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Underwater Noise Pollution as an Ecological Crime: A Global Problem in the Anthropocene

Noise pollution is recognized globally as a genuine environmental pollutant. Its effects are not limited to just terrestrial ecosystems, they can also affect aquatic environments at different levels. The scientific community has provided ample evidence of this. It is essential that legal systems and environmental protection regulations reflect this understanding. The aim of this study is to analyse the evolution of international legislation concerning noise pollution, as a response by legislative bodies to the environmental impacts it can have. These impacts have been classified on the basis of the ecological studies which are the subject of the analysis. Thus, the possible configuration of some types of noise pollution as criminal is analysed according to the concept of Green Criminology. The ecological damage generated at the different levels of the ecosystem approach is the focus of this analysis. This classifying system could allow us to configure an appropriate criminal response to the effects generated by this polluting activity.

Keywords: ecological/environmental crime, ecosystem approach, green criminology, green crimes, underwater noise pollution

Unterwasserlärmverschmutzung als ökologisches Verbrechen: ein globales Problem im Anthropozän

Lärmbelästigung ist weltweit als Umweltverschmutzung anerkannt. Ihre Auswirkungen beschränken sich nicht nur auf terrestrische Ökosysteme, sondern können auch die aquatische Umwelt beeinträchtigen. Die Wissenschaft hat dies hinreichend bewiesen. Es ist von entscheidender Bedeutung, dass die Rechtssysteme und Umweltschutzvorschriften diese Erkenntnis widerspiegeln. Ziel der Studie ist es, die Entwicklung der internationalen Gesetzgebung zur Lärmbelästigung zu analysieren, die eine Reaktion der Gesetzgeber auf mögliche Umweltauswirkungen darstellt. Diese Auswirkungen wurden auf Grundlage ökologischer Studien, welche Gegenstand der Analyse sind, klassifiziert. So wird die mögliche Einstufung einiger Arten von Lärmbelästigung als Straftatbestand nach dem Konzept der Green Criminology analysiert. Die ökologischen Schäden, die auf den verschiedenen Ebenen des Ökosystemansatzes entstehen, stehen im Mittelpunkt dieser Analyse. Dieses Klassifizierungssystem könnte es ermöglichen,

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eine angemessene strafrechtliche Antwort auf die Auswirkungen dieser umweltschädigenden Aktivitäten zu finden.

Schlagwörter: green criminology; green crime; ökologische/Umweltkriminalität; Ökosystemansatz; Unterwasserlärmverschmutzung

1. Introduction

Anthropogenic noise poses not only a major public health issue but also a significant stressor for marine and terrestrial life. It has been identified by the World Health Organization (WHO, 2011) as one of the world's most important pollutants and is of growing concern to policymakers and the public. Despite this, comprehensive strategies addressing its impact on marine environments have only been developed in the past decade (Ortíz-García, 2011; Morelle-Hungría, 2020a).

Anthropogenic sounds can be classified as impulsive (pulsed) or non-impulsive (continuous), the former being characterized by short duration and high intensity and the latter by low frequency and long duration (Peng et al., 2015). Underwater, impulsive sounds are those generated by explosions, seismic air guns, sonars (both military and civilian), or percussive pile driving, and non-impulsive sounds are generated by shipping, drilling, or renewable energy devices (e. g. wind and tidal turbines) (Peng et al., 2015). Among these, commercial shipping is one of the most widespread and persistent sources (Merchant, 2019). In addition, shipping has increased low-frequency noise along major shipping routes by a factor of 32 over the past five decades (Malakoff, 2010). Despite efforts to reduce ship noise (IMO, 2014), which is mainly caused by propeller cavitation, its impact is unlikely to diminish in the future. For example, the melting of the North Pole ice due to global warming is leading to the opening of new trade routes in the Arctic, which will expose the once acoustically pristine environment to increasing noise pollution.

Although numerous studies have examined the effects of acoustic pollution on marine fauna (mainly cetaceans and teleost fish, but also incipient studies on invertebrates and reptiles), the long-term consequences of chronic exposure and the cumulative effects on individuals and population stability are still unknown. Initially, legal instruments focused on sectoral issues and were implemented through international conventions or treaties (CITES¹). Such approaches often did not capture the full scope of the issue (Morelle-Hungría, 2020b; Shepherd, 2006). However, environmental protection mechanisms can benefit from science by incorporating measurement, assessment, prevention, and protection tools in a comprehensive and objective manner. Moreover, we must recognise that we are facing a framework of great technical and legal complexity, but that there is a tendency to improve protection mechanisms (Morelle-Hungría, 2020b). In this brief investigation of marine noise pollution, we analyse the international mechanisms that have initiated the current environmental protection system.

¹ CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species. CITES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The World Conservation Union). The text of the Convention was finally agreed at a meeting of representatives of 80 countries in Washington, D.C., United States of America, on 3 March 1973, and on 1 July 1975 CITES entered in force.

We also explore the potential effects of this form of pollution, assessing them through the perspective of green criminology to determine if they can be classified as ecological crimes.

We conducted an evolutionary analysis of the territorial mechanisms aimed at environmental protection against this pollution. An analysis was then made of the scientific studies on the direct and indirect effects of this pollution. In this way, a categorisation based on the type of noise generated by human activity has been made possible, in order to be able to analyse the environmental damage in an ecosystemic way.

Finally, the study proposes the need to involve the criminal justice system. From a broad point of view, from what is known as green criminology, to one that is more focused on the legal system, such as criminal law. From this analysis, the effectiveness of the environmental protection system against this pollution will be analysed in order to be able to improve the integral mechanisms elaborated.

2. Underwater Noise Pollution: Uncovering its Relevance in the International Legal System

This section highlights several Multilateral Environmental Agreements (MEAs) that are relevant to the legal regulation of underwater noise pollution at the supranational level. Which is a fragmented, sectoral and dispersed approach to a growing environmental problem that requires holistic instruments. It is from this perspective that the main international legal instruments that have been developed to deal with this type of pollution will be described.

The United Nations Convention on the Law of the Sea (UNCLOS³) establishes measures to address marine pollution. Its definition of “pollution of the marine environment” explicitly includes underwater noise and describes it as the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such harmful effects as damage to living resources and marine life, hazards to human health, interference with marine activities, including fishing and “other legitimate uses of the sea, impairment of the quality for use of seawater and reduction of amenities.”

The Convention for the Protection of the Marine Environment of the North-East Atlantic, OSPAR⁴, mandates its member states to adhere to the precautionary principle to protect the seas and oceans. Additionally, it also requires them to develop mitigation and adaptation mechanisms to combat marine pollution. Similarly, the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution⁵ stipulates that any activity that may affect the marine environment and that requires authorization by the competent national authorities must undergo an environmental impact assessment.

³ The United Nations Convention on the Law of the Sea was adopted in 1982. It lays down a comprehensive regime of law and order in the world’s oceans and seas establishing rules governing all uses of the oceans and their resources.

⁴ The Convention for the Protection of the Marine Environment of the North-East Atlantic (the ‘OSPAR Convention’) was open for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992. It was adopted together with a Final Declaration and an Action Plan.

⁵ The Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) was adopted on 16 February 1976 in Barcelona and entered into force in 1978.

The Bonn Convention on Migratory Species (CMS)⁶ primarily focuses on the populations of migratory species and sets out specific agreements. Resolution 10.24 from November 2011 refers directly to the reduction of underwater noise pollution to protect migratory species and cetaceans. Member States commit to reducing harmful underwater sound emissions through national, regional, and international management measures (including regulations where necessary). Additionally, they are encouraged to incorporate other measures such as environmental impact assessments or the search for more sustainable technologies to reduce or eliminate underwater noise. The convention also recognizes that underwater noise should be considered in management plans. But if there's any interesting text in this agreement, it's Resolution 9.19 on adverse anthropogenic impacts. This directly addresses the implementation of measures to mitigate anthropogenic noise in habitats or areas where marine mammals or other endangered species may congregate. In addition to restricting the use of high-frequency noise generating equipment, the possibility of establishing "noise-protected areas" is also introduced. Resolution 12.14, "Adverse effects of anthropogenic noise on cetaceans and other migratory species", adopted by the Conference of the Parties at its 12th meeting in Manila in October 2017, includes new guidelines to further improve the understanding of this pollutant. It underscores the importance of updating guidelines in line with technological advancements and increased knowledge of underwater noise. The measures contained in Resolution 12.14 on the assessment of the environmental impact of noise-emitting activities will be strengthened. Typically, new technologies are designed with an anthropocentric approach. Priority is given to mitigating the effects of such activities when the "victims" are human beings. Decisions 13.58 to 13.60 focus on the adverse effects of anthropogenic noise on cetaceans and other migratory species. The Monaco Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, ACCOBAMS⁷, was established as an extension of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn-CMS Convention), adopted in Bonn, Germany, on 23 June 1979. It contains several specific resolutions on underwater noise, focusing mainly on its effects on marine mammals. A few resolutions have been adopted to improve the management of this pollution. The evolution of regulatory instruments has been evident up to Resolution 8.17 of 2022, in which the parties agreed, among other things, to promote a reduction in the speed of maritime traffic, to strengthen international cooperation to combat this pollution, including the private sector, and to strengthen the mitigation measures implemented, considering noise monitoring.

The Agreement on the Conservation of Small Cetaceans of the Baltic Sea, the North-East Atlantic, the Irish Sea and the North Sea, ASCOBANS⁸, has two specific resolutions on underwater noise, the first being Resolution 8.11, which was revised at the ninth meeting of the Parties, MOP-9, in 2020. It states that guidelines for assessing the environmental impact of noise-generating activities in the oceans have been established to present best available techniques

⁶ The Convention on Migratory Species (CMS), also known as the Bonn Convention, is an environmental treaty of the United Nations that provides a global platform for the conservation and sustainable use of terrestrial, aquatic and avian migratory animals and their habitats.

⁷ The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) is a legal conservation tool based on cooperation. Its purpose is to reduce threats to cetaceans notably by improving current knowledge on these animals.

⁸ ASCOBANS was concluded in 1991 as the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) under the auspices of the Convention on Migratory Species (CMS or Bonn Convention) and entered into force in 1994.

(BAT) and best environmental practices (BEP). As requested by CMS Resolutions 9.19, 10.24 and 10.15, ACCOBAMS Resolution 5.15 and ASCOBANS Resolutions 6.2 and 8.11.

The International Maritime Organization (IMO) has also developed several instruments related to underwater noise pollution. First, in the 1980s, with a distinctly anthropocentric character, it worked on the effects of noise on people aboard ships⁹. Two decades later, given the interest in this type of pollution, the Marine Environment Protection Committee (MEPC) began discussions on the harmful effects of underwater noise from ships on marine life. It specifically identified marine noise and emphasized the need for a coordinated global response. In 2008, it approved the inclusion of a new element on “Noise from commercial shipping and its adverse effects on marine life”, but these are non-mandatory standards to minimise noise from commercial shipping¹⁰. Subsequently, in 2014, the IMO recognized the need to implement mechanisms to reduce the effects of noise on aquatic ecosystems. However, once again, a non-binding approach was adopted culminating in the creation of non-mandatory guidelines for reducing underwater noise in commercial shipping¹¹ (Laprade, 2021).

As we can see, a pronounced sectoral approach is evident, with various institutions and organizations developing different legal instruments to deal with underwater noise. However, we believe that this type of pollution has not been included in one of the most important conventions where it could be more effective, the Convention on Biological Diversity (CBD)¹². It is one of the most important agreements for the protection of marine biodiversity, due to its holistic and global approach, in which noise pollution has not been explicitly recognized. For this reason, we agree with some recent studies, such as those published by Gullett (2022, p. 9), which state that,

‘It is the CBD that is the most obvious multilateral treaty to activate to address the problem of anthropogenic underwater noise due to its scale of formal acceptance (196 State parties) and the scope of its mandate to address threats to marine biodiversity from all sources throughout the world. Mechanisms within the CBD can progress the issue with an eventual outcome being the development of overarching requirements for target-based noise reduction.’

Thus far, we have seen how the instruments developed by these international treaties and conventions are based on robust evidence. It is a type of pollution that needs to be effectively regulated if we want to minimise its impact on the environment and, because of its complexity, it needs to be tackled in a comprehensive and holistic manner, taking advantage of the latest scientific advances. To this end, we will analyse two instruments that have been introduced in the European Union which seem to capture the holistic approach required to confront this pollution.

⁹ Finally, IMO approved resolution A.343(IX) Recommendation on methods of measuring noise levels at listening posts, resolution A.468(XII) Code on Noise Levels on Board Ships, and resolution MSC.337(91) Code on Noise Levels on Board Ships. The most recent version of the Code is mandatory and took effect on 1 July 2014.

¹⁰ See MEPC, at its 58th session in October 2008

¹¹ See MEPC.1/Circ.833

¹² The Convention on Biological Diversity (CBD) is the international legal instrument for “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources” that has been ratified by 196 nations.

3. Impacts: From Ecological to Sociological Risks

Underwater sound is critical for many marine animals, playing a key role in communication, navigation, orientation, mating, prey detection and predator avoidance (Simpson et al., 2005, Erbe et al., 2016, Hinojosa et al., 2016). Although the impact of human-made noise on marine mammals has been extensively researched (Nowacek et al., 2007, Erbe, 2012), studies have also identified its adverse effects on fish, turtles and invertebrates such as shrimp, cephalopods, bivalves and even jellyfish (Popper & Hastings, 2009, Slabbekoorn et al., 2010, McCauley et al., 2000, Weilgart, 2018, Solé et al., 2016). These include commercial and critically endangered species such as cod, haddock, Norway lobster and North and South Atlantic right whales (Engas et al., 1996, Edmonds et al., 2016, Parks et al., 2007). A recent study has also shown that acoustic pollution has a negative impact on the flora, altering the roots and rhizomes of *Posidonia oceanica* (Solé et al., 2021), a protected seagrass species and a priority habitat for conservation in the European Union (Habitats Directive, 1992).

The adverse effects of acoustic pollution can be broadly classified into three categories: masking, behavioral disturbance, and physiological changes (including hearing loss, injury and death) (OSPAR, 2009). Masking occurs when the noise pollution prevents an animal from receiving biologically relevant acoustic signals needed for foraging, reproduction, orientation, communication, and predator/threat detection (Clark et al., 2009, Codarin et al. 2009, Erbe et al. 2016). Behavioral responses can range from changes in surfacing, swimming, foraging and breathing patterns to active avoidance of the affected area (habitat displacement), which may result in the cessation of a vital activity (e. g. nursing, feeding, breeding) (Gómez et al., 2016, Aguilar de Soto et al., 2006, Nowacek et al., 2007). Physiological effects of anthropogenic sound include hearing loss in various taxa such as dolphins and whales (Hawkins & Popper, 2017, Hildebrand, 2005), ruptured swim bladders in fish (Popper & Hastings 2009), damage to statocysts in cephalopods (Solé et al., 2013) and jellyfish (Solé et al., 2016), body malformations in bivalve larvae (Aguilar de Soto et al., 2013), and haemorrhages and embolisms in marine mammals (Fernández et al., 2005), which can lead to the death of individuals. Both behavioural and physiological changes can lead to strandings of, for example, beaked whales, pilot whales and giant squid (Cox et al., 2006, Dolman, 2010, Guerra et al., 2011), one of the most visible effects of this pollution to the public.

The socio-economic impacts of anthropogenic underwater noise are related to the loss, to a greater or lesser extent, of ecosystem services provided by marine ecosystems (Söderqvist 2012). According to the Millennium Ecosystem Assessment, ecosystem services (the benefits humans derive from ecosystems) include provisioning services (e. g. food and raw materials), regulating services (e. g. carbon storage and climate regulation, storm protection, disease and natural pest control, and water purification), cultural services (e. g. recreation, aesthetic enjoyment, knowledge and learning, and spiritual fulfilment), and supporting services (e. g. nutrient cycling, photosynthesis, resilience and habitat for species) (MEA, 2005).

In this context, it has been reported that seismic surveys can lead to reduced catches of cod and haddock (due to avoidance of affected areas), reducing the supply of food from the sea and thus causing losses to the fishing industry and society (Engas, et al., 1996). However, studies on Atlantic herring found no negative changes in catches (Culik et al., 2001) and results for the Greenland halibut were variable depending on the fishing gear used to catch them (Lokkerborg et al., 2012), although these results do not mean that individuals did not suffer acoustic trauma (Aguilar de Soto, 2016). Species displacement could also affect recreational fishing and tourism

(e. g. whale-watching tours), but further studies are needed to obtain clear trends on this issue. In terms of regulating and supporting services, *Posidonia oceanica* seagrass meadows provide carbon sequestration and storage, protection against coastal erosion, promotion of biodiversity, nutrient cycling, and water purification, estimated at more than €280/ha/year (Campanne et al. 2015). The physical damage caused by anthropogenic noise will be an obvious economic loss, as well as an ecological loss of incalculable value, as this is the most important ecological community of the Mediterranean (Solé et al., 2021; 2023). However, the magnitude of this impact has not been calculated for the entire Mediterranean, nor for other coastal areas around the world where other seagrass species occur.

Among the cultural services provided by marine ecosystems, human well-being, enjoyment, recreation, science and education, cultural heritage and inspirational services are potentially affected by underwater noise pollution. However, current knowledge of large-scale effects is insufficient to draw conclusions on the magnitude of these effects (Söderqvist, 2014). The effects of noise have been extensively studied, both on human health and on ecosystems and even biodiversity in different environments. Thus, there is a large body of scientific literature on the effects of noise, and a sound footprint in heterogeneous contexts, in different species or in different natural environments (García-Ruiz & South, 2019a, 2019b).

4. Conception as an Ecological Crime: Causality as a Priority

The term ‘ecological crime’ is primarily used for activities carried out by organised groups operating across multiple environmental sites (Walters, 2014; see also Collins, 2015; Fajardo del Castillo, 2015; Sergi & South, 2016; Gore et al., 2019). Some of the most damaging categories of ecological crime have a transnational dimension, but underwater noise has gone unnoticed as a form of pollution because it does not fit into the patterns of organised groups (García-Ruiz, South and Brisman, 2022). In view of this problem, there is a need to formulate a response that can take into account the impact on the ecosystem of this type of activity, which is a real cause of ecological damage that can be quantified.

For this reason, despite the lack of mechanisms to institutionalise and respond to it in aquatic ecosystems, this type of pollution is conceived and articulated as a true blue ecocrime. Nevertheless, as García-Ruiz and Morelle-Hungría (2023, p. 159) point out,

‘... the concept of eco-crime has different connotations, namely it can be defined as any type of behaviour that can be transformed into environmental damage or risk. Therefore, the negative externality caused by underwater noise, which is well established in the scientific literature, should be included in this generic concept.’

Green and blue criminology has evolved as a perspective within criminology that emphasizes environmental harm, facilitating a comprehensive analysis on the impact of human activities on nature. There are numerous authors who have studied and expanded the concept of this definition, but we will focus on a classic, but multi-dimensional definition (Lynch & Stretesky, 2004, 2014; Goyes, 2015; Morelle-Hungría, 2020). There may be different types of ecological damage caused by underwater noise pollution, but these are poorly understood. Science has made progress in understanding this type of impact, but much remains to be determined. In order to address this lack of knowledge, it is necessary to understand and act on the impacts that are known, the current and real hazards and risks. Certain behaviours can elicit a criminal

response due to their consequences and associated risks. Under this premise, the criminal justice system is an avenue for legal action in cases where environmental laws or regulations have been violated. This also applies to situations that, while not yielding a specific outcome, pose a potential danger. However, when we talk about underwater noise, it is very difficult to find an answer in criminal law. In other areas of law, such as administrative law, yes, there are protective regulations against this pollutant.

Scientific evidence shows that noise is a real form of pollution and can cause many negative effects. There are also cases where the level of external interaction has no effect on the ecosystem, even if it affects some aquatic organisms or species. However, in this study we are observing that, depending on different parameters, the consequences of this pollutant can affect different levels of biological organisms, both physically and in terms of behaviour. In any case, we have witnessed how the interference of human activity causes ecological damage at the highest level, even leading to the loss of species. Recent studies have produced the first synthesis of the available evidence. With more than 12 000 articles analysed, the project led by Duarte (Duarte et al 2021) states that “...it has demonstrated the overwhelming evidence of the prevalence of the impact of anthropogenic noise on marine animals, to the point that the urgency of taking action cannot be ignored”. We can also see how the different noises emitted by anthropic activities can neutralise natural sounds with the consequences that can be derived.

In certain areas, noticeable anomalies have been observed, including the absence of natural sounds from species previously recorded, like certain whale species. Such changes are primarily attributed to human noise pollution, which induces significant alterations in the affected species. The regulation of this type of pollution in terrestrial ecosystems has a long history, the Spanish standard for noise protection dates from 2003, more than twenty years of controls. In the aquatic environment, however, this priority has not been respected, one of the possible reasons being that we do not consider our activity to have a direct impact on marine species. It is a significant oversight to neglect this when adopting an ecosystem approach towards the protection of our most expansive natural reserve. Just as we have done in the terrestrial sphere, it is necessary to establish regulations for noise emissions from ships, as there are for cars. There is a need for the incorporation of technological mechanisms that reduce the impact of activities such as seismic exploration. Instead of sending compressed air cannons from the surface down to the sea floor, which affects the animals that swim in the water column, we need to look at other mechanisms that have less of an ecological impact.

Despite the ecological damage caused by this type of pollution, it must be recognized that it will not be possible to establish a harms classification system until scientific knowledge has been developed. The effects of underwater noise pollution will depend on various technical factors, such as exposure time and perceived intensity, and even on the species itself. To establish effective mechanisms, it is necessary to know these emission parameters and to be able to incorporate measures targeted at each type of impact.

Measures or practices can be introduced to mitigate the impacts of noise polluting activities. Monitoring networks can be set up to observe the presence of sensitive species and, and upon their detection, emissions can be halted to prevent the direct or indirect consequences of this pollution. One of the first researchers to analyse environmental harm was Lynch (1990), who raised questions about the inequalities that this type of damage brings to different cultures and to different species¹³. South (2014) provides a simple definition of green criminology: “the

¹³ In 1990, Lynch published *The Greening of Criminology*, which helped launch the concept of green criminology. Although he was not the first, as Pecar had introduced some environmental criminological

study of crime, harm and injustice in relation to the environment and species other than humans". However, there was a great deal of interest in environmental protection in the 1990s, and this was an issue that encouraged the emergence of this perspective within criminology (South, 1998; Clifford, 1998).

This criminological perspective analyses the environmental damage that affects not only the human species, but also all those species that are interrelated with each other, as well as the ecosystems in which they are immersed. For this reason, this discipline focuses not only on the causes and consequences of legally constructed environmental damage, but also on those activities that, although legal, also generate negative consequences for ecosystems (Simmons et al., 2023).

The amendment of the Ecological/Environmental Crimes Directive (ECD) implies the implementation of new mechanisms to deal with global and transboundary risks. The implementation of Community legislation must be a priority in order to avoid possible imbalances in the prosecution of these crimes outside national borders (Lennan, 2021). As previously stated, this type of environmental damage is not confined to one nation and, as in the case of the underwater noise pollution, there are often cumulative effects that vary at different levels depending on the species.

European legislation makes it possible to deal with environmental damage from a criminal point of view if the damage is significant. This concept is legally complex and therefore difficult to apply in practice. To improve the effectiveness of environmental criminal law, the European Union is implementing and improving the wording of this provision. The aim is to improve legal certainty and thus the effectiveness of environmental prevention in the field of environmental crime. The ambiguous wording and the use of certain terms have not helped either, which is why it also offers substantial improvements in this aspect, with a new modality of more practical sanctions. Despite these improvements, it should be clarified whether this type of pollution is directly included in the new criminal typologies.

Another aspect to be considered is the effectiveness of the legislative technique used in several countries, known as blank criminal law. In this case, the typical behaviour has to be completed by to extra-criminal rules, mostly it is administrative law, which can lead to a disparity in the rules to be taken into account. Against this background and in view of this formulation, it is impossible to set limits in the penal codes for all forms of ecological aggression. We agree with the idea that these thresholds should be established in administrative norms or that the legislator should consider, in view of the above-mentioned complexity, the creation of specific penal laws to deal with the different forms of pollution.

5. Discussion

Scientific evidence has shown that there is a cause-and-effect relationship between underwater noise pollution and the alteration of some ecosystems. Despite this causal relationship, there

concepts in 1981, Lynch identified three pillars on which to develop his theory. Firstly, he analysed eco-feminism, according to which environmental degradation is unequal between the sexes and affects women more than men; secondly, he recognised the effect of a certain colonial legacy that generates environmental racism, according to which environmental impacts are unequally distributed and harm certain ethnic groups and races more; and finally, he developed what is known as ecological socialism, according to which aggravated capitalism endangers certain species and even the planet itself (Hall & Varona, 2018; Jarque, 2020).

are several factors that need to be considered in order to determine the alteration that this pollution may cause. It is here that we must try to determine whether it is possible to intervene at a strictly criminal level. In spite of the various sources of emissions, the vast majority of which are caused by the human species and its economic development. This type of pollution must be dealt with in a unique way, but with an integrated approach. This means structuring and designing a solid regulatory framework that does not only cover terrestrial ecosystems. This model of protection and control should be twofold: on the one hand, it should provide for administrative sanctions and, on the other, depending on the severity, extent and duration of the damage caused, a criminal response. However, in order to make this model more effective, in both cases there must be quantification mechanisms and thresholds that allow us to distinguish between the two articulated responses.

The consequences of this pollutant are serious and may have long-lasting effects. This means that it is necessary to act with a plan. A plan that includes mitigation and adaptation measures in the short, medium, and long term. Although these activities are authorised, they can pose a clear and obvious risk to some species due to the effects of this type of pollution. This will also affect other species from an ecosystem perspective. At this point, it is necessary to redouble efforts to propose measures against impulsive noise. Even if these activities are authorised, their effects may be difficult to reverse. We must therefore ask ourselves: How can we combat the loss of species in an essential and fragile ecosystem such as our aquatic environment?

Ecological damage should be considered as a fundamental pillar in the analysis of the effectiveness of conservation measures. Only with a comprehensive vision can we address this type of risk, which can affect different ecosystem components at different levels. The studies carried out by Green Criminology can help us identify the real and integral impact of this type of pollution. As García-Ruiz and South (2019b) point out, there is a need for a multidisciplinary perspective in the treatment of noise, as it does not only require the analysis of ecological damage. Green criminology can analyse this type of pollution in a multi-level way. It takes into account the development of a green culture (Brisman & South, 2014). Thus, in order to provide a comprehensive response to this problem, we can consolidate an integrated structure. This includes sensory, affective, or emotional aspects, leading us to speak of sensory criminology, as García-Ruiz and South (2019b) and McClanahan and South (2020) note. In order to address the complexity of this type of environmental crime more rigorously and effectively, and thus improve the mechanisms of ecological justice, this vision is a priority. Cultural sensitivities need to be developed on the basis of research into the auditory, visual, olfactory, aesthetic and environmental experiences of (in)justice.

We shouldn't solely focus on the immediate effects. Instead, our victimological analysis should encompass the various trophic levels impacted. With this multi-level analysis, we can address the need to incorporate maximum levels in response to the ecological damage caused, akin to what is stipulated in soil regulations.

International criminal law must deal comprehensively with the protection of the environment. This requires the global integration of criminal law. Before this can happen, nations will have to shift their perception of the environment as a legal good. The link between environmental criminal law and administrative law is a relationship on which the configuration of the crime is based. With the creation of an international environmental criminal law, this configuration could be reconsidered. It would be possible to establish a criminal response to certain global

situations that endanger ecosystems and their components. Species trafficking, polluting discharges and the introduction of substances that could seriously alter ecosystems are some examples that could be established without being linked to an administrative regime.

For example, a global ecological crime could be created if the polluting activity causes serious environmental damage, or if the structure of the ecosystem is threatened by damage or danger. Species trafficking crimes would also be a proposal for consideration in international criminal law. The crime of ecocide is when the environmental damage is of such intensity that it endangers or affects an entire species. Authors such as Nieto (2011) propose others, such as geocide or patrimonicide, when environmental harm affects a large spatial area. This is without doubt one of the major problems facing the seas and oceans, and therefore the entire planet. At the same time, it seems to be unknown to our species in the aquatic environment. Regulatory standards have only existed for a few decades. Legislative mechanisms with a holistic approach have only been developed in the last decade. It is true that initiatives and projects have been undertaken in certain areas to establish threshold values. However, a large coalition of countries is needed to address and structure a regulatory framework that considers the complexity of aquatic ecosystems. In order to create a real mechanism capable of dealing with a type of pollution that causes legal and illegal damage to aquatic ecosystems and indirectly affects other ecosystems, regulatory instruments must take into account not only quantitative but also qualitative values.

6. Conclusions

With this interdisciplinary vision and approach, a broad concept of eco-crime can be addressed and based on marine science, a structure can be proposed so that criminal law can respond more effectively (García-Ruiz et al., 2022). Therefore, based on an analysis of the impacts that may result from marine ecology, it is necessary to integrate emission ceilings. Effective instruments for the management of such impacts must be part of international criminal law, and this is the aim of this paper. First, international administrative rules on the different types of noise that may be introduced into aquatic ecosystems must be developed to achieve this objective.

It is therefore necessary to have maximum emission levels in place, on the basis of an analysis of the impacts that can be derived from marine ecology. At the international level, terrestrial regulations can serve as a basis for building a new regulatory scenario in aquatic ecosystems. The issue is complex because it is not only about a threshold value, but also about the two types of noise, impulsive and continuous. Thus, regulation must be inclusive of these possible regulations, so that there is an articulation of a legal response to the control of legal environmental damage that legal systems allow. On the other hand, it is essential to distinguish between the type and seriousness of the damage caused or generated, in order to activate a greater legal response. To achieve this, it is necessary to establish a two-tiered response mechanism, one administrative and the other criminal. In the case of unlawful damage, the first response must be administrative, since environmental regulations are the first to be breached. If this is not sufficient, or if the level of noise generated can cause significant damage or affect endangered species, the criminal response will be articulated as the most powerful mechanism of our legal system.

Applying these thresholds, both administrative and criminal, raises another issue which needs to be considered. On a legal basis, this could raise issues of legal certainty since it could result

in divergent results. However, it could be solved by the inclusion of limit values at the administrative level and others at the criminal level. This would be very effective, but on the basis of the scientific evidence it will be very complex. In any case, significant and serious damage to the ecosystem would trigger the criminal response immediately. In order to assess the seriousness of the damage, due to the cumulative effect that this type of pollutant can have, we will take into account the damage caused or caused, the extent of the damage and its duration. Finally, we must bear in mind that the ecosystem must be considered as a legal asset, so that if one species of the ecosystem is affected, the whole ecosystem is affected from an ecosystemic point of view. However, despite this effect, it may be that criminal intervention is not necessary.

Countries must tailor their response to the impact on the affected ecosystem, and to this end, science must be effectively integrated into the protection instruments. It is not enough to consider certain parameters. As demonstrated, underwater noise pollution is a genuine form of pollution with the potential to disrupt ecological balances. The distribution and imbalance of ecosystems can affect the terrestrial system itself, creating a global impact that is difficult to repair. This issue of interconnectedness must be taken into account in order to improve existing regulatory mechanisms. Thus, the regulatory framework must be implemented through an international administrative and criminal regulatory framework, as the affected environment, the oceans, are a global component.

Despite the efforts of many countries to protect the environment, these measures are not effective. A global basis is needed to establish international mechanisms for effective criminal protection. In order to increase the effectiveness of these measures, it would be interesting to have international judicial bodies specialized in environmental matters. Other crimes, such as ecocide, could be prosecuted by the International Criminal Court. It would also be interesting to have criminal protection against legal environmental damage. Abuse of nature conservation by officials or rulers should be included in this type of crime

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