The International Convention for the Prevention of Pollution from Ships (MARPOL 1973/1978) has proven to be an effective instrument for improving the problem of global ocean pollution from ships. One state alone would not be able to improve the health of the world's oceans because pollution from other states' ships would continue to exacerbate the problem. Thus, ocean pollution from ships is a collective action problem. The presence of a treaty, MARPOL, helps to ensure global collective action, incentivizing all member states of the treaty to incur the costs of addressing the problem at hand. MARPOL's ability to help overcome this collective action problem can be seen by examining two broad components of the treaty. The first of which is how the treaty lays out its obligations, specifically what part of the problem of pollution from ships it centers. The second component is its ability to expand in membership and focus to address even more issues than its original concern. This analysis will begin with background information about the treaty itself and the issue of pollution from ships. Then, it will explore each of the two main components of MARPOL that contribute to its effectiveness at addressing the problem of global ocean pollution from ships.

II. A Crash Course on MARPOL 73/78

MARPOL seeks to address the problem of ocean pollution. The treaty is a combination of the 1973 Convention and its 1978 Protocol; the former ended up being absorbed by the latter to yield the final, combined instrument that entered into force on October 2, 1983.\(^1\) The requirements for entry into force were that at least fifteen states that represent at least 50% of the

gross tonnage of the world's merchant ships had signed and ratified the treaty.\(^2\) This is to ensure that member states would only be bound by the treaty and need to take action if enough other states were also taking action, thus having enough actors to yield improvements in the condition of ocean pollution.

Specifically, the treaty takes up the goal to eliminate and mitigate pollution from oil and other harmful materials that are discharged by ships.\(^3\) This treaty covers discharge that is accidental, intentional, or even unknown by the polluters.\(^4\) MARPOL sets up a method by which member states craft annexes that create regulations for the prevention of various types of pollution. Annexes may be created at any point in time\(^5\) to continue to most effectively align the treaty's obligations with new scientific knowledge and evolving ocean pollution concerns. At the time of ratification of the 1973/1978 Convention and Protocol, two such annexes were a part of the treaty and thus are required for all member states to adopt. Annex I pertains to oil pollution,\(^6\) while Annex II focuses on pollution from Noxious Liquid Substances (NLS) carried in bulk.\(^7\) Four additional annexes have since been created, which are optional for member states to ratify.\(^8\) These annexes provide regulation for the prevention of pollution from harmful substances carried at sea in packaged form, sewage, garbage from ships, and air pollution from ships.\(^9\)

Ocean pollution from ships sources was a consequential problem at the time of this treaty's creation. In the late 1960s and early 1970s when MARPOL was being negotiated, the cargo tanks on ships that were used to carry oil also carried ballast water. When ballast water was emptied into the ocean, oily residues were released along with the ballast water. This was not accidental oil pollution, rather the result of at-the-time operational industry standards. Thus, MARPOL specifically had the goal of eliminating *operational* oil pollution. Other ocean-related environmental concerns at the time stemmed from highly visible oil spill disasters such as the

\(^2\) International Convention for the Prevention of Pollution from ships (MARPOL), 1973/78, Article 15(1); Cited hereafter by Article.
\(^3\) International Convention for the Prevention of Pollution from ships (MARPOL), 1973/78, Preamble.; Cited hereafter by Article.
\(^4\) MARPOL, 1973/78, Preamble.
\(^5\) Article 16(1).
\(^6\) MARPOL, 1973/78, Annex I; hereafter referred to as "Annex I."
\(^7\) MARPOL 1973/78, Annex II; hereafter referred to as "Annex II."
\(^8\) Article 14(1).
\(^9\) MARPOL 1973/78, Annexes III-VI.
For these reasons, oil pollution was the original central focus of MARPOL's regulatory attempts.

The International Maritime Organization (IMO) serves as the secretariat for MARPOL. The IMO oversees this treaty and has led negotiations for other agreements to improve the health of the oceans, but there are a number of criticisms of the organization. Compared to other secretariats for international agreements, the IMO tends to be less transparent with relevant data for the conventions it oversees. It's difficult to find centralized data on whether or not member states are meeting MARPOL's obligations. The IMO also does not analyze MARPOL enforcement reports provided by member states in an effective way. Because of the IMO's failure to regularly synthesize and report on enforcement data, the IMO has not made it clear to member states that reporting information is necessary to foster the effectiveness of the treaty, thus failing to incentivize states to follow MARPOL's formal reporting duties.

III. The Effective Creation of Obligations: Centering the Root Cause of Oil Pollution

The first lens through which to consider MARPOL's effectiveness is looking at how its obligations are structured. One of the biggest strengths of MARPOL is that, for the first time in the history of oil pollution regulation, it utilizes both discharge and equipment standards. The use of equipment standards in particular has contributed to MARPOL's success. By centering obligations around the root cause of oil pollution rather than mitigation alone, the treaty compels actors to eliminate pollution from its source.

MARPOL replaced the 1954 International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL). While concerns about oil pollution had plagued the international agenda since the 1920s, OILPOL was the first successful convention to be drafted, signed, ratified, and entered into force that centered on preventing oil pollution at sea. Past oil regimes like OILPOL focused exclusively on the prohibition of discharges above certain limits within certain zones. But, the 1954 agreement showed in its lack of upfront, preventative commitments

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13 Mitchell, *Intentional Oil Pollution at Sea*, 81.
14 Mitchell, 82.
that many states did not yet prioritize the environmental concerns relating to oil pollution and that "most governments were still not willing to accept any important control costs themselves or even to impose such costs on their industries." The enforcement system of OILPOL was widely unobservable and could only be enforced in ports. Discharge standards set out by OILPOL were not enough to improve the problem of ocean pollution.

MARPOL still includes discharge standards that ended up looking almost identical to those of the 1969 amendments to OILPOL. Because of their similarity to the existing discharge standards, these proposals were agreed upon with little contention from parties. But, negotiators of MARPOL learned from the weakness of its predecessor. MARPOL also employs equipment and construction standards. Equipment standards were negotiated so that ships of member states would be able to meet the discharge standards, but they posed a dramatic price increase compared to at-the-time equipment standards.

Deciding these equipment standards proved to be the hardest part of negotiations for the treaty. The final negotiation came down to two main packages. The first consisted of a proposal for segregated ballast tanks (SBTs)—so ships' ballast water never came into contact with the oil it was transporting—for all new and existing tankers over 20,000 tons. The second capitalized on the new technology of crude-oil-washing (COWs). The second package proposed COWs for all crude oil carriers over 70,000 tons, a solution that was estimated to remove 80 to 90 percent of oil residues from within oil tanks. COWs had a lower capital and operational cost than SBTs. A compromise between the two packages was reached: tankers built pre-MARPOL would need to be retrofitted with the COW system, tankers built between 1978 and 1980 could pick either SBTs or COW, and all tankers built after 1980 would need to have SBTs. A 1992 amendment now also requires that all tankers built after 1993 have double hulls. If something were to happen to the container in which oil was being transported, a double hull provides added protection to keep leaking oil from flowing into the sea.

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15 M’Gonigle and Zacher, 89.
16 M’Gonigle and Zacher, Pollution, Politics, and International Law, 107.
17 M’Gonigle and Zacher, 113.
18 M’Gonigle and Zacher, 108.
19 M’Gonigle and Zacher, 131.
20 Mitchell, Intentional Oil Pollution at Sea, 101.
MARPOL played a key role in getting actors to adopt these equipment standards. Data before 1976 strongly indicates that SBTs were almost never installed before MARPOL required them.\textsuperscript{22} Then, there was a spike in the number of tankers constructed with SBT right after MARPOL took effect, with numbers jumping from 8 percent to 27 percent by 1981.\textsuperscript{23} While 27 percent may not seem like a large percentage, only tankers built after 1980 required SBTs, so the tankers built between 1978 and 1980 would not have been required to install SBTs. Ninety-eight percent of tankers that required SBTs after 1980 had installed them, suggesting a massive shift in the amount of SBT installations being completed.\textsuperscript{24} Important to reiterate is the high cost, yet complete lack of economic benefits of installing SBTs.\textsuperscript{25} In total, SBTs increased a tanker's operating costs by almost $1,600 per voyage at oil prices from 1976.\textsuperscript{26} With no external economic driver, it seems unlikely that there is another influence causing this shift in behavior. Thus, the increase in installation of SBTs can be strongly attributed to MARPOL and its equipment standard obligations. Regular inspections being a part of the treaty helped to ensure compliance. This helped to explain why oil companies installed SBTs only after MARPOL took effect, despite always having the option to do so.\textsuperscript{27} As representatives at Shell and Lloyd's—a multinational oil and gas company—put it in 1990: "If there were not a regulatory requirement, there would not be SBT."\textsuperscript{28}

The other main equipment standard was COW. Despite its clear economic benefits, scholars do note that it seems unlikely that tanker owners would have installed COW so quickly and on such a wide scale in such a condensed time period.\textsuperscript{29} Ninety percent of old tankers and 99 percent of new tankers had installed COW by the 1990s\textsuperscript{30}—extraordinary percentages to come about without any further incentive—suggesting that requirements set out by MARPOL played a partial role in getting oil companies to have COW installed on their tankers.

There are a number of reasons that these equipment standards have proven more effective than discharge standards alone. One reason is that it's easier to check that ships are in compliance with the standards right when they are built. Constantly tracking discharge as the only method of

\textsuperscript{22} Mitchell, 269.
\textsuperscript{23} Mitchell, \textit{Intentional Oil Pollution at Sea}, 269.
\textsuperscript{24} Mitchell, 270.
\textsuperscript{25} Mitchell, 299.
\textsuperscript{26} Mitchell, \textit{Institutions for the Earth}, 234.
\textsuperscript{27} Mitchell, \textit{Intentional Oil Pollution at Sea}, 306.
\textsuperscript{28} Mitchell, 276.
\textsuperscript{29} Mitchell, \textit{Institutions for the Earth}, 233.
\textsuperscript{30} Mitchell, \textit{Intentional Oil Pollution at Sea}, 276.
pollution reduction proves difficult; the ocean is large and there are many ships. Monitoring in this way alone cannot often be completed with the lack of resources available. Another reason is that once certain equipment is installed, certain types of operational oil pollution simply won't occur. If an oil tanker has segregated ballast tanks (SBTs), ballast water will not mix with oily residues and be expelled into the ocean through shipping operations. Between 1981 and 1997, operational oil discharges to the ocean decreased from 1.49 million tons to 0.47 tons, showing how immediate an effect MARPOL's equipment standards had on improving the condition of intentional oil pollution at sea. Because MARPOL utilized these equipment standards along with existing discharge standards, it has proven to be an effective instrument at mitigating and eliminating a part of the ocean pollution problem it was designed to address.

For all the accolades these equipment standards have garnered, there are still weaknesses in the way some of MARPOL's other obligations were created.

Port reception facilities are an important part of pollution management, but remain severely underprovided as a result of MARPOL's structure. The convention requires states to "undertake to ensure the provision" of port reception facilities. Due to the vagueness of this statement, states claim that building reception facilities is not legally binding, arguing that as long as someone else provides reception facilities, that specific obligation is met. States remain deterred from building reception facilities because of their high upfront costs. In particular, developing countries are not given funds to build these facilities. Most do not provide any port reception facilities at their ports. In 2019, data from the World Port Index shows that, of the 3,630 ports in the dataset, just 47% have an oil receptor facility and only 25% have the proper capabilities to deal with dirty ballast water. MARPOL has not effectively created an incentive structure for states to provide the necessary port reception facilities to process the pollution types the treaty regulates.

Actors can also still choose to pollute if they so desire. As of 2019, there is still a 2.5% oily waste delivery gap, meaning that 2.5% of oily wastes remain unaccounted for between ships'
records and the records of port facilities. Ships from Norway, the Bahamas, and Liberia are just three examples of ships that have been found in violation of MARPOL and sentenced to fines between 2015-2019. A popular form of non-compliance is "magic pipe" violations where oil tanker workers pump oily wastes from oil storage tanks out to sea through a detachable pipe. Radar satellite imagery can now spot slicks of leaked oil bilge in the ocean. When paired with Automatic Identification System (AIS) data, oil bilge can often be linked to a particular ship. Actors still can decide to pollute, but that choice must be deliberate—and is getting easier to detect.

Data from the Paris and Tokyo regional Memorandum of Understandings (MOUs) on Port State Control show wide scale trends of MARPOL-related violations from the late 1990s to present:

![Paris MOU Data on MARPOL Violations 1997-2020](image)

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41 While this dataset includes violations for all annexes, Annexes II-VI will be discussed in-depth in the following section of this analysis.
For both Paris and Tokyo data, the number of ships found with MARPOL violations for all annexes has decreased overall. Actors still can pollute, but the amount who choose to do so is decreasing. For the European Union and the Paris MOU, the amount of total inspections and the percentage of those being MARPOL deficiencies has been almost constant every year since 2015. Of the 2,400 annual inspections, around 20% are MARPOL deficiencies; 63% relate to certificates and documents, while only 37% are deficiencies of pollution prevention standards. Annex I violations remain the most common type of MARPOL violation for both regional MOUs. But with better technology to detect non-compliance, there seems to be less incentive to violate MARPOL's regulations.

IV. Expanding Effectiveness: Inclusivity, Flexibility, and the Diversification of MARPOL's Regulatory Goals

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The second perspective through which to consider MARPOL's effectiveness is looking at inclusivity, flexibility, and its expansion over time. These are all characteristics of MARPOL that have allowed it to be an effective tool to mitigate and eliminate various types of pollution from ships.

For the treaty to effectively combat ocean pollution, it had to be ratified by as many states as possible that account for as much of the world's shipping tonnage as possible. If one state that accounted for a large percentage of shipping activity was still contributing to the problem of ocean pollution, the condition of the ocean would continue to deteriorate. As of May 2022, 160 states are bound by MARPOL and the combined merchant fleets of these states account for 99.01% of the gross tonnage of the world's merchant fleet.\textsuperscript{45} Not only have the majority of states ratified the convention, but these states account for almost all of the world's shipping tonnage. This goes back to the collective action problem framework of ocean pollution. With high rates of participation in the treaty, there is more collective action mitigating the problem of pollution from ships. If everyone is acting in a way that they should according to MARPOL's obligations, more good will come out of these actions that will benefit everyone.

Another strength of MARPOL is how it has evolved and expanded to cover other types of pollution. MARPOL's original focus was eliminating operational oil pollution with the larger goal of improving the overall state of the oceans. Because the treaty has been able to expand in scope to regulate these other types of pollution, it has become more effective at addressing the larger goal of the health of global oceans, no longer focusing on just oil pollution. MARPOL's primary substantive obligations exist in its annexes, which can be created and amended even after the treaty has been ratified. Annexes I and II have always been a part of the treaty. Annex I regulates oil pollution and Annex II outlines requirements for member states' ships to prevent pollution from Noxious Liquid Substances (NLS). Since the treaty's entry into force, there have been four additional annexes negotiated. Each of these later four annexes regulate a different form of pollution and is optional for any state to ratify.

<table>
<thead>
<tr>
<th>Annex Number</th>
<th>What It Regulates</th>
<th>Number of States That Have Ratified</th>
<th>Percentage of Gross Tonnage of World's Merchant Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annex III</td>
<td>Harmful substances in packaged form</td>
<td>150</td>
<td>98.49%</td>
</tr>
<tr>
<td>Annex IV</td>
<td>Sewage</td>
<td>146</td>
<td>96.33%</td>
</tr>
<tr>
<td>Annex V</td>
<td>Garbage (including plastics)</td>
<td>155</td>
<td>98.64%</td>
</tr>
<tr>
<td>Annex VI</td>
<td>Air pollution (SO₂, NOₓ, particulate matter, ozone-depleting substances)</td>
<td>101</td>
<td>96.75%</td>
</tr>
</tbody>
</table>

**Figure 2.** Table depicting the optional annexes of MARPOL 73/78 specifying what each annex regulates, how many states have ratified each annex, and what percentage of the world's shipping tonnage is accounted for within the signatory states of each annex.⁴⁶

MARPOL now includes the regulation of many forms of ocean pollution other than oil pollution. The decision to make these additional annexes optional serves to incentivize more states to ratify the convention than otherwise would. Letting states pick and choose which of these further regulations to which they will be subject allows states that may be hesitant about controlling only one pollution type to still have other pollution types be regulated. This decision doesn't seem to have had a large impact on the percentage of the world's shipping tonnage being regulated. Annexes III–VI are all optional, yet over 95% of the world's shipping tonnage is being regulated by all four optional annexes, indicating that the majority of actors are being regulated with respect to all of these pollution streams despite having the option to opt out.

One difficulty in determining the effectiveness of the treaty is that all of these pollution types are also emitted from land-based sources as well as ships. Once a piece of plastic enters the ocean from either a ship or from somewhere on land, it's difficult to trace the origin of that

particular piece of plastic. The same goes for air pollution; no matter the source, SO\textsubscript{x}, NO\textsubscript{x}, and particulate matter pollution all end up in the atmosphere. The only viable way to know the source of the pollution is to rely on the reporting of ships themselves. The possibility of misreporting information either intentionally or accidentally remains high, making it hard to evaluate MARPOL's effectiveness on changing the behavior of ships in particular.

That being said, there are some data and reports that indicate the degree to which MARPOL has improved the condition of the sea with respect to these other forms of pollution. Annex II, one of the two required annexes, regulates noxious liquid substances (NLS) and does so in a similar way to Annex I by using equipment standards. Chemical tankers are built with tank stripping equipment that reduces the amount of NLS in cargo residue, which in turn then reduces the amount of NLS in those residues that get discharged either at sea or in port.\textsuperscript{47} The equipment reduces NLS discharge to a "very low level,"\textsuperscript{48} showing that MARPOL's Annex II equipment standards have been effective at minimizing the amount of NLS discharge.

Data on the other annexes does not provide as clear a success story. In 2021 there remained a 10% waste delivery gap for sewage, which is approximately 136,000 cubic meters per year of sewage that remains unaccounted for.\textsuperscript{49} Compared to other types of pollution, this waste gap is not as large. But with minimal available data on the amount of sewage discharge pre-MARPOL or even in less recent past years, it's difficult to say how effective MARPOL has been at getting states to reduce sewage pollution at sea.

Garbage has been a growing problem in the world's oceans. For 2010, the exact amount of plastic in the ocean is still difficult to determine, but there is estimated to be anywhere between 10,000 to 100,000 tons of plastic waste in the world's oceans.\textsuperscript{50} It's also estimated that 20% of litter in the oceans comes from ships.\textsuperscript{51} Annex V notably includes a ban on disposal of any type of plastic at sea,\textsuperscript{52} but according to the 2018 Impact Assessment conducted by the

\begin{footnotesize}
\begin{itemize}
  \item[48] GESAMP, 26.
  \item[49] GESAMP Working Group 43, “Sea-Based Sources of Marine Litter,” 40.
\end{itemize}
\end{footnotesize}
European Commission for a Directive on Port Reception Facilities, there are "no indicators that the amount of garbage from ships has decreased in recent years." For garbage, there remains a waste delivery gap of anywhere between 7% to 35%, which equates to 60,000-300,000 tons of garbage. This data is for European ports and does not encompass the rest of the world's shipping fleet, but having no indicators of a decrease in garbage from ships in recent years suggests that there is more Annex V of MARPOL can do to effectively address this waste stream. Again, this determination is difficult to make due to lack of clear comparison of data from pre-MARPOL or even data from the early years after Annex V's ratification.

Maritime transport accounts for 33% of trade-related emissions from fossil fuel combustion, with the other 70% of conventional and greenhouse gas pollutants occurring from land. Maritime shipping is responsible for 10%-15% of the world's anthropogenic SO\textsubscript{x} and NO\textsubscript{x} emissions, with approximately 15 million tons of SO\textsubscript{x} and 25 million tons of NO\textsubscript{x} being emitted by shipping alone in 2007. Since the entry into force of MARPOL's Annex VI in 2005, greenhouse gas emissions from ships have actually gotten worse, going from 816 million tons of CO\textsubscript{2} per year in 2007 to 961 million tons in 2012. This trajectory is expected to continue, with nitrous oxide emissions projected to increase around 20% by 2030. MARPOL's regulation of SO\textsubscript{x} and NO\textsubscript{x} are encouraging shipping companies to switch to liquified natural gas (LGN) fuel, which would help them to meet the required targets. LGN would reduce the emissions of SO\textsubscript{x}, NO\textsubscript{x}, particulate matter, and CO\textsubscript{2}, but it produces far more methane—a more potent greenhouse gas than CO\textsubscript{2}—than other fuel types. MARPOL's Annex VI standards have encouraged some behavior change, but it's not clear how effective those changes are going to be—at least in the short-run—in decreasing the problem of air pollution from ships.

MARPOL has set ambitious goals for the regulation of many types of pollutants from ships in the oceans. Annexes that have equipment standards tend to have the strongest effect on

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54 GESAMP Working Group 43, “Sea-Based Sources of Marine Litter,” 40.
56 Walker et al., 507.
57 Walker et al., 508.
58 Walker et al., 509.
reducing pollution from ships. The effectiveness of the other annexes is more difficult to determine based on the nature of necessary data collection. While there's potential for the success of MARPOL's expansion, it has not proven itself as effective yet as it has at eliminating operational oil pollution.

One large criticism of MARPOL that has not yet been addressed is how the treaty functions within the practice of flags of convenience (FOCs). This practice, referred to as "flagging out," is when a ship owner registers their ship with a country other than their own. If a country offers an open registry—or has a "flag of convenience"—a ship owner may register their ship with that country and be subject to that country's regulations.59 The potential gains of registering under a flag of convenience are not trivial. A ship registered in the United States faces 70% higher operation costs, 90% higher labor costs, and 100% higher repair costs.60

All FOC states except for North Korea are members of the MARPOL convention and most have even ratified the optional annexes.61 One may think that if all states are members of MARPOL, does it matter which flag they fly? It turns out it matters a lot. MARPOL gives all of the power to the flag state to initiate violations proceedings and enforce the obligations of the treaty.62 This has been one of its greatest downfalls in the face of flags of convenience.63 Because the main interest of FOC states is to minimize the costs for the shipowner to encourage more shipowners to register within the FOC state (thus bringing more money into the FOC state), FOC states have little incentive to initiate MARPOL violations proceedings.64 Even if states had incentive to detect ships in violation, FOC states have fleets so large that it would be difficult to execute the violation proceedings included in MARPOL's obligations.65 Due to competing incentives posed by the practice of flags of convenience, a proposed change to the treaty may be

60 Becker, 636.
62 MARPOL 73/78, Article 4(1).
63 Curtis, 708.
65 Curtis, 708.
to give more power to the port states to initiate violations proceedings; they may provide a more objective enforcement lens than the FOC flag states responsible for the operation of the ships.

V. Conclusion

Despite the challenges of incentivizing international collective action over the ocean global commons, MARPOL has been an effective instrument to incite action amongst member states to improve the problem of ocean pollution. It remains difficult to work within the framework of the global ocean commons; determining the source of each pollution type through a means other than self-reporting from ships is nearly impossible, even with the technological advances made since the negotiation of the treaty. In spite of these challenges, most MARPOL violations are certificate/documentation deficiencies or individual decisions of individual actors, not major scale equipment violations. Though reporting on relevant environmental conditions and relevant actor behavior could be better coordinated through the IMO, many regional MOUs and other organizations have stepped up to gather and provide as much information as possible.

MARPOL's success can be attributed to two main factors. The first is its focus on equipment standards, undertaking the crux of the issue of operational oil pollution. This prevents certain types of pollution from ships from being a possibility while decreasing the burden of constant monitoring throughout the life of a ship. The second factor is its ability to be expansive, including a wide range of member states, actors, and pollution types. Future international environmental laws should prioritize these two components, especially if they are treaties working to reduce or eliminate a known pollutant from any environmental commons.