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Legal Issues Concerning the Impact of Anthropogenic Underwater Noise in the Marine Environment

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Abstract: Anthropogenic underwater noise has an adverse effect on the marine environment. Therefore, it is of essential importance to establish the problem consciousness regarding this issue and then regulate it by the application of laws. In order to achieve the aim of protecting the marine environment through solving the problem of anthropogenic underwater noise, this article will comb through the existing domestic legislation and international agreements for potential solutions. At the same time, lessons can be drawn from major developed countries in order to lay down the rules which can in turn improve the law-making procedure in dealing with anthropogenic underwater noise. In brief, restricting underwater noise is indispensable from the joint efforts of the international community. To solve the noise problem, it is deemed necessary to clarify the precautionary principle, make full use of the existing legal framework, and promote targeted law-making more effectively through different channels and mechanisms. Moreover, adopting government supervision as a necessary guarantee can also help to hit the target. Meanwhile, paying close attention to science and technology progress is also vital for solving anthropogenic underwater noise issues.



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1. Introduction

Sound, including underwater sound, is essentially a wave generated when objects vibrate [1]. Therefore, underwater sound is an inevitable by-product of human activities on the sea. When it comes to whether various sounds constitute noise, there is no absolute standard [2]. For example, sonar is considered as a useful technique for human beings. Accordingly, the concept of ‘underwater noise’ traditionally refers to sounds (including those produced by marine organisms) that may impact the performance of sonar or other underwater equipment [3]. By contrast, the ‘anthropogenic underwater noise’ discussed in this paper focuses more on the marine environment perspective, consisting of all the noises that are ‘unnecessary to’ or may ‘interfere with’ the normal activities of the marine environment or the marine life [4], such as those produced by sonar, explosions, shipping, scientific research, industrial activities, or other human activities. This paper intends to address the regulation of anthropogenic underwater noise and suggests that the control of anthropogenic underwater noise requires joint efforts from the international community. On the one hand, international law has, to a certain extent, curbed the abusive use of the sea, and imposed the obligation of noise control on waters outside the jurisdiction of the states. On the other hand, domestic legislation, as a means to perform the State’s environmental obligations, could be used to regulate the noise production by actors within the State. In addition, collaboration with different disciplines, such as biology, physics and mechanical engineering, is essential for the control of anthropogenic underwater noise. From a legal

perspective, the existing legal frameworks are the basis for rudimentary regulation, while specialised legislation is deemed the ultimate safeguard for the resolution of this issue.

2. The Impact of Anthropogenic Underwater Noise to the Marine Environment

Anthropogenic underwater noise may immensely impact the marine environment in a detrimental way [5]. Given the low visibility and the great difficulty in odour identification in the deep sea, sound plays an ever-important role in the marine environment. As a form of energy, sound creates sound pressure, while involving particle motion. The former primarily affects marine mammals, while the latter is mostly perceived by fish and marine invertebrates [6]. In general, fish and other marine animals rely on sound and hearing in key activities for their survival, such as foraging, mating, and communicating [7]. Certain marine mammals may even collect other types of information, such as about their surroundings, through echolocation [8]. Therefore, the harm of underwater noise is unneglectable. Noise not only masks the animals' signals but may also cause sound-induced damages that further affect their behavioural reactions, alter their habitats, or even threaten their lives [9]. These are merely the impacts on one level of the food chain. Domino effects along the chain would disrupt biological balance, inflicting different degrees of harm on other animals, plants, and micro-organisms in the sea [10]. Humans may also be implicated in the plight, with the development of fisheries impeded and health of underwater operators endangered. There may also be other harms that have not yet been fully unravelled due to the limitations of current technology [11]. In summary, anthropogenic underwater noise is a hazard that may not be overlooked or underestimated.

Moreover, the ocean is a powerful medium for the transmission of sounds [12]. On the one hand, sound speed is positively correlated to temperature, salinity, static pressure and other factors. In general, sound travels slightly faster in seawater than in freshwater, and considerably faster than in air. While the above-mentioned factors may have a limited impact on the speed of sound, their influence is substantial on other characters of sound transmission, such as the distribution of sound energy, and the distance and duration of transmission. On the other hand, the physical properties of sea water change with depth (temperature, salinity and static pressure are all related to depth. Temperature and salinity do not have a quantitative relationship with depth, but are mostly determined by experiments. In contrast, static pressure is positively correlated to depth), while sound propagation presents the characteristics of horizontal stratification, and sounds that are horizontally transmitted will fluctuate up and down at the lowest level of sound speed [13]. As such, sound energy is rather concentrated, travelling off the ocean surface and floor, and capable of long-distance transmission without much loss [14]. Low-frequency sound waves are particularly prone to long-distance transmission due to the low absorption by the sea [15]. In addition, ocean acidification caused by global warming further reduces the ocean's ability to absorb sound [9], meaning that noise may travel across the ocean in the underwater sound channel. The detriments caused by anthropogenic underwater noise become even worse considering the fast speed and broad scope of sound transmission.

The problem of anthropogenic underwater noise has become increasingly prominent in recent years [16]. Since the introduction of the sea power theory by Alfred Thayer Mahan at the end of the 19th century, States have been paying more and more attention to the sea. The ocean's rich reserve of natural resources, as well as the convenience in transport and trade, has only added weight to such attention, leading to a string of national maritime strategies [17]. For example, China's strategy covers an array of areas, including development of the marine economy, innovation of marine technology, protection of marine ecology, strengthening of marine military force, safeguarding of marine security, and the perfection of marine control and management [18]. Likewise, people are investing more energy and resources into the development and utilisation of the sea. Prime examples in this respect include seawater desalination, mariculture, industrial water uses, medical and pharmaceutical uses, extraction of substances, shipwreck salvage, transport and commute, exploration of mineral reserves, development of energy resources, use of space,

tourism and entertainment, and harvest of animals or plants [19]. From an international perspective, resource development in the outer continental shelf is imminent; with the increase in human activities on the sea, the amount of anthropogenic underwater noise also grows increasingly.

Regarding the adverse impacts of anthropogenic underwater noise on the marine environment, it is imperative to establish problem awareness and to clarify the legal methods of problem resolution. A number of States and international organisations have come to this awareness. The International Maritime Organisation (IMO), the International Union for Conservation of Nature, the International Whaling Commission (IWC), and the United Nations Division for Ocean Affairs and the Law of the Sea have all initiated research projects on noise pollution.

3. International Law Relating to the Regulation of Anthropogenic Underwater Noise

Anthropogenic underwater noise is hazardous to the marine environment, in particular, the marine life [20]. One of the direct impacts of such noise is interference with the audio signals used for communication by marine animals, causing physical injuries to the auditory system [21]. This will in turn lead to changes in the animal's behaviour and reaction, thereby threatening its life, or even survival. Eventually, the overall balance of the marine eco-system may be disturbed, and the stability of the marine environment disrupted. Such impacts would seriously undermine the goals of sustainable development. Therefore, it is necessary to sort out the provisions in international law relevant to this issue, to clarify the legal framework for regulating anthropogenic underwater noise.

3.1. International Law

At the international level, there is no treaty specialising in the regulation of anthropogenic underwater noise [11]. Nevertheless, the issue is not completely elusive in the current international legal system. Noise is a hazard to the marine environment (the marine life forms in particular); therefore, it falls into the scope of a number of international treaties that seek to protect marine species.

3.1.1. The United Nations Convention on the Law of the Sea

The United Nations Convention on the Law of the Sea (UNCLOS), known as 'the constitution for the oceans', did not explicitly touch upon the issues regarding anthropogenic underwater noise. This is the result of the law's evitable lagging behind society's development. UNCLOS was adopted by the United Nations General Assembly in 1982, while the international community did not turn a spotlight onto the issue until the beginning of the 21st century [21]. With that being said, by virtue of treaty interpretation, UNCLOS is still flexible enough to cope with newly emerged international issues. Some even argue that a 'framework convention' is the necessary product of the future-mindedness of the international environment law [22]. Be it any explanation, Part XII of UNCLOS provides for the protection and preservation of the marine environment. A factor that may adversely impact the marine environment, noise is also regulated under this legislation [23].

Specifically, Article 192 of UNCLOS explicitly states that States have the obligation to protect and preserve the marine environment, while Articles 194 and 196 outline the different sources of marine pollution. Article 194 also highlights the requirement that in carrying out measures to deal with pollution of the marine environment, States may not unjustifiably jeopardise the rights enjoyed by other States or interfere with the rights enjoyed by other States. Articles 207, 208, 209, 211 and 212 further elaborate this requirement. In order to prevent, reduce and control pollution of the marine environment, States should adopt domestic laws and regulations, endeavour to achieve harmonisation at the regional level, and seek cooperation at the international level, with considerations of innocent passage, seabed activities, sovereign immunity, and other rights provided for under UNCLOS or other international treaties. In order to more effectively reduce pollution and protect the marine environment, UNCLOS also contains supplementary provisions, such as

those on international cooperation and technical assistance, monitoring and environmental assessment, enforcement and safeguards.

The above provisions contain either the environmental protection obligations borne by the State Parties, or the supplementary obligation thereto. As a subordinate term to environmental protection, anthropogenic underwater noise regulation also falls under the scope of these provisions.

3.1.2. The Convention on Biological Diversity

The 1992 Convention on Biological Diversity (CBD) points out, in its Preamble, that biological diversity is being significantly reduced by certain human activities. Anthropogenic underwater noise also poses a threat to marine biodiversity. Therefore, States should, on the basis of filling the information and knowledge gaps pertaining to this issue, reduce anthropogenic underwater noise and other sources of environmental pollution, so as to cope with the crisis that threatens the common interest of all humankind. In the exercise of their sovereign rights, States have a responsibility to ensure that no damage is caused to the environment of other States or of areas beyond the limits of national jurisdiction. For the conservation of biological diversity, States should, as far as possible, cooperate with other States and international organisations. States should also adapt their national strategies to reflect the needs of biodiversity conservation, while developing the appropriate legislative, administrative or policy measures. One highlight of the CBD is the recognition that ‘economic and social development and poverty eradication are the first and overriding priorities of developing countries’, which confront more serious conflicts between economic development and biodiversity conservation. Therefore, to promote the purpose of CBD, as stipulated in the Preamble and Articles 3, 5, 6, 12, 17, 18, 19 and 20 of the CBD, other States should provide assistance in terms of research and training, exchange of information, technical and scientific cooperation, distribution of benefits, and financial resources, among others. The realisation of the purposes of the CBD entails more attention and effort be dedicated to the issue of anthropogenic underwater noise.

3.1.3. The Fish Stock Agreement

Adopted in 1995, the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks notes the need to conserve fish stocks and biodiversity, and to ensure the sustainable development of fisheries, while being ‘conscious of the need to avoid adverse impacts on the marine environment, preserve biodiversity, maintain the integrity of marine ecosystems and minimise the risk of long-term or irreversible effects of fishing operations’. Paragraph F of Article 5 stipulates that fishing and other human activities should minimise pollution by utilising environmentally safe and cost-effective fishing gear and techniques to the extent practicable. The term ‘pollution’ in this provision should include noise. In other words, in fishing and other activities, humans should, to as great an extent possible, ensure the noise emitted to the marine environment does not harm the marine life. In addition, Article 6 provides a precautionary approach to the protection of the marine environment, i.e., ex ante prevention rather than ex post reparation. This is also true for the control of anthropogenic underwater noise. Although qualitative changes are very difficult, quantitative changes are feasible. While the production of anthropogenic underwater noise is inevitable, the level and duration of such noise may be lowered, so as to mitigate its negative effects.

3.1.4. The Convention on the Conservation of Migratory Species of Wild Animals

Additionally, known as the Bonn Convention and adopted in 1979, the Convention on the Conservation of Migratory Species of Wild Animals intends to conserve migratory species, including marine species, by protecting their migratory ranges. Article III(4) (a) of the Bonn Convention notes that States are obligated to take actions, while emphasising the need to ‘conserve and, where feasible and appropriate, restore those habitats of the

species which are of importance in removing the species from danger of extinction'. This reasonably implies a requirement to control anthropogenic underwater noise which is harmful to marine migratory species.

Moreover, the 12th Meeting of the Conference of the Parties to the Bonn Convention that took place in 2017 had a specialised agenda item for marine noise. On the basis of the adverse impacts of noise on the marine ecological system, Annex 2 to the agenda item elaborated the impacts of multiple human activities, as well as the mechanisms relating to the monitoring, reporting, and review of such noise. The agenda item intended to provide guidance for the formulation of noise pollution standards at domestic level. The 12th Meeting also directed the Secretariat to draw the marine noise issue to the attention of other international organisations, in particular the IMO, with a view to minimise the harmful effects of shipping noise on marine species. Although not yet legally binding, its comprehensive report on the anthropogenic underwater noise issue is a valuable reference.

3.2. Regional Treaties

Europe was among the first to recognise anthropogenic underwater noise as an issue to be addressed. The results of the European studies of this issue have turned into legal regulations.

3.2.1. Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas

The 2003 Amendment to this Agreement specifically states, in Article 1, that in order to protect animals and the environment essential to their survival, factors of significant disturbance should be prevented, especially those of an acoustic nature. Although the areas of the Agreement are limited to the Baltic, North East Atlantic, Irish and North Seas, it is a milestone as one of the few international legal instruments that directly regulate anthropogenic underwater noise. Following this, at the 3rd Meeting of Parties in 2000, several resolutions relevant to marine noise were made. It is noted that the precautionary approach is the necessary response to the noise issue as stated in Resolution 5.4, with a number of methods available for the reduction in noise exposure by animals, including the appropriate setting of human activities, the proper timing of human activities to avoid the periods with the highest densities of animals, and the use of technical measures for reducing sound emissions, which have been elaborated in Resolution 6.2. In addition, according to Resolution 8.9, it is required that State intervention be strengthened, and that licensing systems be introduced to regulate human activities. Parties and non-Parties are also encouraged to collaborate closely to mitigate the adverse impacts on wildlife. As such, the above instruments formulate a relatively comprehensive and detailed regime for regulating anthropogenic underwater noise. Further developments were at the 26th Baltic Sea Parliamentary Conference held in 2017, which called upon the Baltic Marine Environment Protection Commission to become the coordinator of the regional implementation of ocean-related goals of the 2030 Sustainable Development Agenda of the United Nations. This statement was reiterated at the 27th Conference.

3.2.2. The Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)

The Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) also sets out the Parties' obligations for marine environment protection for purposes of cetacean conservation. Although anthropogenic underwater noise is not mentioned in the text of the ACCOBAMS, it should be within the scope thereof. As indicated by the implementation of the ACCOBAMS, noise control is an important safeguard for the realisation of the Agreement's purpose. It is worth mentioning that in 2015, the 'Overview of the Noise Hotspots in the ACCOBAMS area' project was launched, which produced a map of anthropogenic underwater noise of the area. The project was of great significance in facilitating understanding and the final resolution of the noise issue. In addition, since the beginning of the 21st century, the Meeting of the

Parties have emphasised, on multiple occasions (such as in Resolutions 2.16, 3.10, 4.17, 5.15, 6.17 and 6.18), the harmful impacts of anthropogenic underwater noise, as well as the necessity to take actions. The Guidelines to Address the Impact of Anthropogenic Noise on Cetaceans in the ACCOBAMS Area was also adopted under Resolution 4.17. The Guidelines urge the States to regulate the various sources of human-made noise, while also providing practical guidance to the States.

In summary, the above treaties and agreements constitute the legal basis for addressing the issue of anthropogenic underwater noise at the international level. These are all valuable developments at such an early stage. As noted previously, however, there is no open treaty that specifically regulates this issue to date [11]. To render things worse, due to historical limitations, noise pollution is excluded from the scope of a number of important environment treaties. For example, the International Convention for the Prevention of Pollution from Ships and its annexes are key instruments for the reduction in shipping-related pollution. Nevertheless, Article 1 of this Convention requires that it regulates ‘the pollution of the marine environment by the discharge of harmful substances or effluents containing such substances in contravention of the Convention.’ Therefore, noise, as a form of energy, is not included. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its Protocol has similar shortcomings. Article 1 of this Convention makes it clear that the objective is to ‘prevent the pollution of the sea by the dumping of waste and other matter,’ which is restated (and expanded), in Article 2 of the Protocol, as ‘to prevent, reduce and where practicable eliminate pollution caused by dumping or incineration at sea of wastes or other matter.’ Even after the expansion, noise pollution still falls outside the scope. This loophole is, however, somewhat addressed by the Particularly Sensitive Sea Area regime adopted by an IMO resolution, namely, Resolution A.982(24), adopted at the 24th session of 2005, contained the Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas (PSSAs). Between the traditional principle of freedom of the seas and the emerging environmentalism, the Particularly Sensitive Sea Area regime leans towards the latter [24], and may significantly reduce anthropogenic underwater noise in the specialised areas through precautionary measures. On top of this regime, in 2014, the IMO issued the Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life, as a further step towards regulation of shipping-related noise [25]. Overall, as an emerging issue at the international arena, the issue of anthropogenic underwater noise is still insufficiently regulated and the improvement of which relies on joint efforts from the international community.

4. State Practices Relating to the Regulation of Anthropogenic Underwater Noise

Currently, the regulation of anthropogenic underwater noise is mostly carried out by developed countries. This section will explore the examples in different regions. The practice of the United States is discussed based on the fact that it was the first to regulate against noise pollution around the world. Attention has also been paid to the practice in the European Union, in particular, Germany, on the basis that it has taken legislative measures to mitigate the adverse impacts of underwater noise on marine environment. Australia is surrounded by the oceans and the impact of human activities to the marine environment is of its essential concern while making decision. It is, therefore, included in the discussion.

4.1. The United States

The United States was among the first to legislate against noise and had the most advanced noise regulation in the 1960s and 1970s [26]. At its early stage, regulation was focused on land-based noise. Nowadays, the United States also leads the world in the research and regulation of underwater noise. From the end of the 20th century, the United States National Research Council produced a series of reports on the potential impacts of ocean noise on marine mammals [9]. On the basis of such research, the Marine Mammal

Protection Act was amended in 1995 to set the upper limit for the sound levels to which marine mammals might be exposed [27]. This was one of the earliest attempts to regulate the underwater noise issue.

In addition, the National Oceans Protection Act, one that seeks to protect marine ecology, also heeds the harmful effects of noise. The Act seeks to establish a National Ocean Noise Pollution Research Fund, so as to support research on ocean noise, and to develop alternative technologies that would reduce the impact of noise-generating activities. Laws enacted for the protection of marine life also contain provisions on ocean noise. For example, noise pollution is highlighted in the International Whale Conservation and Protection Act as a major threat to whales. It is recognised that the reduction in vessel noise, in particular, the incidental noise from commercial shipping operations, is of great importance for the protection of whales and other marine life. The roles played by the IWC and the IMO are also to be noted. The Save Right Whales Act, which was introduced in the Senate on 9 October 2019, while not directly mentioning noise pollution, requires a reduction in impacts of human activity on North Atlantic right whales, implying the need to reduce anthropogenic underwater noise.

Anthropogenic underwater noise is also an issue covered in a number of Congress resolutions. For example, H. Res. 714 of the 112th Congress urges the United States to mitigate ocean noise and other threats to whales and their habitat, for the successful conservation of marine environments. H. Res. 244 of the 115th Congress contains a similar statement, although its purpose is to express support for Japan to end its whaling in all forms and to strengthen measures to conserve whale populations. In addition, in accordance with 107th Congress (2001–2002), the United States Congress has also provided funds for research on the means of reducing fighter aircraft engine noise. Studies on low-frequency active sonar are also a priority for the United States Navy [9]. These developments are all conducive to the control of anthropogenic underwater noise.

4.2. *The European Union with a Special Focus on German Practice*

As a member of the European Union (EU), Germany is subject to adopt EU legislation, in addition to its domestic laws. Therefore, when discussing the German practice in regulating anthropogenic underwater noise, this paper will review both German and EU laws, in chronological order.

Earlier German laws on noise control were also concentrated on air and land transport, as well industrial operations. The Federal Immission Control Act, which was officially promulgated on 14 May 1990, is a prime example in this respect. In the 21st century, underwater noise became a focal issue to be addressed by German environmental laws; in light of the transcript of the 48th session of the German Committee on the Environment, Nature Conservation and Nuclear Safety of 2015, the German government has taken legislative measures to mitigate the adverse impacts of underwater noise on marine environment, acknowledging that the prevention of anthropogenic underwater noise is one indispensable aspect to the conservation of whales, dolphins and other animals, and recognising that environmental assessment reports are a measure of vital importance at the current stage.

At the EU level, Directive 2008/56/EC, also known as the Marine Strategy Framework Directive, requires the establishment of a framework for community action in the field of marine environmental policy for the aim of conserving marine ecosystems and promoting sustainable use of the seas. In general, a Directive is a form of EU law that binds all the EU members. Annex I to this Directive specifically stipulates that the introduction of energy, including underwater noise, should be at levels that do not adversely affect the marine environment. Thereafter, Article 22 of Directive 2013/53/EU is dedicated to noise emissions. Annex I to this Directive provides for a three-tier maximum sound pressure level, on the basis of the rated engine power of a single engine of a craft. In addition, the EU General Union Environment Action Program to 2020 has reiterated the importance of biodiversity to the ecological system, listing the protection, conservation and enhancement

of natural capital as the EU's first priority objective. Underwater noise was regarded as a major impediment to the achievement of 'good environmental status' by 2020.

In 2015, the Greens called for the protection of the ocean at the global level, and urged the State to take actions, including those for the reduction in underwater noise, to prevent the loss of biodiversity. In 2017, Germany further formulated environmental goals for the Baltic Sea, in accordance with the Marine Strategy Framework Directive that was entered into force on 7 June 2017, so as to prevent adverse impacts on marine life by human activities. The above discussion demonstrates that in Germany, domestic actions and EU measures are complementary, jointly providing a viable framework for the mitigation of anthropogenic underwater noise's impacts on the marine environment.

4.3. Australia

Australia is a State surrounded by the sea. Therefore, in general, protection of the marine environment is of particular importance to Australia [28]. The regulation of anthropogenic marine noise, as a hazard for marine environment, has undergone a development process. The Australian government first noticed how noise generated by military activities would affect the speed of submarines and the function of sonar systems [29]. The impact of noise on the ecological environment did not come to attention until later [30]. In the beginning, anthropogenic underwater environment was merely a subject of academic research [31]. Government regulation was later introduced, under the auspices of the Senate Standing Committees on Environment and Communications.

Mr. McPherson was one of those scientists that have been actively promoting the regulation of underwater noise, and who submitted a report on the management of the Great Barrier Reef in 2014 that contained 23 suggestions on the control of noise from commercial ships. The noise issue was further mentioned in the 2017 Report on Oil or Gas Production in the Great Australian Bight, which expanded its consideration to noise from other sources, such as transport, seismic surveying, and resource exploration. Despite the lack of in-depth discussion, it was still significant progress. In practice, the Environment Protection and Biodiversity Conservation Act (EPBC Act) should also apply to noise control, although noise is not mentioned in that law. The reason is that underwater noise could be a hazard to marine biodiversity, and the neglect of which would undermine the purpose of the EPBC Act. The law's silence on noise is a result of historical limitations. With the development of science and technology, the Government's regulation of noise is consistent with the purpose of environmental protection and biodiversity conservation. A number of non-governmental organisations, such as the Animals Australia and the Australian Marine Conservation Society, have also dedicated efforts into the prevention of noise pollution. Such commitments are also helpful for the resolution of the noise issue.

5. What Lessons China Can Learn in Coping with the Anthropogenic Underwater Noise Issues?

China has developed various laws and policies to administer its extensive economic growth. While the utilisation of marine resources will inevitably be coupled with certain negative impact to the oceans, it is important for China to learn from other experiences in coping with the emerging issues such as the anthropogenic underwater noise. Environmental laws are perhaps at par values to govern and administer the ecological environment protection in the exploration of marine resources. A thorough review of China's existing laws applicable to anthropogenic underwater noise is the necessary premise for proper use of the international experiences. The emphasis should be put on drawing on the strength of each other and improving the overall legal framework in coping with anthropogenic underwater noise.

5.1. The Current Legal Framework

Internationally, China is a Party to UNCLOS, the CBD, and the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stock. Thus, on basis of *pacta sunt servanda* [32], China is obligated to protect the marine environment and to conserve marine life. However, China is not a party to the treaties that contain more detailed provisions on anthropogenic underwater noise, such as the Convention on the Conservation of Migratory Species of Wild Animals, the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, and the ACCOBAMS. International treaties are usually the product of compromises by sovereign States [33], which may result in the ambiguity of treaty provisions. States' obligations and responsibilities are generally provided for, while specific rules and measurable standards are left open. Therefore, the implementation of a State's marine environment protection obligations further relies on domestic legislation.

Domestically, Article 9 of the General Provisions of the Civil Law provides for the environmental principle for carrying out civil activities. Articles 2, 4, 5 and 42 of the Environmental Protection Law specify that protecting the environment is a fundamental national policy of the State, and that giving priority to protection while focusing on prevention is the basic principle for marine protection and noise control. Article 94 of the Marine Environment Protection Law stipulates that pollution damage to the marine environment includes the introduction of energy into the marine environment which results in deleterious effects, implying that anthropogenic underwater noise, as a form of marine pollution, falls under the scope of this law. Article 10 of the Provisions on the Prevention and Control of Pollution from Military Environmental Noise mentions that military vessel signals should be used in accordance with regulations. However, the specialised law on noise pollution, the Law on Prevention and Control of Pollution from Environmental Noise, excludes anthropogenic underwater noise from its scope of application. In general, China's legislation on ocean noise is rather rudimentary, with relevant provisions dispersed in different instruments. The provisions are also loosely targeted and are of low operability.

5.2. Improvement of China's Legislation

On the basis of the current legal framework, the international treaties and other State practice could provide guidance for the improvement of China's legislation.

Firstly, it should be made clear that the traditional 'control after pollution' approach is not feasible. Noise is a form of energy, rather than a substance. As such, it is intangible, easily diffusible, and almost impossible to re-collect from the environment. Hence, precautionary measures, i.e., prevention from the source, are the most fundamental strategy for the control of anthropogenic underwater noise [34]. This does not mean that marine activities should be totally prohibited, but that the government should, on the basis of the current situation and practical needs, compare the overall economic benefits with the environmental consequences, and make a sound decision to regulate anthropogenic underwater noise. On the one hand, the government may set the upper limit for anthropogenic underwater noise, accompanied by warnings, fines, the suspension of operations, orders to relocate, or other administrative penalties that would motivate potential violators to comply [35]. On the other hand, the government may levy a pollution discharge fee or environmental tax, so as to encourage companies to increase their investment on environmental protection. In other words, the cost would be internalised as the expenditure for upgrading facility and to reduce noise emission.

Secondly, at the preparatory stage, scientific research should play a key role. The mapping of ocean noise is a significant tool to demonstrate current human activities. Clear notions on the level and scope of noise pollution will facilitate the adoption of targeted measures that mitigate the impacts of anthropogenic underwater noise in the most affected areas. In the meantime, given that the impacts of anthropogenic underwater noise on

marine life are not yet thoroughly established, scientific research could help in mapping out the consequences, thereby providing a starting point for the adoption of precise measures for regulation and control. As such, cooperation with other States and strengthened connection with international organisations, for the purposes of information exchange and gain-sharing, could expedite the human race's understanding of the natural process and lay the foundation for the resolution of the noise issue.

Thirdly, in terms of the sources of law for the regulation of anthropogenic underwater noise's impacts on the marine environment, it is very unlikely for China to enact a specialised law for anthropogenic underwater noise. Given that underwater noise comes from a range of sources and sectors, and that each competent department is more experienced in the administration of its responsible sector, a more practical strategy is department-led administration in the form of administrative regulations and departmental rules. Examples of such administration include the formulation of sector-based noise standards to reduce noise emission, the limit of human activities to times and places that do not interfere with wildlife (especially migratory wildlife) activities, and the improvement of filing and licensing systems for maritime activities [6]. It should be accentuated that given the international nature of the shipping industry, the Ministry of Transport should, in making of the relevant regulations and rules, take into consideration of China's obligations under international treaties. In addition, the lowering of human activity frequency and the increase in operation power are also viable methods for reducing anthropogenic underwater noise [36]. Emphasis should also be placed on the advancement of technology. Despite the high cost of this strategy, the long-term benefits are rather promising. As such, the government should increase the funding of scientific research and environmental protection activities. Underwater noise could roughly be divided into two categories: that generated deliberately, such as by seismic surveying and military sonar, and that generated incidentally, such as by shipping and piling. The first category needs to be controlled with the development of alternative technology, while the second relies on lowering the volume of the source [37]. Modern noise-cancelling technologies are mainly applicable to the second category, with frequency converters [28], vibration isolation measures [38], damping materials and water-based paint [39] as viable means. In addition, regular equipment maintenance is also a key aspect [38].

Lastly, in terms of enforcement, given that there could hardly be a specific victim of anthropogenic underwater noise to require the cease of tort and claim damages, and that public interest litigation is not a mature strategy, the competent authorities in the maritime, oceanic and fishery sectors are at the core. Therefore, their powers and responsibilities should be clearly defined, and their supervision be strengthened, and their penal decisions be made in accordance with law [40]. In addition, environmental and animal protection groups should be supported. The government may fund non-governmental organisations (NGO) through the procurement of NGO services and reductions in/exemptions from tax, to maximise the NGOs' promotion of the environmental cause [41]. Likewise, industry associations play a key role in regulating their members. A due-track enforcement mechanism that involves both governmental administration and social supervision and a multi-stakeholder environmental protection regime are powerful safeguards for the resolution of the anthropogenic underwater noise issues [42].

In light of the above, it is evident that governmental regulation is indispensable for the reduction in anthropogenic underwater noise. Therefore, on the basis of a thorough mapping of noise distribution and the harms thereof, it is recommended that China should construct a comprehensive framework which consists of basic principles, specific measures, and monitoring mechanisms, in order to better regulate human activities, reduce noise emission, and protect the marine environment and marine life.

6. Conclusions

The findings of this paper suggest that there is no international treaty specialising in the regulation of anthropogenic underwater noise; however, the issue is not completely

elusive in the current international legal system. Noise is a hazard to the marine environment; therefore, it falls under the scope of a number of international treaties that seek to protect marine animals. At the domestic level, the regulation of anthropogenic underwater noise is mostly carried out by developed countries. While the United States was the first country to regulate against noise pollution around the world, Germany has taken legislative measures to mitigate the adverse impacts of underwater noise on the marine environment. The practice in Australia indicates that non-governmental organisations play an important role in facilitating the prevention of noise pollution. Constructing a comprehensive framework that consists of specific measures and monitoring mechanisms is recommended for China, because it is very unlikely for China to enact a specialised law for anthropogenic underwater noise issues.

The adverse impacts of anthropogenic underwater noise are undeniable and complicated. Noise may affect marine life's behavioural habits, threaten their health, and disrupt biological balance in the ocean. However, the awareness of this issue among scholars in the biological and legal fields, States, and the international community, is yet to be strengthened. As an emerging issue, the impacts of anthropogenic underwater noise on marine mammals, fish species and invertebrates are not fully determined. This circumstance will inevitably create limitations for this paper and further scientific research is therefore in dire need.

This is not a mere research question, nor an issue, faced by a single State. Rather, this is a mission critical to the maritime community of a shared future, which entails the cooperation and resolution of States around the world. Attempts by a single State are insufficient, while joint efforts by the international community are more likely the only feasible and effective strategy. This does not necessarily mean that a uniform environmental standard should be set for all States. Due to the objective fact of the different economic development levels, scientific strength and geographic locations, the environmental obligations of each State should be differentiated, consistent with its actual situation. Moreover, developed countries are suggested to provide more assistance in terms of scientific knowledge and advanced technology, to realise the goals of sustainable development.

On the basis of the location of the source, anthropogenic underwater noise could be divided into two categories: that within a State's jurisdiction, and that outside any State's jurisdiction. Regulation of the former may be in conflict with the State's sovereignty and is dependent on the balance of domestic interests. Regulation of the latter may be in conflict with the principle of freedom of the seas, which requires intervention by international law. As such, international law and domestic law are complementary in the resolution of the noise issue. These two types of law are also of a close and interrelated relationship, given that international law is ultimately dependent on domestic law for enforcement. Both international and domestic laws are indispensable in the regulation of the anthropogenic underwater noise issues. Due to the common target of regulation, these two types of law may draw reference from each other and develop together.

Admittedly, the provisions on anthropogenic underwater noise, be them from domestic legislation or international treaties, are still at a rudimentary stage, with low operability resulting from incomprehensive coverage, vague requirements, unclear measures, and loose supervision mechanisms. Moreover, law-making and treaty-making are both prolonged processes with complicated procedures and sharp interest conflicts. Therefore, it is desirable to impose new obligations of noise control within the existing domestic or international legal regime for environmental protection. Existing domestic institutions and international organisations also play a key role in the enforcement, administrative, and supervisory measures that are intended to mitigate the impacts of anthropogenic underwater noise on the marine environment. In conclusion, the legal regulation of anthropogenic underwater noise for the protection of the marine environment is still at a relatively embryonic stage. It needs the cooperation by States and international organisations around the world, within the existing legal framework, for the purpose of sustainable development.

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References

- Leon, C. *Underwater Acoustics*; Chen, G.; Chen, K., Translators; Editorial Board of the Hydroacoustics Translation Collection, 1977; Volume 1, p. 1. (In Chinese)
- Berglund, B.; Lindvall, T.; Schwela, D.H.; World Health Organization. *Guidelines for Community Noise*; 1999; p. vii. Available online: <https://www.who.int/docstore/peh/noise/Comnoise-1.pdf> (accessed on 21 April 2021).
- Hang, R. *Underwater Noise*; China Ocean Press: Qingdao, China, 1983. (In Chinese)
- Papanicolopulu, I. Warships and noise regulation: The international legal framework. *Mar. Pollut. Bull.* **2011**, *63*, 35–39. [CrossRef]
- Vakili, S.; Ölcer, A.I.; Ballini, F. The trade-off analysis for the mitigation of underwater noise pollution from commercial vessels: Case study—Trans Mountain project, Port of Vancouver, Canada. *Proc. Inst. Mech. Eng. Part M J. Eng. Marit. Environ.* **2020**, *234*, 599–617. [CrossRef]
- Faulkner, R.C.; Adrian, F.; Merchant, N.D. Guiding principles for assessing the impact of underwater noise. *J. Appl. Ecol.* **2018**, *55*, 2531–2536. [CrossRef]
- You, K. *The Wonderful Marine Life*; Fishing Association of the Pingtan County: Fujin, China, 2017; p. 27. (In Chinese)
- Chen, W.; Zheng, C.; Zhang, Q. *Marine Mammals*; China Ocean University Press: Qingdao, China, 1992; p. 342. (In Chinese)
- Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals of the National Research Council. *Ocean Noise and Marine Mammals*; Yang, Y., Translator; China Ocean Press: Qingdao, China, 2010; p. 75. (In Chinese)
- Michael, G. *Food Chain and Ecological Balance*; Zhu, B., Translator; Shanghai Educational Publishing House: Shanghai, China, 1987; p. 9. (In Chinese)
- Vakili, S.V.; Ölcer, A.I.; Ballini, F. The development of a policy framework to mitigate underwater noise pollution from commercial vessels. *Mar. Policy* **2020**, *118*, 104004. [CrossRef]
- Rako-Gospić, N.; Picciulin, M. Underwater noise: Sources and effects on marine life. In *World Seas: An Environmental Evaluation*; Academic Press: New York, NY, USA, 2019; pp. 367–389.
- Li, F.; Gao, H. (Eds.) *The Speed of Sound in Sea Water Is about 1450–1540 m/s*; Environmental Oceanography; Higher Education Press: Beijing, China, 2013; p. 77. (In Chinese)
- Chen, Y.; Zhai, F.; Song, H.; Huang, H. *Marine Technology*; Zhejiang University Press: Hangzhou, China, 2018; p. 55. (In Chinese)
- William, K.; Philippe, R. *Underwater Acoustics. Springer Handbook of Acoustics*; Springer: Cham, Switzerland, 2007; pp. 149–204. [CrossRef]
- Tatiana, I.; Richard, E.Z.; Peter, G.B. Future Ocean Increasingly Transparent to Low-Frequency Sound Owing to Carbon Dioxide emissions. *Nat. Geosci.* **2010**, *3*, 18–22. [CrossRef]
- Chang, Y.-C. The Exploitation of Oceanic Methane Hydrate: Legal Issues and Implications for China. *Int. J. Mar. Coast. Law* **2020**, *35*, 348–381. [CrossRef]
- Halliday, W.D.; Matthew, K.P.; Stephen, J.I. Underwater noise and Arctic marine mammals: Review and policy recommendations. *Environ. Rev.* **2020**, *28*, 438–448. [CrossRef]
- Cheng, Z. Contents and Design of China’s Ocean Strategy. In *Asia-Pacific Security and Maritime Affairs*; 2017; Volume 6, (In Chinese). Available online: <https://mall.cnki.net/magazine/Article/YFZH201706003.htm> (accessed on 21 April 2021).
- ERA. State of the Environment Report 2018: Reporting Status from 2009 to 2015. Environment and Resources Authority (ERA). 2018. Available online: <https://parlament.mt/media/97648/state-of-the-environment-report-2018.pdf> (accessed on 9 April 2020).
- Markus, T.; Sánchez, P.P.S. Managing and Regulating Underwater Noise Pollution. In *Handbook on Marine Environment Protection*; Salomon, M., Markus, T., Eds.; Springer: Cham, Switzerland, 2018; pp. 971–975. [CrossRef]
- Mazen, A. The Application of the Law of the Sea and the Convention on the Mediterranean Sea. UN-Nippon Foundation Fellow 2009. Available online: https://www.un.org/Depts/los/nippon/unnnff_programme_home/fellows_pages/fellows_papers/adi_0809_syria.pdf (accessed on 9 April 2020).

23. Ed, C.; Tuula, H. (Eds.) International Environmental Law-Making and Diplomacy Review 2010; Department of Law, University of Eastern Finland: 2011. Available online: <http://www2.ecolex.org/server2neu.php/libcat/docs/LI/MON-091101.pdf> (accessed on 21 April 2021).
24. Gillespie, A. The precautionary principle in the twenty-first century: A case study of noise pollution in the ocean. *Int. J. Mar. Coast. Law* **2007**, *22*, 61–87. [CrossRef]
25. Han, J.; Zhang, S.; Lv, X.; Zheng, M. Particular Sensitive Sea Area from Perspective of Global Governance. *Navig. China* **2017**, *3*, 109–112. (In Chinese)
26. IMO. Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life, MEPC. 1/Circ. 833. 7 April 2014. Available online: https://www.ascobans.org/sites/default/files/document/AC21_Inf_3.2.1_IMO_NoiseGuidelines.pdf (accessed on 21 April 2021).
27. George, C.M.; Carol, R.A. (Eds.) *Control of Hazardous Noise. Technology for a Quieter America*; The National Academies Press: Washington, DC, USA, 2010. Available online: <https://www.nap.edu/read/12928/chapter/6> (accessed on 21 April 2021).
28. Dolman, S.J.; Michael, J. Evolution of Marine Noise Pollution Management. *Aquat. Mamm.* **2015**, *41*, 357–374. [CrossRef]
29. Evans, K.; Bax, N.; Smith, D.C. *Australia State of the Environment 2016: Marine Environment, Independent Report to the Australian Government Minister for the Environment and Energy*; Australian Government Department of the Environment and Energy: Canberra, Australia, 2017.
30. Derek, W. Getting in Early: Lessons of the Collins Submarine Program for Improved Oversight of Defence Procurement. Available online: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp0102/02RP03#hull (accessed on 9 April 2020).
31. See Report on the Upgrade Patrol Boat Facilities Darwin Naval Base to the Joint Standing Committee on Public Works. 2005. Available online: https://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=pmc/darwinnavalbase/report.htm (accessed on 9 April 2020).
32. Fewtrell, J.L.; McCauley, R.D. Impact of air gun noise on the behaviour of marine fish and squid. *Mar. Pollut. Bull.* **2012**, *64*, 984–993. [CrossRef] [PubMed]
33. Brian, B. Pacta Sunt Servanda State Legalization of Marijuana and Subnational Violations of International Treaties: A Historical Perspective. *Pepperdine Law Rev.* **2019**, *46*, 69.
34. Jiang, H.C. On the Norms of International Law in Marine Scientific Research. *NTU Law Forum* **1999**, *4*, 67–128. (In Chinese)
35. Irini, P. Underwater Noise. *Int. J. Mar. Coast. Law* **2008**, *23*, 365–376.
36. Götz, T. Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment. *Ospar Biodivers. Ser.* **2009**, *441*, 1.
37. Nathan, D.M. Underwater noise abatement: Economic factors and policy options. *Environ. Sci. Policy* **2019**, *92*, 116–123.
38. Zong, J.; Zhang, H. Energy-saving Application of Frequency Converter in Fan Motors on Off-shore Platforms. *Plant Maint. Eng.* **2018**, *15*, 157–158. (In Chinese)
39. Qiu, S. Analysis on the Future Development of Ship Noise Protection Technologies. *Ship-Build. Technol.* **2013**, *3*, 5–9. (In Chinese)
40. Wang, Y.; Zhou, C.; Ma, L. Current Status and Future Development of Noise Reduction Coating Technology. *Chin. Foreign Entrep.* **2018**, *36*, 135. (In Chinese)
41. Zhang, X. The Core Issue in Amending Environmental Laws—Department-Led Legislation. In Sustainable Development. Environmental Protection and Disaster Prevention and Relief. In Proceedings of the 2012 Annual Conference of the Environmental and Resources Law Association, Zhejiang, China, 24 November 2012; p. 1052. (In Chinese)
42. Cicin-Sain, B. United Nations Sustainable Development Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development. Available online: <https://www.un.org/en/chronicle/article/goal-14- conserve-and-sustainably-use-oceans-seas-and-marine-resources-sustainable-development> (accessed on 9 April 2020).