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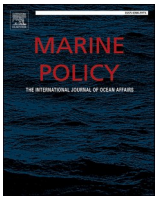

Barriers to wildlife movement in straits: Problematizing habitat connectivity across marine ecosystems

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ABSTRACT

The innovative development of the legal regime of straits has prevented the erection of 'sovereignty-barriers' to the movement of humans in and above straits. However, it overlooks to a great extent the significance of straits for marine organisms and birds. This article examines if it is necessary to supplement the legal regime of straits with rules that would allow circumnavigating 'sovereignty-barriers' also for wildlife movement considering the obligation to protect and preserve the marine environment. The main users of straits are not humans, but rather marine species. They rely on straits for moving from one ecosystem to another. That perspective to straits shifts the emphasis away from anthropocentric connectivity. It raises a question about the need to update the current navigation-oriented legal regime of straits with new wildlife-centric rules. This implies an additional scrutiny on human activities that have a significant negative effect on marine organisms and the fragile marine environment of straits. A wildlife-centred approach enables to reconsider the appropriateness of some human uses of the seas that are environmentally hazardous, but still relatively commonplace in straits. It is possible to facilitate the unimpeded movement of marine species through straits by the prohibition of some detrimental maritime practices that have a reasonable alternative. Such practices include, e.g., the detonation of naval mines in clearance operations, the construction of such causeways that are impassable for marine species, and the use of overhead power lines in straits. In addition, limits could be set to the use of sonars and to the speed of ships in straits.

1. Introduction

The law of the sea guarantees an unimpeded passage through straits for human beings. This legal regime is designed to protect humans against humans from obstructing the passage or overflight of ships and aircraft based on states' sovereign interests. Broadly speaking, the legal regime of straits, as stipulated in the United Nations Convention on the Law of the Sea [1] (LOSC), overlooks the significance of straits for marine organisms and birds. Article 233 of LOSC addresses environmental problems in straits, but that provision has a limited effect since it regulates coastal state rights only against ship-based 'major' marine pollution in straits and, as examined below, does not provide means for preventing or responding to other types of significant obstacles for wildlife movement in or above straits.

However, the preamble to LOSC acknowledges 'that the problems of ocean space are closely interrelated and need to be considered as a whole'. Articles 192ff of LOSC require states to protect and preserve the marine environment and, inter alia, to provide for measures to prevent, reduce and control pollution of the marine environment. This raises the question if the current legal framework applicable to industrial activities in straits should be supplemented with more rigorous wildlife-centric rules that would enable to eliminate the barrier effect in straits.

In the context of wildlife movement, the barrier effect has been defined as "[t]he combined effects of physical barriers, infrastructure avoidance, traffic mortality and habitat loss /…/" [2]. For the purposes of the present study, the barrier effect is used in a broader meaning to also encompass acoustic (e.g., underwater noise) and chemical (e.g., marine pollution that stems from wastewater and agriculture) barriers that deter or reduce wildlife movement in a particular area. The impact of barrier effect on wildlife movement has been subject to scrutiny in the context of industrial activities on land, such as the construction of roads and railways [3], as well as rivers (e.g., dams supplemented with fish ladders) and oceans in general (e.g., the protection of highly migratory species and anadromous species under Articles 64 and 66 of LOSC and the Straddling Fish Stocks Agreement [4]). Yet to the extent of the present author's knowledge, it has not been at the focus of attention in

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relation to the governance of straits.

The barrier effect in straits and its implications to the legal regime of straits has been to a great extent unexplored [5]. In this context, this study aims to contribute to the mapping of the main sources of human pressures on the marine environment in straits. The United Nations has listed, inter alia, underwater noise that it associates with shipping, sonar and seismic surveys, as well as interference with migration from structures in the sea, including windfarms and causeways as one of the main sources of man-made obstacles to wildlife mobility [6]. This study complements that list by examining the deleterious effects to wildlife mobility of countermining operations and the use of overhead power lines in and above straits. This paper explores reasonable alternatives to such environmentally hazardous practices that are currently relatively commonplace in straits.

From the anthropocentric point of view [7], the classification of straits is mostly based on the distinction between the legal regimes of transit passage, non-suspendable innocent passage, and permit-based passage. Yet the main users of straits are not humans, but rather marine species. They also rely on straits for moving from one ecosystem to another. Under the 1992 Convention on Biological Diversity (CBD), ecosystem is defined as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.' [8] This study examines if marine species and birds are allowed to cross straits without unreasonable impediments to their movement. For this, it somewhat distances itself from doctrinal legal research and adopts a wildlife perspective.

Thus, this paper departs to a significant extent from positive law [9]. It debates the suitability of some environmentally hazardous industrial practices that may have a disproportionately negative effect on wildlife in and above straits. This study seeks to find out if there is a need for banning the creation of such man-made blockages that make straits impassable or have disproportional damage for marine species and birds.

This paper first briefly outlines the central premises of the legal regime of straits and explains the significance of straits for marine species. It proceeds with problematizing the effect of underwater noise to the marine environment with a focus on the appropriateness of the detonation of naval mines in clearing operations in straits, as well as the construction of causeways and the use of overhead lines. In principle, these practices may in specific instances fall under the definition of the pollution of marine environment (see Art 1(4) of LOSC) except for the use of overhead lines that mainly pose a hazard to species living outside the marine environment, such as birds.

The scope of this study does not cover such maritime industrial projects that do not create major blockages for marine species or birds in and above straits, e.g. the laying of pipelines and cables or construction of windfarms, tunnels or bridges provided that proper mitigation measures are used and site selections are subjected to stringent environmental impact assessments. Also excluded from the scope of this analysis are some legal complexities that otherwise fall under the scope of the current research problem, but which have been already extensively debated in doctrinal legal research, such as the debate over the conformity of compulsory pilotage with the regime of transit passage in straits [10].

2. The Central Premises of the Legal Regime of Straits

The legal regime of straits, as stipulated in Part III of LOSC, guarantees the right of unobstructed passage of ships through straits used for international navigation [11]. This is embodied in the concepts of transit passage and non-suspendable innocent passage (see Arts 38 and 45 of LOSC). Part III of LOSC was drafted in response to the extension of the territorial sea from the generally accepted 3 nautical miles (nm) to 12 nm under Article 3 of LOSC that threatened to subject international navigation and overflight to coastal state's control based on its sovereignty over the territorial sea. In essence, the progressive evolution of the law of the sea by means of designing new legal concepts, such as the rights of transit passage and archipelagic sea lanes passage (Art 53 of LOSC), enabled to cross the 'sovereignty-barrier' in straits.

It is inherent in the nature of legal principles that they have a few exceptions. In the case of straits used for international navigation, the main exceptions to the free passage of ships stem from the laws of naval warfare [12]. In addition, according to Article 35(c) of LOSC, the legal regime of straits under Part III of LOSC does not affect for historic reasons a few straits in which passage is regulated in whole or in part by long-standing international conventions in force specifically relating to such straits. It is widely accepted that the Turkish Straits [13], the Danish Straits [14], the Åland Strait [15], and the Strait of Magellan [16] fall under this exception. However, although these long-standing treaties create exceptions to certain types of passage, they do not stipulate significant obstacles for the general free flow of international navigation through the afore-mentioned straits. These treaties provide significant safeguards for commercial navigation through the straits. For example, the 1857 Copenhagen Treaty [17] was signed for abolishing the Sound dues that for centuries had created obstacles for the free flow of maritime trade through the Danish Straits.

Yet while humans have granted themselves the freedom of navigation and overflight in straits under the regime of transit passage and archipelagic sea lanes passage as well as the right of non-suspendable innocent passage of ships for most other categories of straits used for international navigation, they are, in principle, legally still entitled to create barriers for the movement of marine organisms and birds in or above straits. This raises the question if the legal regime of straits or the framework of regional seas' conventions needs further progressive development to meet the global environmental challenges underpinned by rapid biodiversity loss. In other words, while the innovative development of the legal regime of straits under the LOSC prevented the erection of 'sovereignty-barrier' to the movement of humans, the law can now be complemented with rules that would allow to circumnavigate the 'sovereignty-barrier' also to wildlife movement in and above straits.

3. Challenges to Marine Wildlife Movement and the Role of Straits

Traditionally, straits have been free for the passage of marine species and birds. However, that state of affairs has been jeopardized since the 20th century as the increase of human settlements in and around straits complemented with the rapid rise of commercial, industrial, and military uses of marine areas has created physical, acoustic, and chemical barriers in straits for other species. Impediments to marine species' mobility in straits may stem from dumping grounds, minefields, causeways, pipelines, ship traffic, etc. Large bridges, windfarms and power lines have a negative effect on wildlife mobility above straits. The emergence of such technologies has created new challenges that wildlife has hitherto not experienced in and above straits. In addition, land-based sources pollute the seas with chemicals that have led to the eutrophication and so-called desertification of large sea areas, including in the Baltic Sea and the Gulf of Mexico [18]. On top of this, plastic pollution has an adverse effect on the habitats and foraging sites of marine species and birds.

While adapting to these previously unknown phenomena, marine species and birds are simultaneously under increasing pressure from climate change, ocean acidification, and global decline of biodiversity [19]. It is well documented that the decrease of the Arctic ice sheet and the warming of the oceans leads to the loss of important habitat sites for seals, polar bears, corals, etc. Similarly, in the Sea of Straits and the Viro Strait that are both located in the northern Baltic Sea and form the objects of the case studies below, it is expected that the ice cover will significantly decrease in the 21st century. In the Viro Strait, the ice cover lasted on average three months per year in the period between 1961 and 1990, but it will likely remain ice-free by the end of this century [20]. In

the same period, the duration of ice cover in the Sea of Straits will decrease from four months to barely one month per year [21].

This study does not focus on these greater environmental problems. Instead, in the broader context of the world's biodiversity loss, the object of this study is habitat fragmentation that results in the barrier effect in straits that serve as critical passageways for the migration of marine species. While numerous studies have been conducted on the barrier effect in relation to motorways and railways that humans have created on land, this problem has been underexplored in relation to straits that act as highways for human and wildlife movement on, in and above the sea. Straits have particular significance for wildlife movement. If passage through a strait is blocked, then it results in impediments to the movement of marine organisms, leaving them potentially trapped in semi-enclosed seas (Art 122 of LOSC) without the possibility to migrate to the ocean. As debated in this study, there are numerous measures that are at states' disposal for significantly facilitating wildlife movement through straits. The examples provided in the case studies below include, e.g., the prohibition or reduction of the use of sonars in straits, limitation of the speed of ships in straits, alternatives to the detonation of naval mines in clearance operations in straits, the creation of passageways in causeways and the use of submarine cables instead of overhead power lines.

For centuries, marine mammals as well as fish and birds did not require stringent environmental safeguards to facilitate their sustainability and wildlife movement between different ecosystems. The final quarter of the 20th century signifies the end of such understanding as the public became aware, particularly after the 1972 Stockholm Conference [22], that the heavy industrial use in and around straits at the expense of marine wildlife is unsustainable unless environmental policies and practices are changed. This marks, for example, the adoption and entry into force of the 1979 Convention on the Conservation of Migratory Species of Wild Animals [23] and the 1992 CBD complemented with the establishment of the Ecologically or Biologically Significant Marine Area (EBSA) framework [24], the advent of regional treaties for the protection of habitats and marine environment (e.g. the 1979 Berne Convention [25], the 1992 Habitats Directive [26], and numerous regional seas conventions), and treaties that regulate environmental impact assessments (the 1991 Espoo Convention [27] and the 1998 Aarhus Convention [28]). Notably, the regional seas conventions, such as the 1974/1992 Helsinki Convention [29], OSPAR Convention [30], Cartagena Convention [31], Barcelona Convention [32], all incorporate at least to some extent the basic premises of ecosystem approach. The Convention on the Conservation of Antarctic Marine Living Resources [33] represents one of the earliest and most explicit utilizations of ecosystem approach in regional seas governance [34].

Of particular importance for the protection of wildlife movement is the Convention on the Conservation of Migratory Species of Wild Animals. Its Article 2(3)(h) stipulates that states parties shall endeavour to conclude agreements covering the conservation and management of migratory species included in Appendix II. Appendix II focuses on migratory species that have an unfavourable conservation status, and which require international agreements for their conservation and management. Article 5 of the same convention provides guidelines for concluding such agreements and encourages the elimination of, to the maximum extent possible, activities and obstacles which hinder or impede migration as well as the prevention, reduction or control of the release into the habitat of the migratory species of substances harmful to that migratory species (Art 5(5)(h)-(i)).

Often straits serve migratory marine species as the only passageway from one marine area to another. Globally, there are 66 internationally recognised large marine ecosystems [35] (LMEs), of which approximately a third are interlinked via straits. For example, the Danish Straits connect the Baltic LME with the North Sea LME, while, in turn, the latter is connected to the Celtic-Biscay Shelf LME by the Strait of Dover. The Kara Strait connects two LMEs in the Arctic Ocean, and the Turkish Straits link the Black Sea LME and the Mediterranean LME, while the latter is connected to the Iberian Coastal LME via the Strait of Gibraltar. These examples include straits and LMEs in Europe, but straits are equally significant for oceans connectivity [36] in other regions of the world. In short, straits are just as important for marine organisms as they are for humankind.

In the end of the 20th century, the International Maritime Organisation (IMO) began to designate particularly sensitive sea areas (PSSAs) in recognition of their special ecological significance and need for protection against industrial activities. The first PSSA was established in 1990 in the Great Barrier Reef and to date, there are 14 PSSAs globally (the Great Barrier Reef PSSA has been extended twice and now covers the Torres Strait) [37]. About half of the PSSAs cover straits, including the Strait of Bonifacio, the Dover Strait and the rest of the straits located adjacent to the United Kingdom, straits in the Canary Islands and the Galapagos Archipelago, as well as in the Baltic Sea [38]. This underlines the sensitivity of straits in comparison with other sea areas.

The increasing expansion of human settlements in localities around straits complemented with the stable rise of international shipping and new infrastructure development projects in straits sets the marine environment in straits under pressure. In this context, it is unclear if the current anthropocentric and navigation-oriented legal regime of straits is suitable for meeting the challenges posed by man-made barriers to wildlife movement in and above straits. It is analysed next if there is a need for updating the legal regime of straits with rules that pay due regard to the importance of these narrow maritime areas for the movement of marine organisms. This is assessed based on case studies that intentionally set the focus on the Baltic straits for drawing conclusions on whether the current marine policies of the above-referred regional seas' conventions governing bodies and the applicable rules of international, European, and domestic environmental laws in combination with the PSSA and Natura 2000 frameworks are sufficient for preventing human-made barriers to wildlife mobility in and over straits.

4. The Effect of Underwater Noise from Ship Traffic and Mine Detonations on Marine Species in Straits

It is well-known that ship traffic causes significant increases in underwater noise and deadly collisions with marine species. In the case of vast ocean space, this can be avoided or reduced by rerouting ship traffic in the relevant area [39]. By contrast, in straits that, by definition, are the areas of highest ship traffic density in the world, there is simply not sufficient space for undertaking meaningful rerouting due to the narrowness of the marine area [40].

Most commercial ships need to pass straits on their way from one port to another. While in other marine areas the underwater noise caused by ship traffic is distributed along the multiple ship routes in the vastness of ocean space, the traffic becomes congested as soon as ships reach straits. For example, it is estimated that some 15% of global cargo is trafficked via the Baltic straits [41]. Approximately a third of global shipping or even over a half of global merchant fleet capacity crosses the South China Sea, including its adjacent straits (Malacca, Singapore, Sunda, Lombok, etc) [42]. Furthermore, the traffic density in the Taiwan Strait is over a twice greater than in the Strait of Malacca and about ten times greater as compared to the Suez Canal [43]. In straits that have a heavy ship traffic, it is possible to somewhat reduce underwater noise pollution, e.g., by means of prohibiting or limiting the use of sonars in straits and by requiring ships to reduce their speed when navigating in straits [44].

Straits are geographically and functionally distinct from other maritime areas. As previously explained, straits often serve as the only gateway from one large marine ecosystem to another. They are also narrow. Hence, unlike other areas of the vast ocean space, constant exposure to excessive underwater noise in straits has the potential to create not only acoustic, but also behavioural barriers to the movement of marine organisms across marine ecosystems. To the extent of the present author's knowledge, this problem has not been so far properly

acknowledged by the competent international organizations (e.g., the IMO) or the governing bodies of regional seas' conventions.

Negligence towards the problems that underwater noise causes to marine wildlife movement in straits is exemplified by the repeated naval mine detonations in some of the world's most fragile marine environments during routine countermining operations. While marine species might adjust over time to such physical barriers as causeways, they are defenceless against sudden and intensive noise pollution in the marine environment that results from mine detonations. The detonation of a single naval mine can cause irreversible and often fatal damage to the auditory organs of marine mammals even if they are located at the other end of a strait.

Countermining operations are necessary for ensuring the safety of shipping or clearing the area for construction activities, e.g., the laying of submarine cables and pipelines, establishment of windfarms and bridges. However, countermining operations cause significant noise pollution in the marine environment. For marine mammals, hearing is vital. It has been estimated that a recent detonation of 88 naval mines on the Netherlands' continental shelf in a single year "very likely caused 1280, and possibly up to 5450, permanent hearing loss events (i.e., instances of a harbour porpoise predicted to have received sufficient sound exposure to cause permanent hearing loss)." [45] Harbour porpoise is particularly vulnerable to underwater noise. Based on their detailed measurements and model results, Salomons et al. concluded that "harbour porpoises are at risk of permanent hearing loss at distances of several kilometers from large explosives." [46] It has been observed in another study that the noise pollution that results from the detonation of naval mines in the Gulf of Finland spreads to marine areas as far as 23 km away from the epicentre of the explosion [47]. This is due to the special characteristics of the marine environment where the speed of sound is nearly five times greater than in air [48].

Due to military strategic reasons, straits are the most likely maritime areas to suffer from mine warfare. In the Baltic Sea, the clearance operations are still underway in respect of the countless naval mines that were laid almost a hundred years ago in the two world wars. For example, it is estimated that over 170,000 mines were placed in the Baltic Sea during the two world wars, and it is suspected that tens of thousands still remain in the Gulf of Finland alone [49]. Most of these mines are situated outside the Russian maritime area in the entrance to the Gulf of Finland proper where the sea is less than 24 nm wide as measured from the Finnish and Estonian baselines, thus meeting the legal criteria of a strait under Part III of LOSC.

Under Article 5 of the 1907 Hague Convention on naval mines [50], belligerents are required at the close of an armed conflict "to do their utmost to remove the mines which they have laid, each Power removing its own mines." This obligation has become part of customary international law applicable to naval mine warfare [51]. States can also cooperate and engage in joint operations to meet this obligation [52], particularly when large quantities of mines need to be cleared which is a highly time-consuming task. For example, a recent NATO joint mine clearance operation in the Gulf of Finland lasted for ten days and involved 21 ships from 11 states, resulting in the identification of 130 historical ordnances of which 49 were countermined [53].

At the same time, countermining operations cause significant environmental impact. At the domestic level, it is unclear to what extent states require carrying out environmental impact assessments (EIA) prior to mine detonations in sensitive sea areas. One of the main problems in relation to carrying out an EIA prior to a countermining operation is that the assessment may last for years, while clearance activities are usually time-critical tasks [54]. Under international law, both the Convention on Biological Diversity and LOSC encourage the use of EIAs of proposed projects that are likely to have significant adverse effects on biological diversity, but it is not a strict obligation for the states parties as these conventions expect such assessments to be carried out only as far as possible and appropriate or practicable [55]. By contrast, the Espoo Convention stipulates strict procedure for EIAs, but it includes only 45 states parties, mostly from Europe [56].

In peacetime, underwater countermining operations usually fall under the law enforcement framework, also if they are carried out by the military [57]. The United Nations Mine Action Service guidelines provide that 'under some circumstances' an EIA is appropriate or required before countermining operations and specifies that, "[a]n EIA should be made whenever:

- mine action operations are expected to take place within, or close to, designated protected environmental areas, or other areas known to be environmentally sensitive;
- there is a legal or contractual obligation to do so;
- the NMAA [the National Mine Action Authority] determines that an EIA is necessary; and/or
- any other occasion when there is uncertainty about the scale or significance of environmental impact." [58]

The United Nations Mine Action Service has also drafted guidelines on the conduct of an EIA in the planning of countermining operations [59]. Nonetheless, it has been argued that these standards "developed as a framework to guide national authorities and operators alike, do not incorporate specific practical measures to minimise potential environmental impacts." [60] This is confirmed by recent state practice in northern Europe, as examined next.(Figure Map 1).

In August 2019, a mine clearance operation was carried out in the Fehmarn Belt, located between Germany and Denmark and connecting the Baltic LME with the North Sea LME. The clearance operation was conducted close to the Fehmarn Belt nature conservation area that is part of the Natura 2000 network under the Habitats Directive [61]. The Fehmarn Belt area has been also designated as an EBSA under the CBD, since '[t]he area is important for migratory aquatic species, such as the western population of the harbour porpoise.' [62] It is also part of the Baltic Sea PSSA (designated by the IMO) and a marine protected area under the Helsinki Convention [63]. In that strait, construction works are underway for building the world's longest immersed road and rail tunnel [64]. In the autumn of 2019, following the clearance operation, 41 harbour porpoises were found dead. The German Federal Agency for Nature Conservation concluded that underwater explosions served as one of the main causes of deaths [65]. In the Baltic Sea, it is a critically endangered whale species of which less than 500 have remained [66].

In the practice of the United States and German Navies, naval mines are detonated in the sea only where it is not possible to use alternative measures [67], such as the displacement of mines to shallow waters or land for detonation or neutralization [68]. Also, the use of so-called time-area closures in the context of mine clearance operations is a common management measure for increasing wildlife movement [69]. States can prohibit the detonation of naval mines and other maritime industrial activities in a sensitive sea area during the time when protected species breed or are particularly vulnerable to external factors in the first phases of raising their offspring. Outside that timeframe mine detonations are generally permitted, but even then, the so-called "scare" charges and bubble curtains (an artificial creation of a round-shaped pneumatic barrier around the mine that is detonated) need to be used for significantly decreasing the spread of underwater noise and other contaminants [70].

Nonetheless, as the Fehmarn Belt incident shows, the detonation of naval mines can still have deleterious effects on marine organisms even if states make use of various mitigation measures. States should consider prohibiting peacetime mine detonations in sensitive sea areas. Instead, States can use alternative techniques for neutralising naval mines, for example deflagration [71]. In the case of deflagration, the main charge of a mine is neutralised by means of using a burning process. Unfortunately, despite preliminary research had shown at least a couple of decades ago that deflagration offers a low cost, high benefit solution for clearing mines, the application of this technique to clearing naval mines has been under-explored. In a 2006 research article, it was concluded

Map 1. Fehmarn Belt.
Source: OpenStreetMap, https://www.openstreetmap.org (Accessed 15 December 2021). The map is modified by the author to include a reference to the location of the strait.

that in relation to land mines, this new technology promises an effective, safer, and less expensive means for mine neutralisation [72]. When applied to naval mine neutralisation, the use of deflagration would have minimal effects on the marine environment as compared to the common practice of detonating mines.

Robinson et al. write in their 2020 research article on the measurement of underwater noise stemming from deflagration that: "Deflagration is a much less energetic process and anecdotal evidence has suggested that it is "quieter" than traditional high-order detonation, but until now no acoustic measurements have been reported to support this conclusion." [73] They conclude that: "Compared to high-order methods, deflagration offers the potential for greatly reduced acoustic noise exposure of marine fauna and reduced destruction of the seabed." [74] But they also point out that the technique is not yet familiar within the civil offshore explosive ordnance disposal community, regulators, and developers [75]. This needs to change. States have to start considering options for prohibiting the detonation of naval mines in straits in favour of the use of alternative and cost-effective mine clearance techniques, e.g. deflagration, that have minimal effects on the marine environment.

5. The construction of causeways and overhead power lines in straits

Industrial activities in straits also cause barriers for birds. Straits usually attract a lot of birds as a habitat site due to various reasons, including their relatively shallow waters and thus greater opportunities for finding food, proximity to the opposite coasts that, among other things, provides shelter against storms. At the same time, straits tend to be located around human settlements which is why they are often used for the transmission of electricity from one mainland coast or island to another. Where straits are many kilometers wide and they are used for international navigation, then it is either impossible or impractical to use overhead power lines. Instead, in such geographical circumstances, use is rather made of submarine cables. However, the laying of submarine cables is expensive. Therefore, overhead power lines are still relatively common in small straits where they do not bear navigational importance. Unfortunately, this poses a significant threat to birds.

For example, a 125-years-old causeway that connects Muhu Island with Saaremaa Island crosses the Small Strait that forms part of the Sea of Straits in the Estonian western archipelago. The strait is heavily crossed not only by vehicles, but also by birds: each day, approximately 3000–4000 birds fly either over the causeway or in its vicinity [76]. The Small Strait cannot be crossed by marine mammals or fish, since the causeway does not include any passages for them [77]. Thus, the causeway contributes to habitat fragmentation in the area.

The Small Strait forms a Natura 2000 site both under the Habitats Directive and under the Birds Directive [78]. It has been also designated as an EBSA under the CBD, since '[t]he area is home to a large number of migratory and other species, and is a designated Important Bird and Biodiversity Area (BirdLife International).' [79] The Small Strait is also part of the Baltic Sea PSSA (designated by the IMO) and the 'Väinameri' marine protected area under the Helsinki Convention [80]. The power lines that were constructed on the causeway in 1963 have proved deadly for numerous birds that collide with the power lines as they are apparently unused to such hardly noticeable obstacles [81]. Against this

Map 2. Small Strait and the Estonian Western Archipelago.
Source: OpenStreetMap, https://www.openstreetmap.org (Accessed 15 December 2021). The map is modified by the author to include a reference to the location of the strait.

backdrop, the electricity system operator replaced half of the power lines with a submarine cable in 2019, while planning to demolish the rest of the overhead power lines in the Small Strait by 2024 [82]. By now, the remaining power lines have been equipped with line markers that also act as reflectors in the dark as cars are passing by. This mitigation measure is widely used and is relatively effective in reducing bird collisions [83].

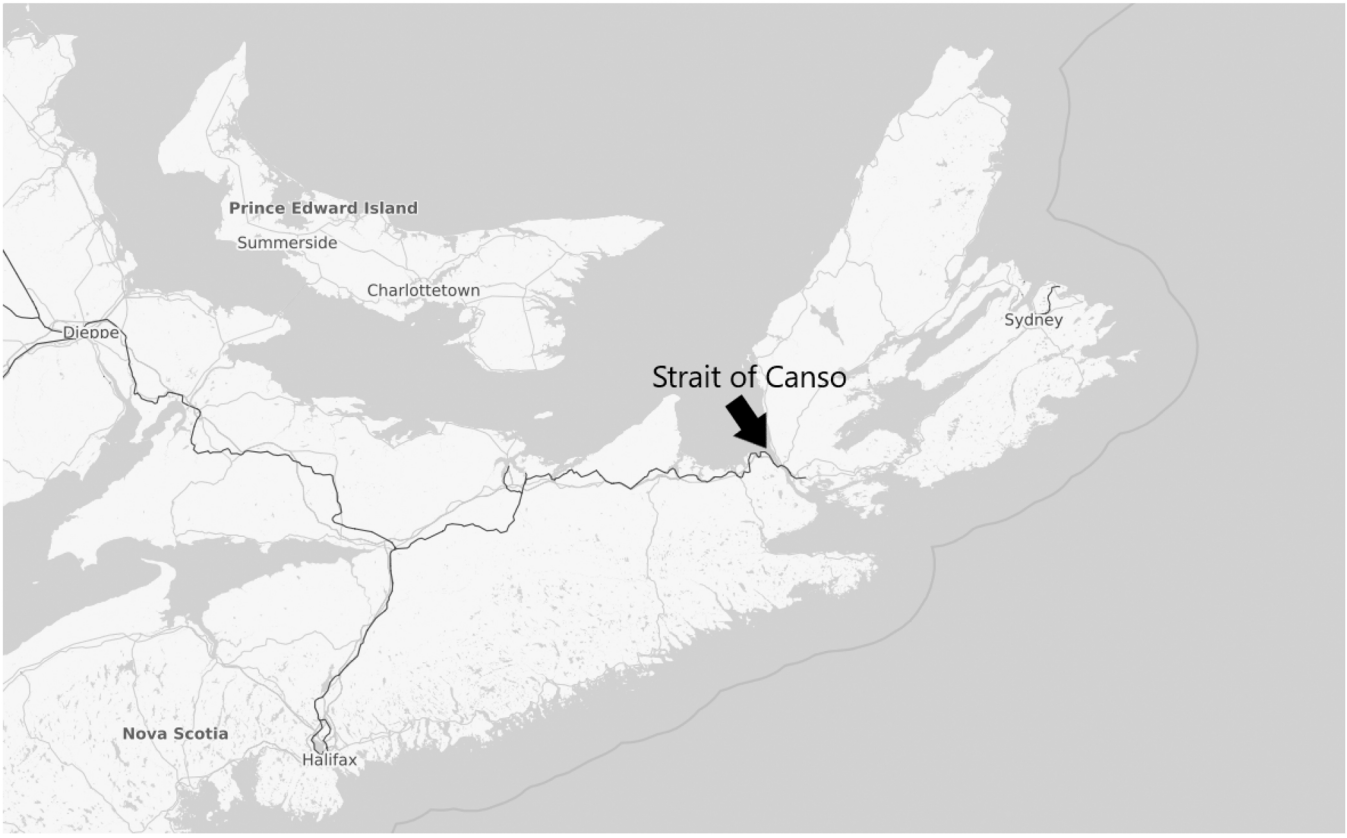
According to the data of Birdlife Estonia, the number of birds in Estonia has declined by approximately 35% in comparison with the 1980s [84]. In broad terms, this corresponds to the global decline of biodiversity and regional losses in avifauna. For example, the North American avifauna has declined by about 29% since 1970 [85]. The use of overhead power lines is a marginal cause of the global decline of avifauna, but their presence in straits that serve often as hotspots for bird migration symbolizes how we have created barriers for wildlife movement in straits, without long even acknowledging it.

In the 20th century, causeways were constructed in various straits of the world. In most cases, they have caused significant environmental problems. The 2-km-long Canso Causeway was opened in 1955 and allows railway and road traffic to cross the Strait of Canso between the Canadian mainland coast in Nova Scotia and Cape Breton Island [86]. The causeway also includes overhead power lines [87]. It is not known if the potential adverse effect of the Canso causeway's overhead power lines to birds is acknowledged. But it has been observed that the migration patterns of some fish species were permanently altered after the construction of the causeway [88]. This has led to proposals for replacing the causeway with a bridge or tunnel or, alternatively, re-engineering the causeway to enable the water along with marine organisms to pass through the causeway [89].

Similar concerns have been raised over the 1-km-long Johor-Singapore Causeway that connects Singapore to the Malaysian mainland coast. The causeway was officially opened for railway and highway traffic in 1924 [90]. As a result, the Johor Strait was closed for ship crossings between the Strait of Malacca and South China Sea. The vulnerability of the Johor Strait's marine environment is mainly due to the marine pollution that results from the heavy ship traffic in the Singapore Strait and the high population density on both coasts of the Johor Strait.

The causeway blocks the natural flow of water and the movement of marine organisms which can cause environmental problems particularly in the western part of the Johor Strait [91]. This is due to the bottom water flows that transports marine pollution from the Singapore Strait to the western part of the dead-end Johor Strait [92]. In the beginning of 2000s, Malaysia proposed to replace the causeway with a bridge due to the causeway's negative effect on the Johor Strait's marine environment, but Singapore declined. Consequently, Malaysia decided to halt the construction of the bridge [93].

The causeways in the Johor Strait, Small Strait, and Canso Strait block not only the natural flow of water and the movement of marine organisms, but also vessel traffic through the straits. Due to the lack of international navigation through these straits, they do not meet the functional criterion of an international strait and are not governed by Part III of LOSC on straits used for international navigation (see *supra* Chapter 2). According to Article 34(1), Part III of LOSC regulates the regime of passage only through such straits that are used for international navigation. Hence, passage rights through the Johor Strait, Small



Map 3. The Strait of Canso.
Source: OpenStreetMap, https://www.openstreetmap.org (Accessed 15 December 2021). The map is modified by the author to include a reference to the location of the strait.

Strait, and Canso Strait are not safeguarded under international law. While the Johor Strait is divided between Singapore's and Malaysia's maritime areas, the Small Strait and Canso Strait fall under the regime of internal waters of a single coastal state (Estonia, Canada).

However, the distinction between straits based on whether the passage of ships and aircraft is safeguarded under Part III of LOSC is not significant from the perspective of the coastal states' obligation to facilitate wildlife movement through straits. From the perspective of environmental law, coastal states' duty to protect the marine environment applies similarly in respect of both international straits and straits in which navigation is not safeguarded under international law. The Annex VII Arbitral Tribunal found in the South China Sea case that sovereignty is irrelevant to the protection and preservation of the marine environment which, as an obligation stipulated under Article 192 of LOSC, applies to all states in all maritime areas, including internal waters [94].

6. Institutional and policy options for eliminating barriers to wildlife movement in straits

While the legal regime of straits under Part III of LOSC guarantees that sovereignty is not an obstacle for the movement of humans through straits, the previous case studies demonstrate that sovereignty over the marine areas in straits is still the root cause of significant obstacles to the protection and preservation of the marine environment. From a wildlife perspective, the causeways and overhead power lines in the Small Strait, the Canso Strait, and the Johor Strait symbolise the physical barriers that humans have created for marine organisms and birds in and over straits. The Annex VII Arbitral Tribunal has underlined that Article 192 of LOSC 'entails the positive obligation to take active measures to protect and preserve the marine environment, and by logical implication, entails the negative obligation not to degrade the marine environment.' [95] In this context, what active measures states ought to take under Articles 192ff of LOSC for facilitating the unimpeded movement of marine organisms through straits?

In the instances studied above, humans have blocked other species' "highway", while creating one for themselves. At the same time, there are reasonable alternatives to such practices, including the use of submarine cables, and the construction of bridges or wildlife crossings (passageways for marine organisms). Apparently, states still often lack the incentive to implement such alternative measures. This points to the need for a stronger implementation of marine environmental protection rules. In respect of straits, this should be done with the aim of banning the creation of such man-made blockages that make straits impassable or have a disproportionally negative effect on the movement of marine species and birds in or above straits.

Arguably, raising awareness and enhancing the implementation of existing environmental protection rules under the above-referred regional seas' arrangements as well as under the IMO and CMS auspices provides sufficient opportunities for eliminating barriers to wildlife movement in straits. It might be possible to achieve this aim without necessarily amending any treaties. For example, it would be very difficult to introduce any amendments to Parts III and XII of LOSC that regulate, respectively, the legal regime of straits and the protection and preservation of marine environment. Boyle has found that Articles 312 and 313 of LOSC that regulate the amendment of LOSC 'prove an unattractive option' for amending the treaty and that, instead, states have introduced new rules complementing LOSC by way of concluding agreements implementing the provisions of LOSC [96]. Such implementing treaties include, to date, the 1994 Agreement Relating to the implementation of Part XI of LOSC on the Area [97], and the Straddling Fish Stocks Agreement. However, the difficult negotiating procedure

Map 4. The Johor Strait.
Source: OpenStreetMap, https://www.openstreetmap.org/#map= 7/58.613/25.024 (Accessed 15 December 2021). The map is modified by the author to include a reference to the location of the strait.

accompanying such implementing agreements is illustrated by the third implementing agreement of LOSC on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction that has been negotiated for over a decade [98].

The overwhelming majority of straits of the world fall under the scope of regional seas' conventions [99]. The main exceptions are the straits located in the Northwest Atlantic (e.g., the Canso Strait), the Northeast Pacific (e.g., the Strait of Juan de Fuca), and the Arctic (the numerous Arctic straits of Russia and Canada). In addition, while the Helsinki Convention covers the Danish Straits and the Åland Strait, the other remaining Article 35(c)-category of straits (the Turkish Straits and the Strait of Magellan) are not governed by any regional seas' convention (see *supra* Chapter 2 on Article 35(c) of LOSC) [100].

As a first step towards eliminating barriers to wildlife movement in straits, it is rather desirable that the intergovernmental organizations established under the regional seas' conventions, e.g., the Cartagena Convention, the Barcelona Convention, the Bucharest Convention, or the HELCOM and the OSPAR Commission, raise awareness among states and stakeholders about the need to use reasonable alternatives to the current industry practices that result in physical and permanent obstructions of passage or acoustic and temporary barriers for wildlife movement. As examined above, such barriers to wildlife movement in straits occur in marine protected areas that have been designated under the relevant regional seas' conventions. In the context of awareness-raising, the Arctic Council in respect of the Arctic straits has a similar responsibility to the intergovernmental organizations established under the regional seas' conventions [101]. States can also strive to conclude regional seas' conventions in respect of the Northwest Atlantic and the Northeast Pacific to protect the marine environment of the seas and straits that are adjacent to the west and east coasts of the United States and Canada.

It is possible that awareness raising does not result in the elimination of barriers to wildlife movement in straits. In such a scenario, the relevant inter-governmental organizations should consider initiating amendments to the corresponding regional seas' conventions for prohibiting the introduction of artificial installations and other pollutants that act as barriers for wildlife movement in straits.

7. Conclusion

This research has shown that humans create significant barriers to the passage of marine species and birds in and over straits. These blockages can occur in various forms, including physical and permanent obstructions of passage (caused by, e.g., causeways, overhead lines) as well as acoustic and temporary obstructions (resulting from, e.g., detonation of naval mines) or chemical barriers (wastewater and other land-based pollution). Although the temporal extent of these types of barriers differs substantially, they can have an equally detrimental effect on wildlife. Unlike the continued presence of overhead power lines or a causeway, a naval mine detonation only lasts a moment. But a single detonation of a naval mine creates intense acoustic pollution that spreads so far that it can cause fatal damage to marine species that are many kilometres away from the epicentre of the explosion. In some straits, such as in the Gulf of Finland, countermining operations are conducted on a regular basis. In effect, this may lead to acoustic and behavioural barriers in straits that unlike other parts of the vast ocean space are only a few kilometres wide but play a key role in the connectivity across marine ecosystems.

Physical, acoustic, and potentially other barriers that obstruct wildlife movement in straits often are fatal to marine species and birds. The deleterious effects to marine environment and birdlife that result from such blockages are avoidable. There are reasonable alternatives that enable to either eliminate or significantly reduce the damage to wildlife caused by such human activities. For example, overhead power lines can be replaced with submarine cables, the use of sonars in straits can be prohibited or significantly limited, ships can be required to

reduce their speed when passing though straits, wildlife crossings for marine species can be constructed in causeways, and in most cases naval mines can be neutralised by using less harmful techniques, such as deflagration, as compared to the robust mine detonations that cause intense acoustic pollution.

Still, the occurrence of man-made barriers to wildlife movement in and above straits is relatively commonplace in Europe. This is illustrated by Germany's recent countermine operations in the Fehmarn Belt that caused the death of numerous protected marine species and by the use of overhead power lines in the Small Strait which has proven deadly for the numerous birds that cross the site. These examples concern PSSA sites that also form part of the Natura 2000 network, the EBSAs network under the CBD, the marine protected areas network under the Helsinki Convention, and are thus subject to one of the strictest environmental protection regimes globally. Nonetheless, this multi-layered legal framework has not been rigorous enough for preventing the deleterious effects to wildlife movement that these barriers have caused. It may thus be hypothesized that barriers to wildlife movement are even more common in such non-European straits that are not subject to strict environmental protection rules. Hence, one may conclude that the legal framework applicable to straits guarantees unobstructed passage through straits only for human species, but not for marine species or birds. In the context of increased public awareness of the effects of man-made pollution to the loss of marine biodiversity, there seems to be room for introducing new rules that would guarantee the freedom of movement in and above straits for marine organisms and birds.

A two-step approach was suggested in this paper for eliminating man-made barriers for wildlife movement in straits involving, first, awareness-raising by intergovernmental organizations created under the regional seas' conventions. If awareness-raising does not suffice for eliminating barriers for wildlife movement, the governing bodies should initiate the necessary amendments to the relevant regional seas' conventions. For example, it is possible to facilitate marine and birdlife diversity in straits by the outright prohibition of the introduction of artificial installations and other pollutants that act as barriers for wildlife movement in straits. In essence, adherence to such a new rule or even the policy of following its aim in the implementation of the current marine environmental protection rules would result in the recognition of the freedom of movement through straits for marine species and birds. At minimum, those migratory species that are either endangered or have an unfavourable conservation status (either globally or regionally) should be able to enjoy such freedom.

Presumably, the implementation of this marine policy would primarily rest on the regional seas governance and legal framework (e.g., the Helsinki Convention, OSPAR Convention, Cartagena Convention, Barcelona Convention). In the course of this process, the guiding principle should be approaching straits from such legal perspective that shifts the emphasis from anthropocentric connectivity to a legal regime of straits that equally considers marine biology perspective and pays due regard to the importance of these narrow marine areas for free and unobstructed movement of marine organisms between ecosystems.

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[98] See 'Background', in United Nation, Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (General Assembly resolution 72/249), ⟨https://www.un.org/bbnj/content/background⟩ (Accessed 15 February 2022).
[99] See *supra* Chapter 3. See e.g. the map of the regional seas' conventions, ⟨https://www.unep.org/fr/explore-topics/oceans-seas/what-we-do/oeuvrer-pour-les-mers-regionales/pourquoi-est-il-important-de⟩ (Accessed 11 April 2022).
[100] The Marmara Sea and the Bosporus and the Dardanelles do not fall under the scope of the Bucharest Convention. See Convention on the Protection of the Black Sea Against Pollution, Bucharest 21 April 1992, entered into force 15 January 1994, Art 1(1).
[101] See, e.g., 'Declaration of the Protection of Arctic Environment', Arctic Environmental Protection Strategy 1991, ⟨http://www.arctic-council.org/index.php/en/document-archive/category/4-founding-documents⟩ (Accessed 11 April 2022).