]. Among these distinct categories, this article applies the term "anthropogenic underwater noise", which refers to all sources of marine noise that have significant potential impacts on many types of marine animals, such as marine mammals, fish, invertebrates, and other animals.

Marine mammals have significant ecological and cultural value. Thus, research on the impacts of AUN on marine mammals generally has drawn more attention than that concerning other marine organisms. Marine mammals have a wide bandwidth of hearing, which makes them particularly vulnerable to increased AUN. As a result, AUN can lead to a decrease in communication space as well as trigger behavioral responses, such as avoidance of the ocean area, displacement (short- and long-term), change in communication behavior, stranding behavior, changes in surface patterns, and change in driving

behavior [6]. Therefore, AUN represents a particular challenge for the conservation and management of marine mammals [14].

Research on the impacts of AUN on marine fish has also received considerable attention from the scientific community, as about 20,000 species of marine fish can hear sounds [15]. Sound is essential for fish to detect their surroundings, communicate with each other, find mates, and avoid predators [16]. Studies have observed potential impacts of AUN on 66 species of fish, including individual behaviors, physiology, anatomy, and development [17]. The impact of noise on the individual behavior of marine fish includes impaired communication, orientation, feeding, and prey detection, as well as increased aggression, leading to reduced group cohesion, avoidance of crucial habitats, lower offspring production, and increased mortality rates [18]. Marine fish physiology can also be impacted by noise exposure, resulting in poor growth rates, weakened immunity, and reduced reproduction rates. In addition, exposure to noise can have negative anatomical impacts, such as hearing loss and injury to vital organs [19] and the development stages of marine fish, such as delayed growth and reduced growth rates [17].

Marine invertebrates play a vital role in supporting worldwide fisheries, making it crucial to investigate the impact of AUN on invertebrates [20,21]. Despite their importance, research on the effects of AUN on marine invertebrates remains limited compared to studies on marine mammals and fish [22]. Current reports suggest that about 36 species of invertebrates have been observed to respond to acoustic cues and detect sound or vibration [17,23]. The impacts of AUN on marine invertebrates include effects on anatomy, physiology (stress), behavior, and masking [17]. In addition to marine mammals, fish, and invertebrates, AUN can also impact other marine species, such as turtles and phytoplankton. Seismic surveys, for example, have been found to cause significant mortality in zooplankton populations, with a single discharge from a seismic airgun having the potential to kill even microscopic zooplankton [24]. Although the effects of marine seismic surveys on turtles remain poorly understood, there is evidence that they can have an impact on these animals [25]. Therefore, more research is needed to investigate the effects of AUN on marine turtles and other species [26].

Apart from the environmental impacts, AUN can have socio-economic consequences, either through a ripple effect on human activities that depend on marine species or by directly affecting humans. Although scientific research on such impacts is still limited, some studies have shown the potential economic losses caused by AUN under certain circumstances. For example, seismic surveys have been linked to decreasing catch rates for several species of fish [27].

The ocean is an incredibly effective medium for transmitting sound, with the speed of sound in seawater being five times faster than in air. As a result, the effects of AUN in the territory of one country may have detrimental effects on another country's territory or areas of the global commons. Therefore, AUN can be regarded as a form of transboundary pollution in the marine environment [28]. Moreover, the transboundary nature of AUN can be observed in ship-generated AUN, where the state of origin is often the flag state, and the state likely to be affected could be a coastal state, port state, or third state. International shipping involves sailing between ports of different countries, meaning the harmful effects of AUN from international shipping could affect two different areas. These areas may include regions beyond national jurisdiction, such as the high seas and the deep seabed, as well as areas within the national jurisdiction of other states, such as exclusive economic zones (EEZ), territorial seas (or archipelagic waters), or continental shelf.

3. The UNCLOS and Its Applicability to Address Anthropogenic Underwater Noise

The UNCLOS is, without a doubt, an essential source of the modern law of the sea, although there are several other sources of the international law of the sea. (Other international instruments relevant to the law of the sea may include the Convention on Biological Diversity (CBD Convention), instruments established by the IMO, the Convention on the Conservation of Migratory Species of Wild Animals (CMS Convention), as well as other

binding and non-binding instruments at different levels. The custom and practices of states, the judgments of international courts and tribunals and the opinion of international jurists also contribute significantly to the development and interpretation of the law of the sea). The UNCLOS, as an essential agreement related to the use of the oceans, does not explicitly mention AUN as a form of marine pollution. Article 1 (4) of the UNCLOS defines pollution of the marine environment as:

> "[I]ntroduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities".

Some scholars argue that this definition encompasses all forms of marine pollution, either present or future, including AUN [29]. However, given that the word "noise" is not explicitly mentioned under this definition, the interpretation of this definition is critical to determine whether "noise" can qualify as a form of marine pollution. Does "energy" under this definition include "noise"? While the definition uses the term "energy", scientific research indicates that noise is a natural form of energy, suggesting that it falls under this definition [30]. In a broader interpretation, the term "energy" might also include all forms of energy, including electricity, vibration, heat and radiation [31]. Additionally, the term "likely to result" in the definition implies that potentially harmful effects on the marine environment can be regulated [32]. Thus, given the scientific uncertainty around AUN, it is reasonable to consider it as potentially deleterious [6,12,33]. Finally, the definition states that pollution of the marine environment must be "introduced by man", which limits the scope of AUN to noise that is introduced by human activities such as shipping, seismic surveys, marine construction, and the use of sonar technology [10]. Other sources of noise, such as geophony and biophony, will not be included as forms of marine pollution.

Taken together, these three elements support the argument that AUN falls within the definition of marine pollution in the UNCLOS. While the Convention was not drafted with AUN in mind, its provisions can be applied to regulate it. The following section explains how the existing provisions of the UNCLOS can be applied to deal with AUN. Additionally, Table 1 in this paper provides a summary of several relevant provisions of UNCLOS that can be reasonably employed to mitigate, adapt to, and reverse the impacts of AUN on the marine environment.

Table 1. Relevant provisions of the UNCLOS for mitigating, adapting to, and reversing the impact of AUN in the marine environment.

Main Argument	Article Number and Text
It is argued that this provision provides general obligation to address AUN	• Art. 192: "States have the obligation to protect and preserve the marine environment"
It is argued that these provisions provide a general obligation to mitigate the impact of AUN in the marine environment.	• Art. 194 (1): "States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source . . . and they shall endeavour to harmonize their policies in this connection" • Art. 194 (2): "States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights" • Art. 194 (3): "The measures taken pursuant to this Part shall deal with all sources of pollution of the marine environment" • Art. 195: "States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another" • Art. 196 (1): "States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control" • Art. 208: "Coastal States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment arising from or in connection with seabed activities subject to their jurisdiction and from artificial islands, installations and structures under their jurisdiction" • Art. 210: "States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment by dumping" and " . . . shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution" • Art. 211: "States . . . shall establish international rules and standards to prevent, reduce and control pollution of the marine environment from vessels and promote the adoption, in the same manner, wherever appropriate, of routeing systems designed to minimize the threat of accidents which might cause pollution of the marine environment"
It is argued that these provisions provide a general obligation to adapt to the impact of AUN in the marine environment.	• Art. 199: " . . . States in the area affected, in accordance with their capabilities, and the competent international organizations shall cooperate, to the extent possible, in eliminating the effects of pollution and preventing or minimizing the damage. To this end, States shall jointly develop and promote contingency plans for responding to pollution incidents in the marine environment" • Art. 61 (2): "The coastal State . . . shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation" and " . . . shall cooperate to this end" • Art. 117: "All States have the duty to take, or to cooperate with other States in taking, such measures for their respective nationals as may be necessary for the conservation of the living resources of the high seas"

Table 1. *Cont.*

Main Argument	Article Number and Text
It is argued that these provisions provide a general obligation to reverse the impact of AUN in the marine environment.	• Art. 61 (3): Conservation and management "measures shall also be designed to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield . . . " • Art. 61 (4): " . . . coastal State shall take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species . . . " • Art. 63: " . . . States shall seek, either directly or through appropriate subregional or regional organizations, to agree upon the measures necessary to coordinate and ensure the conservation and development of such stocks" • Art. 64: "The coastal State and other States whose nationals fish in the region for the highly migratory species listed in Annex I shall cooperate . . . with a view to ensuring conservation and promoting the objective of optimum utilization of such species . . . " • Art. 119: "States shall: take measures which are designed . . . to restore populations of harvested species" and "take into consideration the effects on species associated with or dependent upon harvested species with a view to . . . restoring populations"

3.1. The Protection and Preservation of the Marine Environment

Article 192 of Part XII requires all States "to protect and preserve the marine environment". The use of both "protect" and "preserve" indicates its comprehensive meaning, which goes beyond the prevention of substantive pollution [34]. The term "protect" refers to preventing future damage to the maritime environment, whereas "preserve" refers to maintaining or improving its current condition [34–36]. Professor James Harrison has suggested that the obligation under this provision can be considered as a "statement of principle" that serves to define the scope of Part XII. This means that the interpretation of Part XII should cover all forms of harm to the marine environment [35,37], including the alteration of the marine environment and its components, physical harm and destruction [37]. Given the impact of AUN, States have an obligation to protect the marine environment against AUN through efforts that will prevent future damage and maintain or improve the present condition of the marine environment. This obligation is also considered to be a binding norm of customary international law, which means that all States have a legal obligation, including those that have not ratified the UNCLOS [37,38].

The obligation under Article 192 is linked to Articles 194 (1) and (3). Article 194 (1) contains a general obligation for States to take all measures necessary for preventing, minimizing, and controlling pollution of the marine environment from any sources. As AUN can be considered a form of pollution of the marine environment, States arguably should also take necessary measures to prevent, reduce, and control AUN from any sources. Article 194 (3) requires States to take measures against all sources of marine pollution, including shipping, the use of sonar, exploitation and exploration of oil and gas, and other sources of AUN. In addition, States must "ensure that activities under their jurisdiction or control are conducted so as not to cause damage by pollution to other states and their environment" [39]. The phrase "to ensure" imposes a due diligence obligation on States [38], requiring them to take measures to prevent or minimize harmful pollution. Such measures include conducting environmental impact assessments, regulating activities, using the best available technology, applying the precautionary principle, and enforcing measures for activities causing AUN under their control and within their jurisdiction. This obligation also applies to activities that may have transboundary effects on the marine environment, including those in the ABNJ [31,35,40].

3.2. The Conservation of Marine Living Resources

The UNCLOS outlines two basic approaches to conserving marine living resources. The first approach is based on jurisdiction, wherein a coastal State is granted the sovereign right to explore, exploit, conserve and manage the natural resources, of the water superjacent above the seabed and its subsoil within its exclusive economic zones (EEZ) [41]. Within this jurisdiction, the coastal State has a responsibility for the conservation and management of the marine living resources in accordance with Article 61 of the UNCLOS. The term marine living resources may also include the concept of biodiversity under the CBD Convention, which allows for a more comprehensive interpretation of Article 61 for conserving, sustainably using and minimizing ecosystem impacts within the EEZ [42].

According to Article 61 of the UNCLOS, States are required to establish a total allowable catch (TAC) for the harvesting of living resources within the EEZ, based on the best scientific evidence available. Furthermore, each State is obligated to implement appropriate conservation and management measures to ensure sustainable use of these resources within the EEZ [43,44]. States must maintain or restore harvested species populations to levels that can produce maximum sustainable yield (MSY) considering environmental and economic factors. Given that AUN is an environmental factor that could potentially cause a decrease in MSY in certain populations, it is reasonable to argue that the UNCLOS has a mandate to consider AUN in the establishment of conservation measures and TAC [6,45]. The second approach to conserve marine living resources is based on the species-specific approach. The UNCLOS provides special regimes for specific species applicable to the conservation of shared fish stocks [46], straddling fish stocks [47], highly migratory species (HMS) [48],

marine mammals [49], anadromous stocks [50], catadromous species [51] and sedimentary species [52]. According to this approach, conservation measures are to be determined according to each category of certain marine species. Considering the impact of AUN, several conservation provisions under this subject can also be applied to AUN. (For instance, Article 63 (1) of the UNCLOS states: "States shall seek . . . to agree upon the measures necessary to co-ordinate and measure the conservation and development of such stocks" (shared and straddling fish stocks). Article 64 (1) provides that States "shall cooperate . . . with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region" (highly migratory species). Article 65 of the UNCLOS states: "States shall cooperate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organizations for their conservation, management and study" (marine mammals).

3.3. The Conservation of Marine Biodiversity

The UNCLOS provides two general provisions relating to the conservation of marine biological diversity, laid down in Articles 194 (5) and 196 (1). First, States are obligated under Article 194 (5) of the UNCLOS to protect and preserve rare or fragile marine ecosystems, threatened habitats, depleted or endangered species and other forms of marine life. [53]. Some commentators suggest that this provision aims to protect ecosystems and biodiversity as a whole [34]. Further, the scope is not only for preventing, reducing and controlling pollution but also includes all issues of protection of the marine environment, including AUN. Secondly, Article 196 (1) obligates States to take measures to prevent, reduce and control marine pollution caused by technologies that may cause a significant and harmful change to the marine environment [54]. This provision recognizes the use of technologies as a source of marine pollution and requires States to take measures against uncertain risks possibly from the use of technologies. The term "technologies" in this provision is broad and does not refer to a specific technology [34]. The term technology has a broader interpretation than the installations and devices under Article 194 (1)–(3), which is doubtful if the introduction and use of a (new) technology are encompassed by Article 194 [34]. Given that AUN can result from the use of many different technologies, States arguably have an obligation to take all measures to prevent, reduce and control AUN that may cause significant and harmful changes to a particular part of the marine environment.

4. Institutional Framework and Its Response to the Issue of Anthropogenic Underwater Noise

The UNCLOS is a unique instrument in terms of its institutional framework. Unlike other multilateral treaties, it does not provide a detailed arrangement for facilitating review and implementation. This is largely due to the fact that the UNCLOS addresses a broad range of issues related to the use of ocean space, rather than focusing on a specific area of concern. As a result, developing a comprehensive institutional framework to oversee the implementation and application of the UNCLOS is particularly challenging [55].

During the negotiation process for the UNCLOS, some delegations suggested the establishment of a specific body to periodically review and implement the Convention, but these proposals did not receive widespread support [56]. Consequently, the Convention does not have standing bodies or a conference of the parties, unlike many other multilateral treaties. Instead, the Convention has four annual review cycles, which include the UN Secretary-General's report, the Meeting of the States Parties to the UNCLOS (SPLOS), the Open-Ended Informal Consultative Process on Oceans and Law of the Sea (ICP), and the UN General Assembly's resolution. While these review cycles do not have the same function as the standing bodies of other treaties, some scholars and commentators have argued that they play a role in developing the issue of the law of the sea and the Convention [55]. This section summarizes the four annual review cycles of the Convention and their response to the issue of AUN.

Firstly, the UN Secretary-General's annual report, published at the beginning of each year, reviews developments related to the law of the sea, including the UNCLOS [57]. As the treaty depository function and "administrative hub" under Article 319 of the UNCLOS, the UN Secretary-General is responsible for convening necessary meetings and reporting on issues of a general nature [58]. This legal basis has led to the establishment of the SPLOS. In 2003, the UN Secretary-General first recognized the issue of AUN from shipping and continued to report on it from 2005 to 2020 due to its environmental impact on the marine environment and vulnerable ecosystems [59]. The increasing attention toward AUN has been noted in international forums, such as the International Whaling Commission, the European Parliament, and the International Union for Conservation of Nature (IUCN) [60]. In 2018, the UN Secretary-General provided a special report on the issue of AUN [61].

Secondly, the SPLOS normally convenes in June and aims to receive and consider matters relating to the UNCLOS, the International Tribunal for the Law of the Sea, and the Commission on the Limits of the Continental Shelf, including the election of their members. The SPLOS initially mentioned the issue of AUN in 2006, when some delegations stated that the report of the Secretary-General should "address the concept of maritime security in a broader sense including the effects of ocean noise on marine mammals" [62]. However, the discussion of AUN under the SPLOS was not continued until 2018 and 2019. Under this meeting, some delegations expressed their concern over the threats and pressures caused by many types of marine pollution, including AUN, and called for further action to address those problems. In particular, some delegations suggested the implementation of area-based management tools and environmental assessment as well as the need for capacity-building and transfer of marine technology [63,64].

Thirdly, the ICP usually meets shortly after the SPLOS. It was established on 24 November 1999 by the UNGA following the recommendation of the Commission on Sustainable Development, consistent with the legal framework of the UNCLOS and the goals of chapter 17 of Agenda 21 [65]. The ICP plays a role in facilitating the annual review by the General Assembly of the developments of the law of the sea and ocean affairs by considering the Secretary-General's annual report and suggesting particular issues relating to the oceans and the law of the sea [66]. In 2004, the fifth meeting of the ICP identified AUN and its impacts on marine life as one of the issues that could benefit from attention in future work of the UNGA on oceans and the law of the sea. This issue was further discussed in 2005 under "Agenda item 3: General exchange of views on areas of concern and actions needed, including on issues discussed at the previous meeting" [67]. During this meeting, some delegations stated that the problem of AUN had not been regulated and suggested applying the UNCLOS as a legal basis for action to address AUN, establishing a multinational task force to develop international agreements on noise regulations, and implementing the precautionary principle to reduce or mitigate activities that result in high levels of AUN until effective guidelines are established [67]. One delegation emphasized the international community's need to address the problem of AUN [67].

Finally, the annual review cycle ends with the adoption of the UNGA's resolution on "oceans and the law of the sea". It discusses agenda items on oceans and the law of the sea based on the report prepared by the UN Secretary-General. The resolution of the UNGA consists of reviewing the UNCLOS, calling on the Member States to take various kinds of action, and other normative instruments. Moreover, the UNGA has taken it upon itself to have the competence to undertake such a review and evaluation of the implementation of the UNCLOS as well as other developments relating to ocean affairs and the law of the sea. In this regard, the UNGA has taken upon itself a role that would be fulfilled by a conference of the parties under most other treaties [55]. The concern of AUN was first brought up in 2005 by the UNGA when it adopted Resolution A/Res/60/30 on "Oceans and the Law of the Sea." From 2006 onward, a reference to the issue of AUN regularly appeared in the UNGA resolution [68–71].

Despite the UNGA's concern on this issue, the resolution has not yet produced significant action toward noise regulation such as the development of a task force to develop

international agreements on noise regulation or effective guidelines to address AUN. The existing gaps in knowledge and the limited detailed studies and data on AUN are likely contributing factors hindering the development of specific regulations to tackle this issue. As a result, the current UNGA resolution has primarily focused on promoting further research and consideration of the effects of AUN on marine living resources, and has urged the DOALOS to gather and share peer-reviewed scientific studies received from Member States on its website [72]. Additionally, the resolution has recognized and encouraged the implementation of the IMO Guidelines for reducing AUN from commercial shipping. Furthermore, it has stressed the importance of cooperation and coordination among States and international organizations in conducting research on AUN. The resolution also calls on States to consider cost-effective measures and strategies for addressing the issue of AUN [68–73].

In addition, the ICP-19 focused its discussions on the theme of "Anthropogenic Underwater Noise", as specified in Resolutions 71/257 and 72/73 [74,75]. This meeting, held from 18–22 June 2018, provided the most comprehensive discussion on the AUN issue under the annual cycle of the UNCLOS. The discussions at ICP-19 covered a wide range of topics related to AUN, ranging from its widespread and intricate nature and lack of information on its sources and effects to its socioeconomic impact on sectors such as fishing, tourism, and transportation. The meeting also explored possible management strategies, such as the use of area-based management tools and environmental impact assessments. Moreover, AUN was identified as a form of transboundary pollution requiring mitigation and action through a UNGA resolution [6,76]. Despite these significant discussions, the current UNGA resolution on the law of the sea has produced no substantial results in addressing AUN. However, the ICP-19 report acknowledges that other institutions, at the international, regional and national levels, have adopted and implemented various instruments, initiatives, and programs to tackle AUN, as indicated in Table 2 [6]. For instance, the IMO has adopted the IMO Guidelines specifically designed to address AUN arising from shipping activities. Therefore, it is recommended that Parties to the UNCLOS utilize these existing instruments and initiatives, including IMO Guidelines, as the best environmental practices and the best available technology to effectively address AUN and mitigate its impact on the marine environment.

Table 2. Regulatory framework and its responses to address AUN and its impact on the marine environment.

Category	Instruments/Institutions	Mitigation Measures/Programs/Initiatives
International Instruments	United Nations Convention on the Law of the Sea	• The UNCLOS serves as a fundamental framework for regulating all marine activities, including the protection of the marine environment from AUN. The issue of AUN has been extensively discussed during the three annual meetings of the State Parties to the UNCLOS, as detailed in Section 3 of this paper.
	Convention on Migratory Marine Species	• Resolution 12.14 on Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species was adopted at COP-12 as the CMS, along with its annex on Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities (UNEP/CMS/COP12/Inf.11/Rev.1) [77]. • Best Available Technology (BAT) and Best Environmental Practice (BET) for Three Noise Sources: Shipping, Seismic Surveys, and Pile Driving, 2019 (UNEP/CMS/COP13/Inf.9) [78].
	International Maritime Organization	• Resolution MEPC.1-Circ.833 on the Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life (IMO Guidelines) [79].
	Convention on Biological Diversity	• The CBD has not adopted a specific program or initiative to address AUN. However, it has comprehensively discussed the issue of AUN and encourages states and non-state actors to apply relevant mitigation measures to address AUN [80]. - CBD Decision XII/23: Marine and coastal biodiversity: Impacts on marine and coastal biodiversity of anthropogenic underwater noise [81]. - VIII/28. Impact assessment: Voluntary guidelines on biodiversity-inclusive impact assessment (UNEP/CBD/COP/DEC/VIII/28). It provides detailed guidance on whether, when and how to consider biodiversity in both project level and strategic level assessments (including AUN) [82].
	International Whaling Commission	• IWC, Resolution 2018-4 on Anthropogenic Underwater Noise. This resolution instructs the Conservation Committee to review progress in implementing IWC Recommendations on the mitigation and management of anthropogenic underwater noise and, based on this review, develop advice on priority actions to implement to address the impacts of anthropogenic underwater noise on cetaceans [83].
Regional Agreements and Initiatives	EU Marine Strategy Framework Directive (MSFD or Directive)	• MSFD Descriptor 11 on Energy and Noise (D11): MSFD Descriptor 11 addresses the introduction of energy, including underwater noise, to ensure that it does not have adverse effects on the marine environment [84]. Commission Decision 2017/848 further specifies criteria elements for D11, focusing on anthropogenic impulsive sound and anthropogenic continuous low-frequency sound in water [85]. • Recital 12 of Directive 2014/52/EU: Directive 2014/52/EU, which pertains to the assessment of the effects of certain public and private projects on the environment, recognizes the importance of the marine environment. It emphasizes the need for EIA and screening procedures for projects in marine environments, particularly those involving technologies such as seismic surveys that utilize active sonars. Annex III and Annex IV of the directive also highlight the consideration of the marine environment, including noise and vibration [86]. • Habitats Directive and Birds Directive: The Habitats Directive (Council Directive 92/43/EEC) and the Birds Directive (Council and European Parliament Directive 2009/147/EC) play a crucial role in the protection of species and habitats in the European Union. These directives require measures to prevent significant disturbance to species within Natura 2000 sites (designated areas of high biodiversity importance). Article 6(2) of the directives specifies the obligation to assess human activities that may have a significant impact on the conservation objectives of these sites, including potential disturbances caused by AUN [87,88]. • Monitoring Guidance for Underwater Noise in European Seas, Part I: Executive Summary, JRC Scientific and Policy Report EUR 26557 EN, 2014 [89]. • Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications, JRC Scientific and Policy Report EUR 26555 EN, 2014 [90]. • Monitoring Guidance for Underwater Noise in European Seas, Part III: Background Information and Annexes, 2014 [91].
	The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)	• Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2030 (Agreement 2021-01: North-East Atlantic Environment Strategy (replacing Agreement 2010-03)), 2021 [92]. • Agreement 2015-05 on OSPAR Monitoring Strategy for Ambient Underwater Noise [93]. • OSPAR Commission, CEMP Guidelines for Monitoring and Assessment of loud, low and mid-frequency impulsive sound sources in the OSPAR Maritime Region. OSPAR Agreement 2017-07, 2017 [94]

Table 2. *Cont.*

Category	Instruments/Institutions	Mitigation Measures/Programs/Initiatives
	The Convention on the Protection of the Marine Environment of the Baltic Sea Areas (Helsinki Convention)	• HELCOM's Baltic Sea Action Plan 2021, specifically in Part IV on "Sea-based activities", includes a goal of environmentally sustainable sea-based activities. One of the ecological objectives within this part is to ensure "No or minimal harm to marine life from man-made noise". To achieve this objective, the Action Plan establishes a management objective to "Minimize noise to levels that do not adversely affect marine life". Furthermore, the Action Plan outlines nine specific action plans to address AUN [95]. • Regional Baltic Underwater Noise Roadmap 2015–2017 adopted in 2016 (HELCOM 37-2016) [96].
	The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	• Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region, 2003 [97]. • Action Plan for the conservation of cetaceans in the Mediterranean Sea, 2016 [98]. • Integrated Monitoring and Assessment Programme and related Assessment Criteria (IMAP). Monitoring Ecological Objective 11: Energy including underwater noise [99].
	The Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention)	• Black Sea Integrated Monitoring and Assessment Program for years 2017–2022 (BSIMAP) [100]. The BSIMAP has the objective to answer the policy question on "What are the levels of noise pollution in the Black Sea and how to reduce the risk from noise pollution for fish and cetaceans in the Black Sea?"
	The Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)	• ACCOBAMS, Resolution 2.16 on Assessment and Impact Assessment of Man-Made Noise, (ACCOBAMS-MOP2/2004/Res.2.16), 2004 [101]. • ACCOBAMS Resolution 3.10 on the Guidelines to Address the Impact of Anthropogenic Underwater Noise on Marine Mammals in the ACCOBAMS Area (ACCOBAMS-MOP3/2007/Res.3.10), 2007 [102]. • ACCOBAMS, Annex Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area, (ACCOBAMS-MP4/2010/Res.4.17), 2010 [103]. • ACCOBAMS, Resolution 5.15, Addressing the Impact of Anthropogenic Underwater Noise, (ACCOBAMS-MOP5/2013/Res.5.15), 2013 [104]. • ACCOBAMS, Resolution 6.17 on Anthropogenic Noise, (ACCOBAMS-MOP6/2016/Res.6.17), 2016 [105]. • ACCOBAMS, Resolution 7.13 Anthropogenic Noise, (ACCOBAMS-MOP7/2019/Doc38/Annex15/Res.7.13), 2019 [106].
	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS)	• ASCOBANS, Resolution No. 4 on Disturbance, adopted at 3rd Session of the MOP, Bristol, UK, 26–28 July 2000 [107]. • ASCOBANS, Resolution No. 05 on Effects of Noise and of Vessels, adopted at 4th Meeting of the Parties to ASCOBANS, Esbjerg, Denmark, 19–22 August 2003 [108]. • ASCOBANS, Resolution No. 11 on "CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities", adopted at 8th Meeting of the Parties to ASCOBANS, Helsinki, Finland, 30 August–1 September 2016 [109]. • ASCOBANS, Resolution 8.11 on CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities, at the 9th Meeting of the MOP, Online, 7–11 September 2020 [110].
National Legislation, Programs and Initiatives	Canada	• Canada has adopted several measures, such as: (1) Incentivizing quiet vessel design—The Vancouver Fraser Port Authority (VFPA) and the Port of Prince Rupert in Canada offer discounts on harbor fees for vessels that incorporate specific noise reduction technologies or hold a quiet certification from a recognized classification society, (2) Voluntary measures—The Working Group on Marine Traffic and Protection of Marine Mammals in the Gulf of St. Lawrence (G2T3M), comprising stakeholders from the marine industry, research, and conservation sectors, has proposed voluntary speed reduction measures for maritime transportation vessels in the St. Lawrence River. Led by Parks Canada and the Department of Fisheries and Oceans Canada, these measures aim to mitigate the risks of collisions with whales and minimize the impact of noise on belugas in the region. The Canadian Coast Guard published these measures in the Notice to Mariners—East monthly Edition from May to October 2013, emphasizing the importance of collective efforts to protect marine mammals and reduce noise disturbances in the St. Lawrence River [111].

Table 2. *Cont.*

Category	Instruments/Institutions	Mitigation Measures/Programs/Initiatives
	USA	• NOAA Ocean Noise Strategy Roadmap (NOAA Strategy), 2016 [112].
	Australia	• Australia has adopted several measures to address AUN, such as: (1) The Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) serves as a regulatory framework for activities that have the potential to significantly affect Matters of National Environmental Significance (MNES). Policy Statement 2.1, a component of the EPBC Act, establishes standards and a structured approach to mitigate risks associated with seismic surveys, providing essential guidance to operators conducting such surveys. (2) The North-East Shipping Management Plan encompasses a range of initiatives led by the Great Barrier Reef Marine Park Authority (GBRMPA) with the objective of advancing knowledge regarding the effects of shipping activities on the marine environment. As part of these efforts, GBRMPA and the Australian Maritime Safety Authority continually assess opportunities for research on noise monitoring tools and methodologies, as well as the implications for implementing ship noise mitigation strategies. (3) The Great Barrier Reef Marine Park Regulations of 1983 mandate that GBRMPA assess the environmental, social, cultural, and heritage implications of proposed activities within the marine park, including underwater noise. Recent updates to these regulations (4 October 2017) aim to enhance the consistency and transparency of the application process. These updates require the consideration of direct, indirect, and potential cumulative impacts of activities on the marine park's environment, biodiversity, and heritage values, which are now collectively referred to as "relevant impacts". (4) The Maritime Activities Environmental Management Plan incorporates measures to mitigate and address the environmental impacts associated with noise from military operations. Specific procedures are outlined to manage noise-related impacts, particularly in areas of higher marine mammal abundances and locations with specific sensitivities such as feeding and resting areas. These measures aim to avoid activities generating high noise levels in these sensitive areas. Additionally, since 2011, various sub-national states have implemented strategies, management plans, and initiatives focused on marine conservation areas. For instance, the "NSW 2021: a plan to make NSW number one" outlines goals related to biodiversity protection and conservation, including the establishment of additional conservation areas throughout New South Wales.
	Norway	• Norway has adopted several measures, such as: (1) Regulations for offshore petroleum activities –Regulations governing seismic surveys have been established to prevent or minimize adverse effects. These regulations, specified in the Petroleum Act and Petroleum Regulations, mandate the implementation of impact assessments before the opening of new areas. These assessments encompass various aspects, including the potential impacts associated with underwater noise. (2) A common guideline titled "Implementation of seismic surveys on the Norwegian Continental Shelf" has been published by the Ministry of Fisheries and the Norwegian Ministry of Petroleum and Energy. Additionally, the Norwegian Oil and Gas Association has released comprehensive guidelines that provide further details on promoting coexistence with the fishing sector during seismic surveys on the Norwegian Continental Shelf. (3) Fisheries Liaison Officers on seismic vessels –Vessels carrying out seismic surveys must have a fisheries liaison officer (FLO) on board when it is necessary due to fishing operations in the area. (4) The use of sonar in naval operations has been subject to rigorous environmental assessment procedures since 2003. Generic EIAs have been conducted by the Navy to evaluate the potential impacts of sonar operations. Subsequently, comprehensive guidelines were introduced in 2006 and were later upgraded to regulations in 2009 and military instructions in 2015. These guidelines, regulations, and instructions encompass a range of measures aimed at minimizing the environmental impacts of sonar activities. (5) Underwater explosions—In accordance with the Norwegian pollution control act, provisions exist for granting permission that may include specific terms. These terms encompass mitigating measures, such as employing warning explosions of reduced power, with the primary objective of deterring fish, marine mammals and other animals species. (6) Piling—Piling activities in Norway are not considered to be extensive. However, ongoing efforts are being made to incorporate measures to mitigate AUN into the guidance for sediment management [111].
	Oman	• Oman has implemented several measures aimed at minimizing the effects of AUN, including: imposing restrictions on seismic surveys near sensitive sites and prohibiting such activities during the breeding season of marine mammals and turtles, establishing environmental requirements for projects to minimize the impact of AUN on marine organisms, particularly that related to oil extraction platforms, conducting surveys of marine mammals and turtles to monitor and assess the impacts caused by anthropogenic underwater noise, and regulating marine tourism activities and associated businesses, and issuing diving licenses while considering the potential adverse effects of underwater noise on marine species [111].

Table 2. *Cont.*

Category	Instruments/Institutions	Mitigation Measures/Programs/Initiatives
	Sweden	• Sweden has implemented several measures to address AUN, including (1) EIA for permitting waterworks—Operators are required to prepare an EIA as part of the permit application process. The EIA should encompass an assessment of potential environmental impacts associated with underwater noise, along with proposed mitigation measures. (2) Designation of a marine Natura 2000 area in the Baltic Proper specifically for the conservation of harbor porpoises. This designated area represents the largest marine region proposed by Sweden as a Natura 2000 site. The project's objective is to minimize noise disturbances caused by various activities, including those involving pleasure boats and commercial vessels, as well as the use of underwater sounding devices such as sonars. (3) The AQUO (Achieve QUieter Oceans) initiative aims to reduce the shipping noise footprint. As part of this effort, guidelines have been developed in collaboration with another European Union project. These guidelines focus on measuring and mitigating noise generated by ships, with the goal of achieving quieter oceans [111].
	Venezuela	• Decree No. 1.257 and Official Gazette No. 35.946—Decree 1.257 establishes standards for conducting EIAs of activities that have the potential to degrade the environment. Official Gazette 35.946 mandates the submission of an EIA report for activities that may cause harm to various aspects of the natural and social environment. The EIA report should encompass empirical evidence supported by scientific studies to demonstrate the potential reversibility of underwater noise impacts [111].
Non-State Actors	Central Dredging Association serving Europe, Africa and the Middle East (CEDA)	• The Establishment of the Commission's Working Group on Underwater Sound (WGUS) • CEDA Environment Commission Working Group, "CEDA Position Paper: Underwater Sound in Relation to Dredging", 2011 [113]
	World Organization of Dredging Associations (WODA)	• The establishment of Expert Group on Underwater Noise (WEGUS) • Technical Guidance on: Underwater Sound in Relation to Dredging (Technical Guidance), 2013 [114]. • WODA Workshop Underwater Sound in Relation to Dredging: Translating Science into First-Hand Practice, 26 March 2015, Paris, France.

5. The UNCLOS as Governing Framework for Anthropogenic Underwater Noise

Despite the applicability of the UNCLOS to address AUN, most of the UNCLOS provisions are too general to establish specific international standards to mitigate, adapt to and reverse the various impacts of AUN. To this end, Part XII of the UNCLOS should be understood as an umbrella convention (or framework agreement) that provides the overarching legal framework for a number of agreements on marine environmental protection and marine species conservation [115]. As a framework agreement, Part XII of the UNCLOS provides possible mechanisms to consider specific elements of the UNCLOS as fulfilling the role of sectoral framework conventions [35].

A framework convention is typically referred to as a treaty or convention that incorporates some principles and a general system of governance, provides general guidelines, or establishes international and national policies. At the same time, framework conventions allow states parties to develop and adopt future specific regulations, obligations, and targets to address the evolving international environment [116,117]. Therefore, the UNCLOS embodies both explicit and implicit characteristics of a framework convention, particularly those related to the protection and preservation of the marine environment. Since there is a lack of detailed regulations on the protection and preservation of the marine environment against AUN, the UNCLOS may adopt more detailed rules or standards pertaining to AUN through the implementing agreement or external rules and standards created by other bodies such as competent international organizations or general diplomatic conferences. Accordingly, this article examines three potential options to strengthen the regulation of AUN under the UNCLOS, including the development of new international legally binding instruments for AUN, addressing AUN through the BBNJ Agreement, and rules of references.

5.1. The Development of New International Legally Binding Instruments for AUN

In the absence of specific global binding instruments to address AUN, the adoption of a new implementation agreement under the UNCLOS could be a golden opportunity to address AUN. Such an agreement would improve the existing UNCLOS's obligations related to the protection and preservation of the marine environment against AUN. However, the idea of the adoption of a new implementation agreement to address several emerging marine environmental issues has been proposed by many scholars, although such an idea to develop a specific implementation agreement on AUN is considerably new. Examples of such agreements are those intended to address ocean acidification, land-based pollution, and marine plastic pollution [29]. Nevertheless, to date, no successful implementation agreement has been reached to address these issues. Furthermore, the idea concerning the development of a new implementation agreement for AUN is still fresh. Therefore, a proposal for such an agreement would face various challenges and obstacles.

In addition, while the scientific literature on the impact of AUN on marine living resources has expanded in recent years, extant reports underscore a critical need to enhance the scientific research and data on the sources and impact of AUN in the marine environment, particularly in developing countries. Thus, improving scientific research and data on the sources and impact of AUN constitutes a pivotal stride toward better regulation and management of AUN. The lack of comprehensive knowledge and data on AUN makes it difficult to identify effective management approaches and establish clear targets and standards for reducing AUN. As a result, numerous UNGA resolutions have repeatedly encouraged all stakeholders to improve their scientific understanding of the impact of AUN on marine living resources.

In response to the need for enhanced scientific research and data on AUN in the marine environment, several UNGA resolutions have called upon the DOALOS to compile and make available peer-reviewed scientific studies received from Member States on its website. However, a review of the DOALOS website reveals that no updated information on peer-reviewed scientific studies related to AUN has been made available since 2018. Therefore, it is recommended that DOALOS resume its mandate to collect and disseminate updated

scientific research on AUN. In addition to DOALOS, the ICP has also addressed the issue of AUN and the need to increase awareness and address knowledge gaps related to this issue. During the 2018 ICP meeting, it was recognized that effective management of AUN requires cooperation, coordination, and capacity-building to develop a comprehensive understanding of its impacts in an integrated and cross-sectoral manner [6].

Therefore, it is essential to prioritize cooperation, coordination and capacity-building in the scientific research and data on the sources and impact of AUN on marine living resources, particularly in developing countries, to establish clear guidelines and targets for reducing AUN and enhancing the regulation and management of marine living resources. The cooperation and coordination may occur on an inter-institutional or regional basis within and across different sectors representing noise-generated activities such as mining, oil and gas exploration, military, shipping, fisheries, and marine renewable energy or impacted sectors such as environment, fisheries and tourism [6]. Such cooperation and coordination will have several benefits such as increasing awareness, sharing of information on the sources and impacts of AUN on marine living resources, and the development and sharing of best practices for minimizing the impacts of AUN and addressing cumulative impacts from AUN [6].

Indeed, scientific research has been a driving force in the development of environmental law and policy. Unlike other areas of public international law, where the law-making process may be influenced by political, economic, or commercial considerations, environmental law relies heavily on scientific evidence. The law-making process involves both scientists and lawyers, but scientific evidence often shapes and guides the outputs [118]. As such, the development of environmental law requires the gathering of scientific evidence from a range of sources, including international bodies such as the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), as well as from governmental and non-state entities [119].

According to scholars, global environmental assessments (GEAs) are considered as a crucial instrument for providing information to support decision-making in the field of international environmental governance [120]. GEAs produced by international organizations such as the IPCC, IPBES, and GESAMP are significant innovations in organizing policy-relevant knowledge and advice regarding multi-scale environmental concerns for governments, and for shaping and servicing multilateral environmental agreements (MEAs) [121,122]. For instance, the IPCC, established in 1988, has played a vital role in developing the United Nations Framework Convention on Climate Change (UNFCCC) [123] and several other international negotiations conducted under the UNFCCC. Similarly, GESAMP, established in 1969 as a scientific advisory body on marine pollution and marine environmental protection, has an essential role in providing GEAs related to marine pollution [124].

Given the circumstances, the formation of an institution or ad-hoc expert working group (WG) with a specific mandate to provide GEAs on AUN presents a significant opportunity to address current knowledge gaps. The WG will comprise technical experts from all member States of the UNCLOS, alongside representation from international and regional conventions and organizations and other relevant stakeholders. The WG's explicit mandate will entail identifying all obstacles to combating AUN, including those encountered by developing countries. Additionally, the WG will investigate extant responses at the national, regional, and international levels, including action plans, binding and non-binding instruments, and innovative approaches. The feasibility and effectiveness of different response options will also be examined by the WG. Moreover, the WG may proffer recommendations on prospective options for continuing work, to be considered by the UNGA.

Scholars have generally identified three critical components for the effectiveness of GEAs, which heavily rely on the perceptions of the intended audience [120]. These components are credibility, legitimacy, and salience of environmental assessments. Credibility

pertains to the extent to which a scientific or technical assessment is deemed trustworthy by the intended audience, typically within the scientific community [125,126]. In this context, the assessment's credibility is based on its ability to demonstrate a strong scientific foundation and technical validity. Meanwhile, legitimacy in the context of GEAs refers to how the intended audience perceives the fairness of the social aspects, rules, regulations, and processes involved in the assessment and its procedures. Lastly, salience refers to how relevant and applicable the information produced by the assessment is to the concerns of the intended audience. An assessment with high salience provides information that is perceived to be of practical value to the audience and that can be used to inform decisions or actions. Overall, these three components are crucial for the effectiveness of GEAs, as they ensure that the assessments are perceived as credible, legitimate, and salient by their intended audiences. By prioritizing these components, specific GEAs proposed for addressing the issue of AUN can produce reliable and valuable results. These results can be used to inform decisions or actions related to the regulation of AUN and its impact on marine living resources.

Although there are currently no specific international institutions that provide GEAs on AUN, the Ad Hoc Working Group of the Whole on the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (Regular Process), established by the UNGA, may play a crucial role in distributing relevant information and fostering the science–policy interface concerning AUN. The UNGA established the Regular Process to provide regular assessments at the global and supra-regional levels, and an integrated view of environmental, economic, and social aspects. To achieve this, the Regular Process should be conducted in close collaboration with existing global and regional institutions to ensure that the results can be utilized in decision-making. Thus, the Regular Process may provide a scientific basis for regular assessments of AUN at the global level. In this regard, collaboration with the existing global and regional institutions to address AUN is essential to ensure that the results of the Regular Process can be used in decision-making. Therefore, the Regular Process must be carefully managed in order to ensure the transparency and rigor of the reports of global ocean assessments, particularly in relation to the AUN [57].

5.2. Addressing AUN through the BBNJ Agreement

Despite the various challenges facing the adoption of the new implementation agreement for AUN, the recently agreed-upon instrument of the implementing agreement on biological diversity beyond national jurisdiction (BBNJ) presents a promising opportunity to strengthen the provisions of the UNCLOS to protect the marine environment against the deleterious effects of AUN. The BBNJ Agreement acknowledges the imperative of dealing with the loss of biodiversity and the deterioration of oceanic ecosystems in a coherent and cooperative fashion, in response to diverse environmental pressures. These pressures include, in particular, the impact of climate change on marine ecosystems, including warming, deoxygenation, and ocean acidification, as well as pollution, such as plastic pollution, and unsustainable use. Moreover, the BBNJ Agreement recognizes several provisions of the UNCLOS, such as the obligation to protect and preserve the marine environment and the requirement to evaluate, as far as practicable, the potential impacts on the marine environment of activities within a State's jurisdiction or control, where there are reasonable grounds to believe that such activities could result in significant pollution or harmful changes to the marine environment [127]. Therefore, although the issue of AUN is not explicitly mentioned in the BBNJ Agreement, the term "pollution" employed in the BBNJ Agreement arguably encompasses the issue of AUN and its diverse effects on marine living resources.

The BBNJ Agreement focuses on four key issues to conserve and sustainably use marine biodiversity in the ABNJ, including area-based management tools (ABMTs), including those for marine protected areas (MPAs); environmental impact assessments (EIAs); marine genetic resources; and capacity building and technology transfer [128]. Among

these four issue areas, this article argues that ABMTs (including MPAs), EIAs, and capacity building and technology transfers hold significant promise in addressing several activities that contribute to AUN in the ABNJ. ABMTs, including MPAs, are widely recognized as essential mechanisms for conserving and restoring biodiversity [129–131]. They can also be used as adaptive measures in response to AUN. These MPAs should be established in accordance with the UNCLOS provisions and other relevant international obligations and commitments that aim to protect and preserve the marine environment against marine pollution, including AUN. Therefore, identifying ABMTs, including MPAs, can incorporate AUN issues into indicative criteria for identifying areas that require protection. However, the BBNJ Agreement does not explicitly recognize AUN as an indicative criterion for the identification of ABMTs, including MPAs [127].

The existing criteria for the identification of ABMTs are limited to "vulnerability, including to climate change and ocean acidification" and other factors [127]. It is argued that introducing "anthropogenic underwater noise" as one of the specific criteria into the current draft of the BBNJ agreement could have implications for addressing AUN through ABMTs, including MPAs. Although AUN is not mentioned in the current indicative criteria for identifying ABMTs, it could be considered when establishing ABMTs due to its impact on marine living resources, including its cumulative and transboundary nature. Furthermore, Article 17 of the BBNJ Agreement allows for the indicative criteria in Annex I of the BBNJ Agreement to be further developed and revised by the Scientific and Technical Body for consideration and adoption by the Conference of the Parties. This means that although AUN is not explicitly mentioned in the current agreement, it could potentially be integrated into the existing Annex I of the BBNJ Agreement in the future.

EIAs have become widely accepted as an essential tool to manage and control the impacts of anthropogenic activities on the marine environment, including AUN [132]. The BBNJ Agreement stipulates that States Parties must conduct EIAs to assess the potential effects of planned activities under their jurisdiction or control in accordance with their obligations under Articles 204 to 206 of the UNCLOS [133]. Considering the potential impacts of AUN, integrating the issue of AUN into the EIA process under the BBNJ Agreement offers opportunities to manage and control the impacts of various anthropogenic activities on the marine environment of ABNJ, including any activities likely to generate AUN. There are several potential means through which AUN could be integrated into several phases of the EIA process, such as screening, scoping, public notification and consultation, reporting, and decision-making. For instance, during the screening process, States should recognize the significant nature of impacts associated with AUN from the proposed project or activity in ABNJ. After completing the screening process, the next phase of the EIA process is scoping, which aims to define those impacts that may have a significant effect on the environment. In addition, given the possibility of cumulative impacts associated with AUN, scoping should also recognize the potential for cumulative impacts by activities in widely separated areas [134].

In addition to ABMTs and EIAs, the transfer of technology and knowledge can also provide solutions to address AUN within the BBNJ Agreement. Article 42 of the BBNJ Agreement recognizes the importance of capacity-building and transfer of marine technology (CBTT) and outlines several objectives, including increasing and sharing knowledge about BBNJ, developing marine scientific and technological capacities of States Parties, and ensuring that developing countries have the necessary capacity to manage ABMTs including MPAs and to conduct and evaluate EIAs. CBTT can be particularly useful for developing countries in addressing AUN, as current regulations on AUN are mainly practiced in developed countries. Therefore, CBTT can be an effective tool to bridge the knowledge gap in developing countries and promote the conservation and sustainable use of biodiversity.

Unlike the UNCLOS, Article 48 of the BBNJ Agreement created the COP, which is responsible for monitoring and assessing the implementation of the Agreement. In fulfilling this mandate, the COP is empowered to adopt decisions and recommendations aimed at

facilitating the implementation of the agreement, and to review and exchange information amongst parties to the Agreement concerning its implementation. Furthermore, the COP is tasked with promoting cooperation and coordination with other legal instruments and frameworks as well as with relevant global, regional, subregional, and sectoral bodies, with a view to promoting coherence in the efforts toward the objective of the BBNJ Agreement. To support the effective implementation of the BBNJ Agreement, the COP may also establish subsidiary bodies as deemed necessary. Given the broad range of responsibilities conferred upon the COP, it is evident that this body has significant potential to contribute toward the development of regulations and policies that are specifically tailored to address the adverse impact of AUN on marine living resources.

5.3. Rules of References

Apart from incorporating AUN into the BBNJ agreement, the UNCLOS includes various other provisions that promote a dynamic and long-lasting relationship between the UNCLOS and other instruments concerning ocean-related matters [135]. The obligation for States to work through competent international organizations to develop the principles of UNCLOS and establish specific regulations regarding ocean-related matters can be found in several provisions throughout Part XII of the UNCLOS. Therefore, the regulation of AUN through rules of reference differs from law-making by obligating States Parties to establish more specialized institutions and other agreements related to ocean matters.

This type of interaction, inter alia, recognized under Article 197 of the UNCLOS, states that:

> "States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organisations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features".

This Article can be understood to impose a fundamental duty on States to cooperate in formulating and elaborating "international rules, standards and recommended practices and procedures" for protecting and preserving the marine environment as reflected in several provisions of Part XII of the UNCLOS. This duty shall primarily be fulfilled through competent international organizations that can be considered to be an application of the general obligations established by the UNCLOS [35]. In such circumstances, competent international organizations can provide guidance or specific instruments on what is required under the general obligations of the UNCLOS. In addition, this type of interconnecting provision is further recognized in Section 5 of Part XII of the UNCLOS. Besides the duty of States to adopt laws and regulations to prevent, reduce and control pollution of the marine environment, Section 5 has also placed a fundamental duty upon states to adopt international rules, standards and recommended practices and procedures, "acting especially through a competent international organization (s)" from other regimes to prevent, reduce and control the pollution of the marine environment by different sources: land-based activities (Article 207 (4)), seabed activities (Article 208 (5)), dumping (Article 210 (4)), atmospheric pollution (Article 212 (3)) and vessels (Article 211 (1)) [135,136].

The term "competent international organizations" is prominently featured in five key areas of the UNCLOS, namely, navigation (Article 22), conservation of living resources (Article 61), protection and preservation of the marine environment (Article 211 (5)), marine scientific research (Article 238), and the transfer of technology (Article 266 (1)). The definition of the term can differ depending on the particular context in which it is employed. For example, to address concerns regarding AUN from shipping activities, the IMO is widely recognized as the sole international organization with the authority to establish rules and standards for ensuring safety, security, and environmental protection in international shipping. The IMO has adopted several instruments, including, inter alia, the MARPOL and its Annexes as principal sources of the rules and standards on pollution from vessels that are regarded as implementing the obligation under Article 211 (1) of the UNCLOS to establish

such "international rules and standards to prevent, reduce, and control pollution of the marine environment from vessels". When formulating international rules and standards, the IMO must ensure that they adhere to the basic principles outlined by the UNCLOS [137]. Given that the UNCLOS has a general obligation to address AUN, the IMO as the sole international organization for international shipping should also adopt relevant rules and standards to address the AUN from shipping.

Thus, with regard to the AUN from ships, the IMO, through the Marine Environmental Protection Committee (MEPC), has adopted Resolution MEPC.1-Circ.833 on the Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life (2014 Guidelines) [79]. The 2014 Guidelines were adopted with the primary objective of offering comprehensive guidance to ship designers, builders, and operators on the mitigation measures for AUN from commercial ships. Despite the fact that compliance with the provisions of the guidelines is not mandatory, they are widely regarded as the most applicable instrument among the initiatives of the IMO aimed at protecting the marine environment. Due to several gaps in the current Guidelines, the issue of AUN from ships continued to be a topic of ongoing discussion in MEPC meetings, with a proposal to revise the 2014 Guidelines being presented. Consequently, the IMO reached an agreement in 2021 to conduct a comprehensive review of the existing Guidelines. In this regard, a draft of the revised Guidelines has been submitted for review and approval to the MEPC 80 meeting scheduled to be held from 3 July to 7 July 2023. While these Guidelines may be considered rules or standards adopted by the IMO, their non-binding nature raises the question of whether states parties to the UNCLOS can be obligated by sources that do not have a binding effect on them. The discussion on the legal status of rules of reference is a crucial issue, but it falls outside the scope of this section to provide a comprehensive analysis.

In addition to the AUN from ships, dredging activities, classified as a form of dumping, are acknowledged to be a particular source of AUN in the marine environment. In accordance with Article 210 of the UNCLOS regarding pollution caused by dumping, it is the responsibility of States, working in partnership with competent international organizations, to endeavor to establish and implement global and regional regulations, standards, recommended practices, and procedures aimed at preventing, reducing, and controlling such pollution. The use of the term "international organizations" in the plural signifies that the IMO can complement its global regulatory efforts through the activities of other organizations. The IMO has established collaborative partnerships with other organizations, particularly in connection with the development and adoption of regional agreements. An international framework has been established to manage marine pollution from dumping through a variety of treaties and agreements at both the global and regional levels [138]. These include the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Convention, 1972) and its Protocol to the Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter, 1972 (1996 LC Protocol). Thus, the London Convention and Protocol, which seeks to prevent marine pollution caused by the dumping of waste and other materials, has been addressing the issue of AUN. In particular, the World Dredging Association (WODA) has presented guidance on managing the effects of underwater sound, especially from dredging, to the London Convention and Protocol Scientific Groups. The guidance presented by the WODA contains technical advice aimed at assisting decision-makers, stakeholders, and scientists in handling the impacts of underwater sound from dredging [139]. Although no specific instrument has been developed, the parties to the UNCLOS may consider applying any future specific instruments on AUN if they are adopted by the London Convention and Protocol in the future.

In conclusion, Article 197 and other complementary provisions in the UNCLOS aim to facilitate the adoption of internationally agreed standards, rules, recommended practices, and procedures to prevent pollution of the marine environment through cooperative arrangements involving competent international organizations. The UNCLOS obliges the

parties to abide by these standards by reference, reflecting its framework character. As the overarching legal framework for protecting and preserving the marine environment, the UNCLOS serves as a foundation for other international agreements that provide specific rules and standards for achieving its obligations. The rules of reference serve as an important flexibility mechanism, ensuring the continuous development of the UNCLOS through its openness to external regimes. Therefore, the UNCLOS "lives" within other external regimes, which are expected to "be carried out in manner consistent with the general principles and objectives" of the UNCLOS [140].

6. Conclusions

It is evident that AUN has been regarded as an emergent global marine environmental problem and poses several impacts on the marine environment and biodiversity. This fact has prompted the interpretation of the UNCLOS and examination of its institutional arrangement to respond to this issue. While several discussions have continuously been held in the annual cycle of review of the UNCLOS, there have been no significant policy outcomes to tackle this issue. Therefore, further discussion to strengthen the regulatory framework for the protection of the marine environment against this issue is a paramount necessity. This article argues that the UNCLOS offers a legal basis for protecting the marine environment against AUN. This legal basis can be found through various provisions related to the protection of the marine environment, conservation of marine living resources and conservation of marine biodiversity. However, it must be noted that the UNCLOS does not provide a specific standard to address AUN. Therefore, this article suggests that several provisions of Part XII of the UNCLOS relating to the protection of the marine environment should be interpreted as a framework agreement that contains a general obligation to address AUN. Accordingly, it is argued that the regulation and management of AUN under the UNCLOS can be further developed through three different approaches: the adoption of a new implementing agreement, addressing AUN through the existing implementing agreement (BBNJ Agreement), and regulation through rules of references. In addition, it is argued that the adoption of several instruments and programs by various other institutions (as shown in Table 2) could provide support and enhance the implementation of relevant provisions of the UNCLOS to effectively address the issue of AUN. In such circumstances, it is argued that the UNCLOS can be regarded as a living instrument that provides a flexible mechanism to respond to current and future problems for marine environmental protection. It is noteworthy that this article is relevant to the fundamental theoretical issue of how international law of the sea, based on the UNCLOS as its basic framework, can be further developed to meet new challenges.

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