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Argüello, G., Krabbe, N., Langlet, D. et al (2022). Regulation of ships at anchor: Safety and environmental implications. *Marine Policy*, 140. <http://dx.doi.org/10.1016/j.marpol.2022.105052>

N.B. When citing this work, cite the original published paper.



Regulation of ships at anchor: Safety and environmental implications

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ARTICLE INFO

Keywords:

Waiting at anchor
Ports
Coastal state jurisdiction
Ship routing mechanisms
Port State Control
Innocent passage
Charterparty
Risk allocation
Charter market

ABSTRACT

Ships waiting at anchor are associated with considerable environmental pressures and impacts. Growing and congested anchoring areas are receiving increasing scholarly attention to understand the environmental effects caused by large sea-going ships anchoring in coastal waters. While there is a lack of studies addressing the entire spectrum of environmental pressures and impacts from ships at anchor, ranging from scouring of the seafloor, operational emissions and discharges and waste from maintenance carried out while at anchor, it is well established that anchoring is associated with such pressures. This article takes a problem-oriented approach since there are potential cumulative environmental impacts of ships waiting at anchor. From both a public and private law perspective, we examine the legal structures and challenges associated with the regulation of ships waiting at anchor. We also analyze the public and private law factors that may limit the ability to prevent harmful anchoring practices. Our examination shows that while coastal states have significant jurisdictional powers to regulate anchoring in coastal waters, the current international regulatory framework addresses anchoring incidentally and lacks mechanisms for considering the cumulative impacts of anchoring. Furthermore, the incentives for ships to spend a considerable amount of time at anchor appear to differ substantially across different types of charterparties. Improved regulation requires better scientific knowledge, substantial mapping of legal structures, and a stakeholder survey providing a basis for the exploration of potential contractual practices that may reduce market incentives for anchoring.

1. Introduction: challenges with regulating anchoring

Lying at anchor is a common practice for ships, and it can be done for many reasons. Large sea-going ships lie at anchor e.g. while waiting for a place to berth in a harbor, while waiting for a commission, because the ship is used as storage for a commodity that the owner is betting will yield a better price at some future point in time, as well as for other reasons. It is by now well established that anchoring is associated with considerable environmental pressures and impacts. Most attention has been given to the physical impacts of anchors and chains on the seabed, i.e., scouring [1,2]. When anchoring, a large ship deploys an anchor chain corresponding to three to seven times the water depth [3]. A large section of the chain will move across the seabed as the ship is affected by winds and currents, heavily impacting living and abiotic structures on the seabed.

The environmental impacts of anchoring have received increasing

attention since the earliest identified scientific publication [1]. Most studies have focused on leisure boats [4–11] but there are also a growing number of studies on anchorage by commercial ships [2,12–15]. Still, there are significant knowledge gaps relating e.g. to long term impacts on different kinds of benthic environments from anchoring of large ships [2,12]. Beyond scouring, there are other potentially significant environmental pressures associated with anchoring. There is an increased understanding within the scientific community that the environmental impact of shipping operations is substantial and results from multiple pressures such as nutrients and contaminant loads, energy and underwater noise and spreading of non-indigenous species [16]. The emission and discharge factors for the respective waste streams/sources associated with ships at anchor cannot be anticipated to exactly correspond to the factors from a ship underway. However, most of the ship-related sources of environmental impacts will also occur from ships at anchor. And in particular, with much used anchoring areas, the pressures may

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<https://doi.org/10.1016/j.marpol.2022.105052>

Received 15 November 2021; Received in revised form 26 March 2022; Accepted 30 March 2022

Available online 10 April 2022

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emanate from many ships and be sustained over long periods of time. In addition, there may be pressures resulting from maintenance carried out on anchored ships. These have generally been subject to much less scientific attention than scouring. In fact, there is a complete lack of studies addressing the entire spectrum of environmental pressures and impacts from ships at anchor, ranging from scouring of the seafloor, operational emissions and discharges and waste from maintenance carried out while at anchor. Anchoring is also not included in any of the major shipping environmental assessment models available [17,18]. A further environmental dimension that may be linked to anchoring, although it is not directly caused by the anchoring as such is the practice of going at full speed to an anchoring site only to remain there for a significant time, rather than adjusting the speed and thereby limiting fuel consumption and decreasing emissions of, *inter alia*, carbon dioxide (Figs. 1, 2).

Although there is a need for further scientific studies of the cumulative pressures associated with anchoring, it follows from the above that anchoring can be associated with significant environmental impacts. Not surprisingly, calls have been raised for better regulatory and planning approaches to anchoring in order to manage the environmental risks and prevent harm to the extent possible [19]. From a legal perspective, anchoring is associated with specific challenges which vary depending on the nature and location of the anchoring site. Among other things, the regulation of anchoring is complicated by factors such as unclear mandates, competing or overlapping jurisdiction or ambiguous rules [2]. Attempting to reduce anchoring by addressing the underlying causes or incentives for certain kinds of anchoring practices may prove even more challenging. While much remains to be learnt about the extent of environmental effects of anchoring, there is every reason to take steps to limit those effects, in particular when it can be done without negatively affecting the safety or efficiency of shipping. Since anchoring normally occurs in relative proximity to a coast, and often also a port, coastal states are most immediately affected and for practical reasons best placed to take steps to regulate anchoring.

The current article explores the legal preconditions and challenges associated with the regulation of anchoring by coastal states with the aim of reducing the environmental impacts of anchoring. Potential interventions by other pertinent actors are also discussed. The aim is both to provide a general understanding of the preconditions for regulating anchoring in the interest of environmental protection, but also to identify issues in need of further study or where policy reform or development may be required to provide the means for effective environmental protection while also safeguarding the legitimate interests of shipping, including maritime safety. The few existing studies that look at regulatory dimensions of anchoring from an environmental perspective are mostly focusing on specific national or local conditions [2]. The present study deals primarily with the globally applicable rules of the international law of the sea and widely ratified international agreements or legal standards which define the room for action for any national or local regulatory agent.

2. Methods

This article is primarily concerned with international legal conditions, which are analyzed through the study of international agreements, relevant state practice and court cases. Our point of departure is to identify, based on the general jurisdictional rules of the law of the sea [20], who has the formal capacity to regulate anchoring and associated activities in different areas or situations. Private law practice is also analyzed to understand how commercial agreements require or incentivize anchoring and to what extent private actors can use legal instruments to ensure more sustainable anchoring.

In order to identify relevant rules and regulatory frameworks and assess their appropriateness for limiting as far as reasonable the environmental impacts of anchoring, these impacts, as well as why anchoring occurs in different situations, must be understood, as far as current scientific knowledge allows. For this purpose, a broad range of

scientific literature has been used to map known and expected environmental effects as well as more general data concerning anchoring by large ships. The literature has been identified with the use of established databases (Scopus, Google Scholar) as well as so-called snowballing, where known literature has been used to identify further relevant sources.

The legal analysis is problem-oriented in the sense that it aims to assess the ability of existing regulatory structures and processes to enable regulatory responses to anchoring practices known to be environmentally harmful, or in situations where there is reason to believe that environmentally deleterious effects are likely to result from anchoring. Gaps encountered in the literature, both in terms of scientific knowledge relevant to the regulation of anchoring and knowledge about features of the legal system that affect anchoring in relevant ways are used to inform conclusions on the need for further research [21].

3. Anchoring and anchorages

In this article, anchoring is understood as a ship operation in which a vessel “is held in position by an anchor attached to the bottom of a body of water” [22]. The International Association of Independent Tanker Owners (INTERTANKO) refer to it as a “common and vital operation on any ship” [23]. Anchoring areas or anchorages are hereby defined in broad terms as locations in the marine environment either designated by a competent authority or chosen by the shipmaster where a ship anchors and it is not at berth or moored at a port. Anchorages are usually located in coastal waters. From a legal perspective, these are areas within the national sovereignty of states, namely, internal waters and the territorial sea. It is important to notice that not every seafloor is suitable for coming to anchor. From a seafarer’s perspective, “consideration should be made of the depth of water, the type of holding ground and being clear of underwater obstructions” [24]. A poor holding ground increases the risk of anchoring dragging [24].

Whether anchoring areas or anchorages are considered part of the port could be subject to debate. The 1982 United Nations Convention on the Law of the Sea (UNCLOS)¹ does not define ports explicitly [25]. Based on Articles 11 and 12 of UNCLOS, Molenaar provides an extensive definition of port, *i.e.*

The spatial scope of a (sea)port includes the outermost permanent harbor works—but not offshore installations and artificial islands—as well as roadsteads that extend beyond the outer limit of the territorial sea, provided they are normally used for the loading, unloading, and anchoring of ships [26].

In the absence of an internationally agreed definition of ports, national law is left to address their physical delimitation.² For instance, article 2(2)(b) of the Spanish Law on State Ports and the Merchant Navy includes anchoring areas as an integral part of the port [27]. German traffic regulations applicable to inland waterways, internal waters and particular designated areas in the territorial seas also impose some anchoring bans [28].

4. Jurisdiction over anchoring areas or anchorages in coastal waters

This section delves into the jurisdictional framework governing coastal waters where anchoring areas are proliferating, to wit, internal waters and the territorial sea. States have, in their capacity as coastal states, significant jurisdictional capacity to regulate anchoring. Since

¹ United Nations Convention on the Law of the Sea, Montego Bay, 10 December 1982, 1833 UNTS 396; 21 ILM 1261. In force 16 November 1994.

² It should however be noted that in private law, we discuss the geographical, legal, commercial, and administrative aspects of port limits.

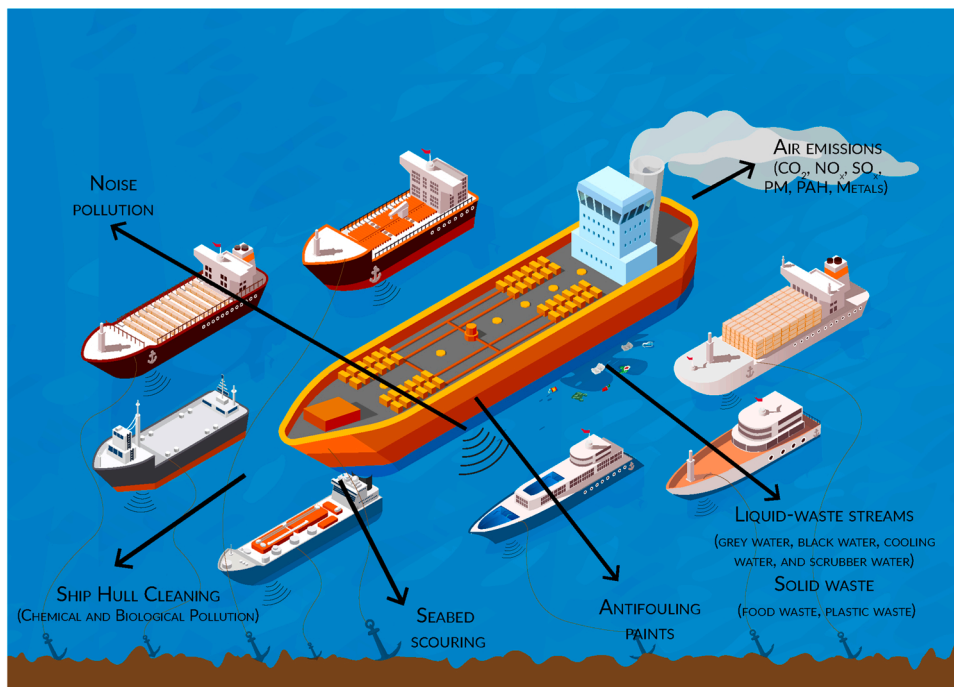


Fig. 1. Environmental pressures and impacts of ships waiting at anchor. The graphic shows a congested anchoring area. The arrows indicate several environmental impacts caused by ships at anchor. The anchors pose a risk to the living and abiotic structures of the seabed. When anchors shift, abrasion and damage to the seafloor may occur. This phenomenon is known as seabed scouring. Invasive species could be introduced through sediments in anchors and chains. Other pressures are associated with ship operations, including emissions to air, discharge of liquid waste streams, chemical pollution from anti-fouling paints, leakage of stern tube oil, biological pollution from ship hulls, and noise pollution.

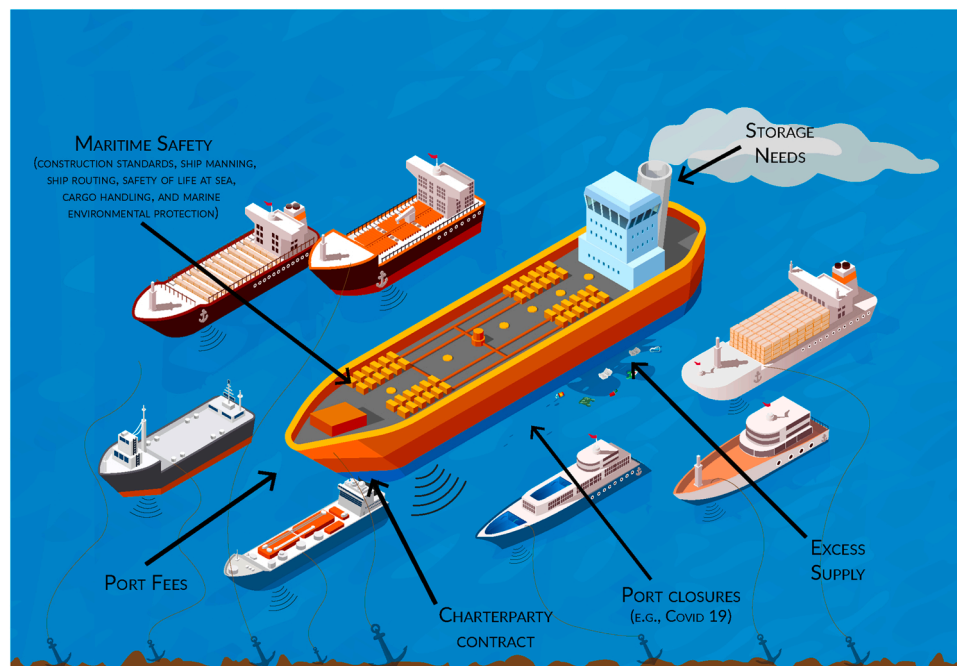


Fig. 2. Reasons why ships lie at anchor. The graphic shows different reasons that incentivize ships for coming to anchor, including storage needs, excess supply, port closures, risk allocation in charterparty contracts, port fees, and coastal state regulations.

anchoring is a *ship operation*, it is incidentally regulated as a maritime safety matter. In broad terms, maritime safety is concerned with the ship (e.g. construction standards) and its operation, i.e. navigation (e.g. safety of life at sea, avoiding collisions), manning, cargo handling, and marine environmental protection [29,30]. However, this regulatory framework does not explicitly address anchoring related environmental pressures and impacts, e.g. scouring or introduction of invasive species through sediments in anchors and chains.

As we further discuss in this section, the location of anchoring areas is fundamental to understanding the legislative and enforcement

jurisdiction states have vis-à-vis the navigational rights of other states and, indirectly, the ships flying their flags.

4.1. Internal waters

UNCLOS provides the jurisdictional basis for regulating activities at sea through its spatial division of the ocean into maritime zones. The basis for measuring maritime zones is baselines [31]. From a legal perspective, baselines define the ‘coastal front’ [31,32] and represent the outer limits of internal waters in accordance with article 8(1) of

UNCLOS. States enjoy full sovereignty over these waters [33] and based on this sovereignty, states may establish particular requirements for accessing internal waters. Such requirements may well include the designation of specific anchoring areas for commercial fleets in general or for particular classes of ships, e.g., tankers and other vessels carrying dangerous substances. In addition, states may establish time limits for ships at anchor or designate no anchoring zones to avoid, for example, anchor scour, minimize ship air emissions and other discharges, and protect submarine cables and pipes. Any such conditions must be duly published and communicated to the International Maritime Organization (IMO) according to article 211 (3) of UNCLOS.

4.2. Territorial sea: anchoring as incidental to ordinary navigation and coastal state jurisdiction

The territorial sea is a maritime zone extending up to twelve nautical miles measured from the baseline. Like internal waters, the territorial sea is also under the coastal state's sovereignty, but as prescribed in article 2(3) of UNCLOS, this sovereignty is subject to the convention and 'other rules of international law.' A significant limitation to the state sovereignty that must be carefully considered in the regulation of ships at anchor is the right of innocent passage [34]. As defined in article 18 (2) of UNCLOS, innocent passage is the 'continuous and expeditious' navigation through the territorial sea that includes stopping and anchoring, in three distinct circumstances: a) if it is incidental to ordinary navigation, b) if it is rendered necessary by *force majeure* or (c) if it is rendered necessary by distress. Under these circumstances, stopping and anchoring are integral components of the right to innocent passage and do not disqualify a passage from being 'innocent'.

A requirement of innocence further qualifies passage in the territorial sea. According to article 19(1) of UNCLOS, such a requirement refers to passage that is not "prejudicial to the peace, good order or security of the coastal state". Innocent passage, as established in Article 18(1), includes lateral and vertical passage [20,35,36]. The former refers to ships traversing the territorial sea "without entering internal waters or calling at a roadstead or port facility outside internal waters," while the latter refers to ships "proceeding to or from internal waters or a call at such roadstead or port facility".

The right of innocent passage does not mean immunity from coastal state jurisdiction. In cases where ships at anchor claim this activity to be within the meaning of their right of innocent passage, coastal states have jurisdictional powers with respect to the exercise of this navigational right provided in Articles 21, 22 and 25 of UNCLOS. Particularly relevant for the regulation of ships at anchor are the measures that coastal states may adopt, according to Article 21(1) of UNCLOS. The bases for such regulation are, for example, maritime traffic regulation, the protection of submarine cables and pipelines, protection of the marine environment, the prevention and control of marine pollution and the conservation of living resources. Thus, coastal states have comprehensive jurisdictional powers to regulate anchoring even if this activity is considered to be included in the meaning of innocent passage. However, innocent passage restricts states' sovereignty significantly since coastal state regulation in practice can neither deny vessels their innocent passage right nor discriminate against ships due to their cargo or flag as prescribed in article 24 (1) of UNCLOS.

Where anchoring is incidental to ordinary navigation, it appears that coastal states cannot impose an absolute prohibition to anchor in the territorial sea, but the regulation and the designation of no anchoring zones are possible. Since there are several reasons for a ship to anchor in the territorial sea, categorizing these reasons as incidental or not to ordinary navigation is controversial. As further explained in this section, we identified two dominant scholarly positions about anchoring. The first one considers anchoring as incidental to navigation in a comprehensive manner, to wit, where it is conducted in connection with the prosecution of the voyage. The second considers anchoring as an exception to the fundamental characteristic of innocent passage, i.e., to

be 'continuous and expeditious' [37]. As an exemption, it becomes relevant to categorize the reasons for a ship to anchor in order to limit the meaning of 'incidental to ordinary navigation'. It is important to notice that anchoring in the territorial sea that does not fulfill the requirements established in article 18(2) of UNCLOS is not unlawful per se [35]. In such a case, as van Hooydonk explains, "the vessel will fall under the full sovereignty of the coastal state" [35].

The first scholarly position defines anchoring as a routine "navigational process involved in operating a vessel of any size" [38,39] and as a day-to-day ship operation, it can be characterized as incidental to ordinary navigation [40]. Thus, this ship operation has been described as a "right incidental to navigation" [41]. While UNCLOS does not define anchoring, it contains references connected with navigational rights. The inclusion of stopping and anchoring as an integral component of the right of innocent passage is nothing new. In the early 1920s, the League of Nations attempted to codify the territorial waters' legal regime and the Rapporteur of the Committee of Experts for the Progressive Codification of International Law prepared a Draft Convention [42]. Article 7 of this Draft Convention established that the "right of passage includes the right of sojourn, in so far as the latter may be necessary for navigation." Sojourn was construed in broad terms, i.e.

in so far as the vessels are sojourning in the foreign territorial sea with the intention of proceeding further: where, for example, a sailing vessel is awaiting favorable weather, or a steamship is unable to continue its voyage pending urgent repairs [42].

Ordinary navigation refers to the vessel's capacity to 'move from one place to another' in the marine environment [41]. It includes an array of technical ship operations, such as all the "activities required to maintain a ship in a safe, seaworthy and operationally reliable condition, meeting all required international and national legislation" [39]. From a broader perspective, navigation includes ship crew, cargo, commercial, and port operations that may require a ship to anchor [43]. Within this view, the definition of anchoring as incidental to ordinary navigation is broad and includes the provision of 'necessaries' to the ship in connection to the prosecution of the voyage. Necessaries is a term defined in maritime law that refers to the authority of the master concerning supplies, provisions, repairs and other items furnished to the ship that are required for the proper service of the vessel [44,45]. According to this view, vessels at anchor in the territorial sea engaged in ship-to-ship interfaces, such as bunkering, stores, and ballast, are within the meaning of incidental to ordinary navigation. While coastal states cannot impose an absolute prohibition to anchor in the territorial sea, so far as it is categorized as 'incidental to ordinary navigation' in the territorial sea, Ankersen et al. argue that *reasonable* local regulation may be permissible. Furthermore, these authors call for "consensus-based efforts to develop managed anchorages and mooring fields may provide the best strategy to reconcile the competing interests of ...users" [41].

The second scholarly position argues that anchoring is incidental to ordinary navigation in limited circumstances. Ringbom considers that anchoring is within the meaning of innocent passage only when ships are port-bound. This means that ships have to be engaged in vertical passage. However, UNCLOS' article 18 (1)(2) does not differentiate between lateral or vertical passage. Ship-to-ship interfaces in the territorial sea, such as bunkering, cargo transfers, stores, and ballast, are

generally excluded from the meaning of anchoring as incidental to ordinary navigation [29,46]. Bunkering has received increasing regulatory attention. In a recent study, Ishii explains that bunkering may occur in any maritime zone and that coastal states, as sovereigns in the territorial sea, have ample authority to regulate it [47].³ An example in point is Section 130 of the United Kingdom (UK) Merchant Shipping Act 1995, which strictly regulates transfers between ships in the territorial sea [48]. At international level, MARPOL, Annex I, Regulation 21(8.2) acknowledges that states, in accordance with their jurisdictional powers, are entitled to deny ship to ship “transfer of heavy grade oil in areas under their jurisdiction” [49]. In 2019, Canada prohibited oil tankers carrying crude oil or persistent oil or any combination of the two to anchor at a port in several locations within the Great Bear Sea [50,51].

Another controversial use of anchoring areas is the phenomenon known as ‘parking’ of tankers. This means that vessels are used as floating storage units and do not intend to enter into a port [52,53]. Vessels may anchor for months waiting e.g. for the oil market to recover. In the 90s, states like Spain and the UK adopted national legislation prohibiting tanker vessels from anchoring for indefinite periods in the territorial sea [46]. From a more restrictive perspective, anchoring in the territorial sea is argued to be an exception and “parking for economic reasons takes the vessels outside the scope of that exception” [53]. Johnson even argues that an anchored vessel waiting for orders is not within the meaning of incidental to ordinary navigation [54].

In many instances, however, anchoring could arguably be categorized as incidental to ordinary navigation. For example, some have pointed out that vessels complying with Vessel Traffic Services (VTS) are within the meaning of article 18(2) of UNCLOS [35], i.e. they are in continuous and expeditious navigation through the territorial sea. As a ship operation, anchoring may be necessary due to technical considerations, e.g. emergency anchoring [23] or “taking on board a pilot to assist with navigation within the territorial sea” [32]; in other circumstances, anchoring could be considered a crew operation, e.g. to manage crew fatigue or a commercial operation, e.g. to reduce running costs while waiting for berth. Ships may also be compelled to anchor when busy ports are incapable of accommodating them [55]. However, there may be several reasons for a ship to anchor, so a case-by-case analysis may be required.

5. Regulatory alternatives available to mitigate the risks posed by ships waiting at anchor

The regulation of anchoring and anchorages is subject to a piecemeal approach. No regulatory framework specifically addresses the environmental pressures of anchoring and the cumulative environmental impacts. Multiple international and national authorities are concerned with implementing and enforcing maritime safety regulations *where anchoring is generally addressed in an incidental manner*. The regulatory focus has been the planning of anchoring areas to avoid port congestion. Special consideration is given to collision regulation, manning [37], and ship source pollution in these areas.

This section discusses three regulatory alternatives that coastal states may use to address the marine environmental impacts of anchoring, to wit, Port State Control (PSC), ship routing mechanisms and vessel traffic services, and area-based regulation. Particularly Sensitive Sea Areas

(PSSA) and marine spatial planning are the most promising area-based tools that could be used to regulate anchoring explicitly. Special areas and emission control areas provided in the 1973/1978 International Convention for the Prevention of Pollution from Ships, as amended (MARPOL),⁴ do not include any other associated protective measure and therefore contribute only incidentally to reducing pollution in anchoring areas that are physically located within the established boundaries of such areas.

5.1. Port State Control

Port State Control (PSC) is a relevant tool to prevent and reduce pollution from vessels lying at anchor. PSC, also known as ‘residual jurisdiction,’ is an enforcement mechanism used by port states to ensure that ships, no matter what flag they fly, comply with internationally agreed shipping standards, adopted, for example, under the auspices of the IMO [26] including those related to the prevention, reduction and control of marine pollution from vessels.

However, in Europe, PSC has a more limited reach. According to the EU directive on Port State Control, international standards subject to PSC (Directive 2009/16/EC, arts 1 and 2)⁵ include, for example, MARPOL and the 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (AFS).⁶ The Directive applies to any ship not only moored at a port but also at anchorage [56]. The definition of anchorage is, however, restrictive. Article 2(7) defines it as a “ship in a port or another area within the jurisdiction of a port, but not at berth, carrying out a ship/port interface.” It appears that ships waiting at anchor which are not interacting with the port are outside the scope of the Directive. PSC may effectively control and exercise corrective jurisdiction when ships do not comply with internationally agreed standards. However, neither Directive 2009/16/EC nor the standards subject to PSC consider cumulative environmental impacts caused by growing and congested anchoring areas [57,58].

5.2. Ship routing mechanisms and vessel traffic services

There is little doubt that sovereignty over the territorial sea allows the coastal state to adopt maritime traffic measures that ships shall observe while exercising their innocent passage right, e.g., sea lanes and traffic separation schemes as established in article 22(1) of UNCLOS. The IMO broadly defines these and other measures as subcategories of ships’ routing [59]. Article 22 (1) should not be interpreted restrictively. Coastal state jurisdiction is by no means limited to the adoption of sea lanes and traffic separation schemes since coastal states have ample legislative powers to regulate maritime traffic in general and protect the marine environment according to articles 21(1) and 211(1) of UNCLOS. So, these states have at their disposal the possibility to implement and enforce various ships’ routing systems [60].

According to Chapter V – Regulation 10(1) of the 1974 International Convention for the Safety of Life at Sea (SOLAS),⁷ “ships’ routing systems contribute to safety of life at sea, safety and efficiency of navigation and/or protection of the marine environment.” (emphasis added) [61–63]. Therefore, protecting the marine environment, including the preservation of seafloor habitats from anchoring scour, is a legal basis for

³ While the authority to regulate bunkering in the territorial sea is well established “whether a coastal state’s law enforcement against a bunkering ship is lawful when the conduct occurs within its EEZ depends on a case-by-case analysis... if bunkering is directly connected with activities subject to coastal state jurisdiction under Article 56(1) of the LOSC, a coastal state’s law enforcement will be justified. In *M/V Virginia G*, ITLOS held that such a connection between fishing and the bunkering of foreign vessels fishing in the EEZ exists, since this enables (fishing vessels) to continue their activities without interruption at sea” [47].

⁴ International Convention for the Prevention of Pollution from Ships as amended by Protocol of 1978 (MARPOL 73/78), London, 17 February 1978, 1340 UNTS 184. In force 2 October 1983.

⁵ Directive 2009/16/EC of the European Parliament and of the Council of 23 April 2009 on Port State Control OJ L131/57 28.05.2009.

⁶ International Convention on the Control of Harmful Anti-Fouling Systems of Ships, London, 5 October 2001, IMO Doc. AFS/CONF/26. In force 17 September 2008.

⁷ International Convention for the Safety of Life at Sea, London, 1 November 1974, 32 UST 47; 1184 UNTS 278. In force 25 May 1980.

regulating ships at anchor. Since ships do not have an indefinite right to anchor, national legislation may well impose time-related limitations on ships at anchor [64].

Ships' routing systems may directly or indirectly impact anchoring. For instance, 'no anchoring' areas and 'areas to be avoided' (ATBA) are measures that coastal states may directly employ to preserve a seafloor habitat from anchor scour. A case in point is the ATBA "in the Atlantic Ocean off the coast of Ghana" [65]. At the same time, traffic separation schemes indirectly affect the location where ships may anchor. Following Regulation 10(g) of the 1972 International Regulations for Preventing Collisions at Sea (COLREGs),⁸ "a vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations."

SOLAS is the most important convention providing the IMO with legal authority to approve mandatory measures beyond the territorial sea. In the territorial sea, the role of the IMO, as prescribed in article 22 (3)(a) of UNCLOS, is recommendatory, but the coastal state must take such recommendations into account. As Harrison explains, "the purpose of this provision is to require the coastal state to consult with affected states through the relevant international organization" [66]. Despite the purely recommendatory role of the IMO, it is beneficial that coastal states adopt ships' routing systems under the auspices of the IMO to ensure their observance and compliance [60].

To contribute to the safety of life at sea, efficiency of navigation, and the protection of the marine environment, Chapter V, regulation 12 of SOLAS allows state parties to establish VTS where the "volume of traffic or the degree of risk justifies such services" [61]. According to this regulation, VTS can be mandatory in the territorial sea, but such regulation should follow the IMO's guidelines [67]. Not without controversy, states have used compulsory VTS to regulate anchoring [35,68]. For example, China, Italy, Spain, the UK, and Sweden have used VTS-areas to regulate and even prohibit anchoring [35,69].

Safety of navigation contributes to the prevention of marine pollution and incidentally reduces the impacts caused by anchor dragging on the seafloor. When a vessel is at anchor, it should be down and holding; otherwise, the ship is considered to be underway [70–73]. COLREGs is the relevant international treaty establishing agreed standards dealing with the prevention of collisions at sea [38]. Its scope of application is comprehensive. According to Regulation 1(a), the treaty applies to "all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels." These rules are subject to variations by national rules relating to harbors, rivers, lakes and inland waterways connected with the high seas. However, the local variations should be negligible because, as prescribed in Regulation 1(b), national legislation "shall conform as closely as possible to these rules." The enforcement of COLREGs at anchoring areas should at least minimize anchor dragging incidents.

5.3. Area-based regulation and anchoring

Anchor scours and marine pollution may increase when a growing commercial fleet is at anchor. As discussed above, coastal states, in their internal waters and territorial sea, enjoy ample jurisdictional powers to protect the marine environment, including the protection, reduction and control of marine ship-source pollution as prescribed in articles 2, 21(1) (f) and 211(3)(4) of UNCLOS. Although UNCLOS preserves the legislative and enforcement jurisdiction of coastal states in internal waters and territorial sea, article 211(1) also requires states to cooperate through the IMO in the development of internationally agreed "rules and standards to prevent, reduce, and control pollution of the marine environment from vessels." To assure a high level of acceptance and compliance,

the adoption of IMO standards should be the preferred regulatory mechanism instead of unilateral regulation [74,75]. As Coelho argues, in the regulation of marine pollution from vessels, the "final goal of states acting unilaterally is often universality, i.e. the creation of a new, widely accepted level playing field" [50].

5.3.1. Special areas and emission control areas

MARPOL's purpose, as established in article 2(2), is to preserve the marine environment from the discharge of harmful substances that have a deleterious effect on human health or the marine environment (including amenities) or that hamper legitimate uses of the sea. The Convention deals with both operational and accidental pollution from ships. Specific rules are found in six annexes dealing respectively with: oil (Annex I); noxious substances carried in bulk (Annex II); harmful substances carried in packaged form (Annex III); sewage (Annex IV); garbage (Annex V); and air pollution (Annex VI).

MARPOL, Annexes I, II, IV and V establish Special Areas, i.e., marine areas determined to be particularly vulnerable, due to their oceanographic, ecological conditions, and vessel traffic characteristics where stricter discharge criteria apply [76]. Special areas cover extensive marine spaces, usually closed or semi-enclosed seas and may encompass several maritime zones. In Special Areas, stricter discharge criteria become applicable only after states bordering the Special Area provide adequate port reception facilities [76]. All ships shall observe these criteria no matter the flag they fly and whether at anchor or underway. MARPOL's Special Areas contribute to reducing pollution in anchoring areas that are physically located within their established boundaries. However, the designation of a Special Area is only concerned with implementing stricter discharge criteria but does not relate to the restriction of navigational rights or traffic-related measures [77].

Concerning air pollution, Annex VI of MARPOL⁹ establishes Emission Control Areas (ECAs). In these areas, more stringent emission criteria apply for sulfide oxide (SOx), nitrogen oxide (NOx), and particulate matter (PM) [49]. The current Special Areas and Emission Control Areas under MARPOL are: (Tables 1, 2).

Apart from implementing stricter emission standards, the designation of ECAs does not include any other associated protective measure. So, these areas become inflexible alternatives to regulate the pollution impacts of ships at anchor, albeit their establishment incidentally reduces air emissions in anchoring areas within ECAs [78].

Table 1
Special areas, MARPOL.

Annex I: Oil	Annex II: Noxious substances carried in bulk	Annex IV: Sewage	Annex V: Garbage
More stringent discharge criteria apply in these areas			
The Baltic Sea, the Black Sea, the Mediterranean Sea, the "Gulfs" area, the Antarctic area, North West European waters, Southern South African waters	The Antarctic area		The Baltic Sea, the Mediterranean Sea, "Gulfs" area, the North Sea, the Antarctic area; and the Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea
More stringent criteria do not apply because adequate reception facilities are still lacking			
the Red Sea, the Gulf of Aden, Oman area of the Arabian Sea		the Baltic Sea	the Black Sea and the Red Sea

⁸ Convention on the International Regulations for Preventing Collisions at Sea, London, 20 October 1972, 1050 UNTS 16, UKTS 77 (1977), 28 UST 3459. In force 15 July 1977.

⁹ From 1 January 2020, the global sulphur limit under MARPOL, Annex VI was reduced from 3.50% to 0.50%.

Table 2
Emission control areas, MARPOL.

Nitrogen Oxides (NOx) Tier III Emission Control Areas (Annex VI, Regulation 13) Not all ships operating within NOx Tier III ECAs must comply with the stricter emission standards. In the North American Emission Control Area and the United States Caribbean Sea Emission Control Area, ships constructed on or after 1 January 2016 are subject to stricter standards when operating in ECAs In the Baltic Sea, Emission Control Area, North Sea Emission Control Area, ships constructed on or after 1 January 2021 are subject to stricter standards when operating in ECAs Sulphur Oxides (SOx), and Particular Matter (PM) Emission Control Areas and Particular Matter (Annex VI, Regulation 14) Within ECAs the Sulphur content (SOx) in the fuel oil used onboard ships must not exceed 0.10% m/m	Baltic Sea Emission Control Area, North Sea Emission Control Area, North American Emission Control Area and the United States Caribbean Sea Emission Control Area [78] Baltic Sea area (SOx), North Sea area (SOx), North American Emission Control Area (SOx and PM) and the United States Caribbean Sea Emission Control Area (SOx and PM) [79]
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5.3.2. Particularly Sensitive Sea Areas

Particularly Sensitive Sea Areas (PSSA) are the most adaptable area-based management measures adopted by the IMO that can specifically regulate anchoring through traffic-associated protective measures. A PSSA is defined as:

An area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities [79].

Based on article 211(5)(6) of UNCLOS, the IMO developed the PSSA concept to comprehensively assess the protection that existing treaties e. g. SOLAS, COLREGs, MARPOL, could provide to a determined sea area to reduce shipping impacts [80,81] including those caused by ships lying at anchor. It is important to note that after the designation of an PSSA, it is the IMO that approves associated protective measures, including, for example, ship routing, no anchoring areas, vessel traffic services, and compulsory pilotage, among others [32]. Currently, there is a mandatory no anchoring area for ships of 300 gross tonnage or over as an associative protective measure for Saba Bank PSSA. The no anchoring area is partially located in the territorial sea and the exclusive economic zone in the North-eastern Caribbean area of the Kingdom of the Netherlands [75,76]. The Florida Keys PSSA also includes three mandatory non-anchoring areas located at the Tortugas Ecological Reserve and the Tortugas Bank [74,77,78]. Before the designation of Florida Keys as a PSSA, the United States of America had national legislation prohibiting anchoring. However, such legislation was largely disregarded by ships [74]. Over the years, coastal states have relied on PSSAs to increase legitimacy and compliance with the regulation of navigational rights, including innocent passage. In the absence of measures adopted under the auspices of the IMO, there is empirical evidence suggesting the constant violation of national traffic maritime legislation [81,82].

5.3.3. Marine spatial planning

In recent decades, marine (or maritime) spatial planning (MSP) has

gained increasing attention and uptake in many parts of the world. The elaboration of marine spatial plans has e.g. been made mandatory for all EU Member states through a directive adopted in 2014 (2014/89/EU).¹⁰ MSP has been characterized as ‘a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process’ [83]. As an instrument for allocating marine space, MSP can aid in the planning and regulation of anchoring by coastal states. It also has potential to strengthen the role of sub-national entities like ports or municipalities that typically play a significant role in MSP-processes [84]. Jajac et al. and Kilić Pamuković et al. [85,86] consider that MSP provides an opportunity to develop anchoring management alternatives that support local authorities to identify, compare, rank and select the most suitable anchoring locations. According to these authors, such a selection should consider the “optimal use of the maritime space”, taking into account the socio-economic incentives as well as the protection of the marine environment [85]. It must be noted, however, that MSP in itself does not entail any new rights or obligations for states or other actors. Any regulatory measures envisioned as part of MSP - such as the designation of mandatory anchoring areas - must still be based on the legal mandates and requirements discussed above.

6. Private law aspects and market elements

As we have seen, there are a multitude of public law obligations, in both international and domestic rules, which establish conditions and requirements for anchoring. In addition to rules set by or concluded between governments, there are private law elements in the form of agreements between private parties in the chain of transport that influence why and for how long ships lie waiting at anchor.

Shipping contracts influence the use of anchoring in different regards. Firstly, these contracts define how voyages are conducted, when the vessel should be present at specific locations and provide sanctions for failure to fulfill these undertakings. Contractual obligations effectively result in substantial standstill periods, in addition to laytime (time used for loading and discharging operations). This may be the effect of excessive time margins as well as rigid timing in contracts, such as undertakings to arrive in the proximity of a harbor at a specific time, whereas the goods are received and offloaded at a subsequent date as well as incentives which provide for a certain speed, resulting in waiting periods at arrival.

Secondly, shipping contracts have increasingly been used to provide not only for the transportation of goods, but also for storage. The legal contractual elements are thereby closely connected to economic aspects; the charter market is part of an open and dynamic freight market. The effective use of shipping as storage implies that different types of vessels, in particular tanker and bulk but also container ships, function as buffers in global trade. Especially in times of market fluctuation or disturbance, the storage element of shipping functions as a means to compensate for excessive output [52]. This is particularly critical in production sectors where it is difficult to adapt to rapid decreases in demand. Consequently, vessels often spend excessive time periods waiting for orders. This waiting is regularly spent lying at anchor.

6.1. Anchoring as a consequence of risk allocation in shipping contracts

Shipping is commonly based on contractual relationships called charterparty, whereby parties who would like to transport goods enter into agreements with carriers who will transport the goods.

The charterparty divides powers, responsibilities, liabilities, risks

¹⁰ Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning, OJ L 257/135, 28.8.2014.

and costs between the parties. What type of agreement is applied impacts the behavior of the ship in different ways.

Waiting at anchor is often the result of obligations in the charterparty and the rigid indications of timing of central operations, which shifts the risk of delay between ship-owner and charterer. Shipping involves numerous factors which may result in delay. These risks, in combination with the potential for sanctions (including damages, demurrage and termination) provided by charterparties, incentivize the parties to include margins in the time planning of different operations. When different delaying factors do not materialize, the excess time is regularly spent at anchor. The likelihood of ships waiting at anchor thus depends on risk allocation for delaying factors, which differs between different charterparties. There are two basic and central forms of charterparties – *voyage charterparties* (hereafter “voyage charter”) and *time charterparties* (hereafter “time charter”).¹¹ In these charterparties, an approach voyage is commonly required prior to the actual start of the charter.¹² As a general rule, common law requires the ship-owner to proceed with reasonable dispatch. A breach of this obligation entitles the charterer to claim damages. The general rule is that the ship-owner bears the risk of such delay unless covered by an exception clause¹³ [87]. The ship-owner thus has reason to arrive early and anchor outside the agreed port, rather than risking damages. After this first stage, incentives for waiting at anchor differ between voyage and time charterparties.

In a voyage charter, the ship-owner remains in control of the ship and undertakes with the charterer to load a specified cargo at a specific loading port for the purpose of transporting and discharging it at a designated discharging port (port charter) or berth (berth charter) [87, 88]. The charterer reimburses the ship-owner with the payment of freight. The freight may be paid in a lump sum or calculated in relation to the quantity of cargo – all depending on what is agreed between the parties [89]. In any event, the ship-owner undertakes to arrive at the port of destination by a certain time and price. In standard forms for voyage charter, the parties commonly agree on a laycan-period, ranging between two dates. The charterer is not obliged to commence loading until the first of these dates (the start of the laytime) if the ship arrives earlier and may have the option of canceling the charter if the ship arrives after the second of the dates (the canceling date).¹⁴ This construct provides incentives for waiting at anchor in several ways.

Most importantly, since delay may result in damages and canceling of the charterparty, the ship-owner has incentives to arrive early rather than risking the termination of the charterparty [88,90–93]. This is in line with a general common law principle which provides that the ship-owner shall proceed with utmost dispatch [88].¹⁵ Even if it would be more fuel- and cost-efficient to reduce speed, contractual and market incentives thus make it difficult to realize these benefits. The charterer, on the other hand, has no obligation to assume responsibility before the start of the laytime. The excess resulting from the formulation of the laycan is regularly spent waiting at anchor. Further incentive for waiting at anchor is provided by charterparty definition of *arrival*, since the risk does not shift from the ship-owner to the charterer until a valid notice of readiness (NOR) has been tendered, implying that the ship has arrived at the contractual place of delivery, loading or discharging.

In port charters, if nothing else is agreed upon, ships are considered

to have arrived in a contractual sense when they have reached the anchoring areas in the vicinity of ports, provided that the area under local law is considered to be within the port. This builds on case law, which has established that the port includes places where waiting vessels customarily lie, provided it is within the port limits.¹⁶ The contractual understanding of arrival thus implicitly builds on domestic public law definitions of port limits, which varies across cases. Often so-called “when in port”-clauses explicitly include anchoring areas as a valid arrival [94]. Arriving at the anchoring area, rather than the actual port is thus decisive for fulfilling the contract. Risk-aversion thus calls for sailing at full steam to this area and spending excess time at anchor rather than mooring at berth.

In berth charters, on the other hand, ships can only validly tender the NOR when the vessel has berthed. Although this may appear to promote actual berthing rather than waiting at anchor, it often results in the contrary. This is because the risk for delays or congestion in the port remains with the ship-owner until a berth has become available [88]. Since major ports apply the first-come, first-served principle, berth charters provide an incentive for arriving at destination as early as possible to prevent damages for delay, and spending excess time at anchor [95,96].

Insufficient port capacity generally amplifies waiting time at anchor for port and berth charter alike. This has also been supported by empirical studies, where the awaiting of free berth was identified as the reason for anchoring for a broad majority of ships [93,97]. A queue arranged on the basis of when the ships left the previous port with a standardized adjustment for sailing time (“standardized ETA”) has been proposed as a solution to the problem. It has been claimed that such a queuing system would eliminate the incentives to race to the port and consequently reduce anchoring [96]. Implementing the proposal would involve difficulties. In particular, the necessary standardization presupposes predictable voyage times. Still, it ought to be considered and tested.

Voyage charter clauses also result in waiting time at anchor as the result of how laytime is agreed. Charterers who fail to complete loading or discharging operations before the end of the pre-agreed laytime are at risk of being charged with demurrage. Although this may appear to incentivize expedient port procedures, it risks resulting in the contrary. In order to reduce the risk of demurrage, the charterer may reserve excessive time margins for loading and discharging. Early completion of these procedures could increase ship-owner revenues by enabling more contracts in times of excess demand [98]. However, excess laytime can hardly be predicted and is therefore regularly spent at anchor in the vicinity of ports [88].

Consequently, in voyage charter, anchoring can at least partly be explained by risk-aversion of both parties. Even if economic and logistic arguments would call for more efficient voyage planning, the economic risks connected to potential damages for delays result in time spent waiting at anchor.

In time charters, many of these elements are missing. This is because the ship-owner hires the ship to the charterer for a specific, and often extensive-time period. Rather than for a specific voyage, the charterer

¹¹ Demise charterparties, which effectively is a lease, represents a third type of charterparty.

¹² The approach voyage is regarded to be “the first stage” of the contracted voyage under a charterparty. See [87], p. 63.

¹³ Excepted perils will only be available after the vessel has started the “approach voyage”. *Louis Dreyfus v Parnasso* [1938] 60 Ll. Rep. 94.

¹⁴ See Clause 9 of the GENCON and the equivalent clause 5 of the ASBA-TANKVOY charterparties.

¹⁵ Most voyage charterparties, contain an express term that the vessel shall perform her service with utmost despatch. See for instance SHELLVOY 6. The term due despatch is also commonly used.

¹⁶ See foremost the so-called Reid test established by Lord Reid in *Johanna Oldendorff* [1973] 2 Lloyd’s Rep 285. According to the test, a vessel is considered as arrived at the port when it is at such a place within the port that she is at ‘the immediate and effective disposition of the charterers’ in the sense that it can reach the berth quickly when informed that one is vacant. In the case, *Johanna Oldendorff* was held to be an arrived ship since it was at anchorage waiting outside the port of Liverpool. Case law was further developed in the *Maratha Envoy* [1977] 2 Lloyd’s Rep 301, where a ship was considered not to have arrived at the port when it was at anchor at a site outside the port limits, since it was considered beyond the immediate vicinity of the berth. Some charterparty forms contain provisions to avoid the effects of the *Maratha Envoy* by providing that a notice of readiness can be given once the vessel has arrived at the customary anchorage if she cannot berth immediately.

regularly pays hire at pro-rata on a day-to-day basis. Whereas a voyage charter is a contract of services, time charter is thus a hire of the ship itself [88]. In time charters, the ship is not bound on beforehand for a specific route or for the carriage of a specified piece of cargo. Instead, this will be directed by means of voyage orders from the charterer to the ship-owner [99]. This transfer of control from the ship-owner to the charterer effectively includes the risk of delay. In longer time charterer contracts in particular, the risk of damages due to delay is small compared to voyage charters [98,100]. Consequently, there is less incentive for arriving before agreed dates and spending excessive periods at anchor. Instead, voyages can be optimized and anchoring areas less used. However, paradoxically, the critical resource represented by the vessel as a means of transport and the relatively limited cost of the charter contract in light of the full value-chain may result in excessive time-charter periods. Conventional “better safe than sorry”-reasoning may thus result in excess margins where the ship-owner is not given any instructions. Moreover, the first-come, first-served principle used in ports provides incentives to race to the port also in time charter. The proposed queue system arranged on the basis of when the ships left the previous port with a standardized adjustment for sailing time could promote slow steaming and decrease waiting time at anchor also in time charter [96].

There are thus incentives in voyage as well as time charterparties that work against optimizing shipping and contribute to waiting at anchor. In addition to the incentives for anchoring represented by the nature and function of voyage and time charter contracts, more specific standard clauses in such contracts contribute to waiting time at anchor in shipping. It is standard practice in time charter contracts that the vessel shall “trade between safe ports, berths or places where she can lie always safely afloat”.¹⁷ Depending on the contract a port, berth and place can be considered safe at all times, only at certain times or safe in relation to the particular ship [101].¹⁸ The requirement to nominate safe places can be coupled with provisions on so called “trading limits,” which effectively impose contractual limitations on how the charterer may direct the ship [101]. Moreover, insurance provisions effectively prevent ships from being used in certain areas, weather conditions or seasons [102]. Such provisions may often be motivated based on safety concerns, but in effect, they render shipping less efficient and contribute to extensive periods of standstill, regularly spent in anchoring areas.

6.2. Anchoring as a market fluctuation buffer

As seen above, waiting time at anchor can partly be explained as a natural consequence of risk aversion in charterparties and gaps between charter contracts, but also as a side-effect of rules in public and private law which extend such periods. There are, however, also cases where waiting at anchor is explicitly intended, based on deliberate commercial motives. In some shipping trades, most importantly in crude oil transportation by tankers but also in carriage of bulk cargo, ships are used not only for transporting but also for storing commodities at anchor.

In transportation of oil by tankers, the cost of the charter is limited compared to the value of the cargo. Especially in times of particularly fluctuating market prices, this leads charterers to use tankers as a buffer to await price recovery [52,99]. Since it takes time to reduce oil production capacity, storage in tankers also compensates for excess supply in times of decreased demand, which has been an increasing challenge in recent years [99]. As a result, waiting at anchor is extensively used in the global oil trade as well as in other commodity supply chains [52]. Particularly at times of economic or political turbulence, such as during the Covid-19 pandemic, large parts of the global tanker fleet are at standstill. A previous study suggests that positive oil supply shocks favor longer storage horizons compared to situations of negative oil demand

shocks [52]. In the offshore oil and gas industry in particular, anchored ships are also regularly used in production and processing as well as storage before offloading onto tankers and pipelines. The use of anchoring as floating storage is also reflected in private law. In the tanker standard contract BPTIME3 there is an express provision that gives the charterer the right to employ the vessel for floating storage purposes.¹⁹ As regards time charters that do not have a special storage provision it is less clear how to deal with a charterer's choice to employ the ship for floating storage use. Effectively, lack of instructions once a ship has been loaded implies use as storage²⁰ [103].

Moreover, floating storage and speculation in future prices involve risks of miscalculations and difficulties to offset the cargo. It is therefore recommended by BIMCO that the rate of hire for additional days or optional periods is negotiated upfront. The risk of such extensions of charters necessitates margins between charter contracts, resulting in further waiting at anchor [52].

7. Conclusion

From our analysis, it can be concluded that coastal states as well as the parties in shipping contracts are important actors when it comes to regulating anchoring so as to prevent or minimize environmental harm. Coastal states have significant jurisdictional powers to do so although some limitations may follow from the right of innocent passage. The choice of charter arrangements and contract clauses used by private actors significantly influence waiting time at anchor. Moreover, for effective and efficient regulatory action to be possible, there is a need for much improved scientific knowledge, both of the pressures and impacts caused by ships lying at anchor generally and of the vulnerabilities of specific areas or ecosystem types. An increased understanding of the extent of pressures and impacts caused by ships lying at anchor must not be limited to ecologically vulnerable sea areas but include all areas regularly used for anchoring. Since many such areas are becoming ‘congested’, they may suffer quite significant impacts even in the absence of features that would make them particularly sensitive. In such areas, stricter ship discharge criteria may be required.

From a legal perspective, a significant deficiency is that international regulatory structures tend to be rather fragmented and lack clear obligations or mechanisms for considering the cumulative impacts of anchoring. The cumulative dimension may relate both to the total effects over time of many ships anchoring in an area as well as to the various ways in which ships at anchor may exert pressure on the environment.

While the international regulatory competencies of states in relation to anchoring are relatively clear, the potential role of private law measures, such as the development of contract clauses is much less explored in the legal literature. Here we can see that voyage charter contracts in particular tend to create incentives for ships to arrive early at their destination even when that necessitates spending time at anchor. The understanding of ‘arrival’ under common law also seems to contribute to the practice of spending time at anchor. There is a clear need for exploring how contractual arrangements can be promoted that reduce incentives for anchoring when not necessary for practical purposes. Charterparties which promote slower speed instead of early arrivals would reduce environmental pressures on anchoring areas. It also appears that it would involve a more efficient use of ships and lower fuel

¹⁹ See clause 21.

²⁰ BIMCO highlights certain aspects relating to storage in shipping contracts: “Like most tanker storage clauses, the provision largely relies on other clauses in the time charter to govern the consequences, responsibilities and liabilities of the ship being used for floating storage. However, most storage clauses were not written with long term storage in mind, and the implications for owners could therefore be far reaching. In the present scenario we may be looking at potentially very long periods during which ships will be used to store oil when anchored or drifting.”.

¹⁷ See for example INTERTANKTIME80 clause 5.

¹⁸ See for example SHELLTIME4 clause 4.

consumption, reducing costs and decreasing the climate impact. A better understanding of the interests of different stakeholders and how these may be accommodated without incentivizing extensive anchoring needs further exploration. In particular, the proposal to replace the first-come, first-served principle used in ports by queue system arranged on the basis of when the ships left the previous port with a standardized adjustment for sailing time should be considered.

Also with respect to public regulatory measures, extensive legal mapping of maritime safety and marine environmental regulation that incidentally applies to ships while laying at anchor is much needed. This would enable better coordination and effective application of existing legal frameworks. It would also help identify potential regulatory gaps, including ones relating to anchor scour or the introduction of invasive species through sediments in anchors and chains. While this need is present at international level it is particularly pronounced in regional and national contexts where additional levels of law come into play. That is also where the practical application of the legal rules to actual anchoring activities happens, and hence where additional regulatory and practical challenges are likely to become visible.

Funding

This project was in part funded by University of Gothenburg and Chalmers University of Technology, Area of Advance Transport, project Ships at anchor wait.

CRediT authorship contribution statement

Gabriela Argüello and Niels Krabbe: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **David Langlet:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Project administration. **Ida-Maja Hassellöv:** Conceptualization, Writing – review & editing. **Claes Martinson:** Writing – review & editing. **Astrid Helmstad:** Resources, Writing – review & editing.

Competing interest

The authors declare they do not have competing interests.

Acknowledgements

The authors are grateful to Professor emeritus Lars-Göran Malmberg, Professor emeritus Kjell Larsson and Associate Professor Abhinayan Basu Bal for their comments and suggestions on earlier drafts of this article. Any mistake or inaccuracy is the responsibility of the authors.

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