PLATFORMS, PLASTICS AND PARASITES: INTERNATIONAL LAW RESPONSES TO CONTEMPORARY MARINE POLLUTION ISSUES

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ABSTRACT

Protecting ocean health is critical to ensure food security, marine conservation and sustainable use of our oceans, as well as the achievement of broader blue economy goals. Despite significant global attention, marine debris, waste and pollution continue to cause concern and cumulatively impact on marine and human health. Legal frameworks have been developed over the last half a century focused largely on preventing deliberate dumping of waste, or accidental environmental damage caused by marine pollution from ships. Several of these regimes were created when much less was known about the ocean and what activities impacted upon it, as well as the techniques and tools to prevent damage. It is therefore timely to re-visit the legal frameworks and explore whether they are able to address contemporary challenges. This paper will outline the current state of the international law drawing upon three case studies: in situ decommissioning of oil rigs and their disposal at sea, the cumulative impacts of plastics in the ocean and bio-security hazards created by alien invasive species. These challenges are all anthropogenic and this article will identify areas where further interventions are needed to better regulate and manage activities and prevent significant harm.

I INTRODUCTION

From the earliest of times people have utilised marine areas for food, recreation, transport and exploration. While populations were low, waste products finding their way into the oceans had no significant negative effect on marine health. Across the centuries the impacts have increased as populations and activities have expanded, and pollution in the oceans has exceeded the oceans' absorption and cleansing capacity.

Marine pollution can arise from industrial activities in the ocean (such as seabed mining, and oil and gas exploration), from ships (either through daily operations or accidental spill events), from land-based sources (such as run-off) and from deliberate dumping of waste. Marine pollution has been a matter of significant global concern since the mid-twentieth century, and the international community has responded with a number of multi-national instruments, combined with regional and domestic laws. Nevertheless, substantial issues remain, and this article explores three specific areas, each of which is topical with challenges for law- and policy-makers, industry and other

stakeholders.

The first issue - the problem of plastics - is a cumulative one that can affect ecosystem quality, food safety and ultimately human health.[1] The challenge is how to address the issue of marine plastic debris given that it emanates from multiple sources, involves various industries and myriad commercial and community uses. The second case study involves alien marine species that can be introduced into new environments in a number of ways with devastating consequences on local organisms and ecosystems.[2] Again this is a complex area, involving all types of maritime transport, and one where there is unlikely to be any easy solutions. Whilst ballast water can be managed, in part, through the use of management systems and treatment facilities, bio-fouling is an inherent problem in all forms of shipping. Thirdly, concerns surround the safe disposal of redundant offshore infrastructure.[3] Although many petroleum exploitation agreements include reference to the complete removal of infrastructure at the end of its field life, the cost, technical difficulty and potential marine impacts now suggest that this may not be the best option. Alternatives include partial or complete *in situ* decommissioning. Whilst this could provide ecosystem benefits in some situations, through the creation of artificial reefs, it comes with its own risks, will not be appropriate in all circumstances and may also be seen as a form of sanctioned dumping of waste in the ocean.

This article explores three contemporary case studies as a lens through which to examine the effects on the oceans from expanding human activities and how environmental law must evolve to keep pace. The paper commences by examining the impacts of these global ocean-based problems, followed by the existing international legal frameworks to address marine pollution. The final section considers potential future developments to ensure that law remains efficient, effective and fit for purpose.

II THE IMPACTS

A *Plastics*

Plastic pollution is a subset of marine debris but its impacts are perhaps the fastest growing environmental challenge now facing our oceans, driven by the exponential growth in the use of this substance over the last 70 years. Plastics are versatile with properties that make them ideal for many applications. This has led to lifestyles where disposability, as opposed to recycling and re-use, remains attractive. It is estimated that around 50% of plastic is used just once and thrown away.[4] We are now producing nearly 300 million tons of plastic every year, half of which is for single use.[5] In 2010, it was estimated that 275 million metric tons of plastic waste was generated in 192 coastal

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Gabrielle Weule, 'Plastic and how it affects our oceans', *ABC Science*, (Web Page, 27 February 2017) <http://www.abc.net.au/news/science/2017-02-27/plastic-and-plastic-waste-explained/8301316>.

[2] 'Rising global shipping traffic could lead to surge in invasive species', *Science Daily*, (Webpage, 18 March 2019) <https://www.sciencedaily.com/releases/2019/03/190318121043.htm>.

[3] Joanna Khan, 'Decommissioned rigs: Precious marine habitats or giant lumps of ocean waste?' *ABC Science* (Webpage, 13 June 2018) < https://www.abc.net.au/news/science/2018-06-13/decommissioned-rigs-precious-marine-habitat-or-more-ocean-waste/9833084>.

[4] Plastic Oceans, *The Facts* (Webpage), <https://www.plasticoceans.org/the-facts/>.

[5] IUCN, *Marine Plastics* (Webpage), <https://www.iucn.org/resources/issues-briefs/marine-plastics>.

countries, with 4.8 to 12.7 million metric tons ending up in the ocean.[6] The extent of the problem is therefore clear.

Plastics have been found in the coastal zone and far out to sea, as well as at different depths.[7] They impact directly on marine species through entanglement and ingestion. Species affected include fish, seabirds, marine mammals, and reptiles such as turtles, as well as invertebrates, and in turn this affects human health.[8] Negative effects on the environment have also been recorded through rafting, where species are transported across the ocean on plastic debris, and although plastics tend to float because of their low density, they have been found throughout the water column and on the seabed where they can smother living organisms.[9] These impacts have been recorded for over 40 years but have become more prevalent with expanding human populations, plastic production and ubiquitous usage.[10]

Plastics found in the oceans originate from multiple sources, including inadequate waste management practices, resulting in land-based marine pollution and discard from ships. These pollutants can be macroplastics (e.g. plastic bags and water bottles), or primary (e.g. from cosmetic products) and secondary microplastics (fragments of original products). The complexity of the issues – from manufacturing, transport, commercial use, re-use, recycling and waste disposal – make legal regulation a challenge. To date, plastic debris has been regulated at the international level through treaties that prohibit the deliberate dumping of waste and accidental spills, as well as domestic laws which implement these obligations and manage the coastal zone and waste management regimes. However, no international law sets standards for land-based marine pollution and no existing regime covers the plastics lifecycle from production to consumption, including reducing, re-using and recycling materials. As will be explored below, recent research has suggested potential governance options.

B *Parasites*

Marine pests are foreign organisms transported from one location to another unintentionally. Sometimes, they are relatively benign or die *en route*, others may be alien invasive species, impacting significantly on local wildlife, industries and human health.[11]

As noted above, non-indigenous species can drift on plastic marine debris, but other vectors include their transport as 'hitchhikers' adhering to the hulls of vessels (bio-fouling) or they may be released into foreign waters during the discharge of water taken on board to stabilise ships (ballast water). These invaders can be molluscs, crustaceans,

[6] Jenna R Jambeck et al, 'Plastic waste inputs from land into the ocean' (2015) 347(6223) *Science* 768, 770.
[7] MH Depledge et al, 'Plastic litter in the sea' (2013) 92 *Marine Environmental Research* 279, 279.
[8] Juliana A Ivar do Sul, Monica F Costa, 'The present and future of microplastic pollution in the marine Environment' (2014) 185 *Environmental Pollution* 352, 352-364.
[9] C&R Consulting for The Department of the Environment, Water, Heritage and the Arts, *Impacts of plastic debris on Australian marine wildlife* (Final Report, 19 June 2009).
[10] Edward J Carpenter and KL Smith Jr, 'Plastics on the Sargasso sea surface' (1972) 175 (4027) *Science* 1240, 1241.
[11] Nicholas Bax et al, 'Marine invasive alien species: a threat to global biodiversity, *Marine Policy* 27(4) (2003) 313.

worms, and algae or a variety of microorganisms. In order to reduce the accidental transport, anti-fouling strategies have been employed including the application of coatings to the underside of vessels. These too can have negative environmental impacts because of the biocides used in the products.[12]

Ballast water is a necessary part of global shipping as it is used to balance vessels and ensure safe transport. The discharge of ballast water has been a matter of concern for some time because of the species that can be taken up in water from one location and then discharged at another. In contrast to bio-fouling, ballast water management has received global legal attention, as will be explored below. As with other forms of marine pollution, such as plastics, the problems are complex and the governance approaches likely to be the same - preventing or reducing the transport of species, managing them once they have been found, eradicating introduced species and restoring species and environments that may have been damaged by them.

C *Offshore infrastructure*

Marine pollution from oil spills is one area where positive developments can be highlighted. Whilst the movement of petroleum products by sea has continued to increase, oil spills have decreased both in terms of the number of accidents and the quantity of oil lost.[13] The oil and gas industry not only faces financial and reputational risks from spills, but also the treatment of offshore infrastructure when it comes to the end of its field life. The petroleum industry first emerged in the US in the 1920s but much later in other countries such as Australia, where it was not until the 1970s that it really expanded.[14] Much of this infrastructure is now aging and will shortly need to be decommissioned.[15] Platforms are just one type of offshore infrastructure that needs to be decommissioned; offshore oil and gas extraction involves rigs, pipelines and platforms, all of which need to be disposed of during the decommissioning process.

Although at the time the construction contracts for infrastructure were entered into their terms favoured complete removal at the end of life, more recently marine science has demonstrated that in some cases artificial reefs have formed around the legs of oil rigs and along pipelines, and these are providing ecosystem services.[16] Their removal could be more harmful than beneficial. Furthermore, construction was assisted by gravity as structural elements were lowered to the ocean floor; reversing this process can be technically challenging and in some cases impossible. Contemporary research has also demonstrated the value of artificial reefs and decommissioned infrastructure could

[12] Katherine A. Dafforn, John A. Lewis and Emma L. Johnston, 'Antifouling strategies: History and regulation, ecological impacts and mitigation' (2011) 62 *Marine Pollution Bulletin* 453.

[13] Our World Data (Max Roser), *Oil Spills*, <https://ourworldindata.org/oil-spills/>.

[14] Joanna DE Athanassopoulos, James Stanwood Dalton and Adam P Fischer, 'Offshore oil platform decommissioning: a comparative study of strategies and the ecological, regulatory, political and economic issues involved in the decommissioning planning' (Masters Project, University of California Santa Barbara, Santa Barbara, June 1999) quoted in Parente et al 'Offshore decommissioning issues: Deductibility and transferability' (2006) 34(15) *Energy Policy* 1992.

[15] John Chandler et al, 'Engineering and legal considerations for decommissioning of offshore oil and gas infrastructure in Australia' (2017) 131 *Ocean Engineering* 338.

[16] N Pradella et al 'Fish assemblages associated with oil industry structures on the continental shelf of north-western Australia' (2014) 84(1) *Journal of Fish Biology* 247.

be re-used for this purpose.[17] End-of-life options therefore include not only complete removal, but also *in situ* decommissioning leaving the infrastructure in place, removal and relocation offshore, as well as partial removal.[18]

The international law in this area favours complete removal although, as will be explored below, there is a possibility for approval of *in situ* decommissioning and the re-use of end of life infrastructure. At the national level, varying approaches have been taken, with the US adopting a rigs-to-reefs approach, whereas in Europe offshore infrastructure must be removed and any artificial reefs can only be made from new materials.[19] Therefore, unlike the issues of marine debris, there is the possibility of safely disposing of waste infrastructure at sea, allowing it to benefit rather than hinder marine ecosystems.

III LEGAL RESPONSES

The three issues raised above are issues of waste disposal and each can lead to marine pollution. Although the legal responses to them differ considerably, the starting point is common - the *UN Convention on the Law of the Sea* (UNCLOS).[20] UNCLOS includes a number of relevant provisions. Most significant is Part XII on the 'Protection and Preservation of the Marine Environment' which includes both general and specific obligations to prevent, reduce, and control pollution. In particular, Article 194 requires States

> to take all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using . . . the best practicable means at their disposal and in accordance with their capabilities.

In order to meet this obligation, States have joined together to adopt global treaties, most significantly in terms of deliberate dumping of waste, accidental pollution from shipping, and more recently, ballast water management. Land-based marine pollution has not resulted in any binding multi-national legal instrument, and nor has the issue of bio-fouling and the resultant introduction of foreign organisms.

A *Dumping*

UNCLOS Article 210 requires States to adopt laws, regulations and other measures to prevent, reduce and control pollution of the marine environment by dumping.

[17] David Whitmarsh et al, 'Marine habitat modification through artificial reefs off the Algarve (southern Portugal): an economic analysis of the fisheries and the prospects for management' (2008) 51 *Ocean & Coastal Management* 463.

[18] Paul Ekins, Robin Vanner, and James Firebrace, *Decommissioning of Offshore Oil and Gas Facilities: Decommissioning Scenarios: A comparative Assessment Using Flow Analysis* (Report, Policy Studies Institute, March 2005).

[19] Erika Techera and John Chandler, 'Offshore installations, decommissioning and artificial reefs: Do current legal frameworks best serve the marine environment?' (2015) 59 *Marine Policy* 53.

[20] *United Nations Convention on the Law of the Sea*, opened for signature 10 December 1982, 1833 UNTS 3 (entered into force 16 November 1994) (UNCLOS).

UNCLOS encourages States to adopt global rules, standards and procedures through competent organisations, and to prohibit dumping in national waters and EEZs without prior informed consent of the coastal State. The *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (*London Convention*) was adopted in response and promotes the effective control of all sources of intentional marine pollution, requiring all practicable steps to be taken to prevent pollution of the sea by dumping of wastes and other matter.[21] It has been ratified by 87 State parties and therefore is binding on less than half the world's nations. The more recent 1996 *London Protocol* prohibits the dumping of all waste unless listed as able to be disposed of at sea; only 48 States have ratified the Protocol.[22] The regime operates to prevent the deliberate dumping of plastics and other waste, although 'platforms' and 'organic waste of natural origin' are included under Annex I of the *London Protocol* as being matter that may be considered for dumping provided floating material and anything capable of producing pollution has been removed. This regime may work to facilitate *in situ* decommissioning of offshore infrastructure for the benefit of the marine environment, but risks harm to the oceans with respect to dumping of waste containing organic alien species.

B *Shipping*

UNCLOS also refers to pollution from ships, and Article 211 calls upon States to establish international rules and standards and promote routing systems to minimise threats. The 1978 *Protocol to the International Convention for the Prevention of Pollution from Ships* (MARPOL) has been the principal international response to accidental and incidental pollution from vessels (which includes fixed or floating structures as well as ships) through the establishment of discharge standards, vessel design standards and navigation restrictions.[23] Annex V of MARPOL is critical in controlling sources of marine debris from ships as it restricts 'at sea discharge of garbage and bans at sea disposal of plastics and other synthetic materials such as ropes and fishing nets, with limited exceptions'. Annex V also refers to 'special areas' where discharge regulations are far stricter. The question of adherence to the law is a vexed one with studies demonstrating widespread breaches.[24] In order to enhance effectiveness, Annex V also requires States to provide adequate port reception facilities to allow for safe disposal of garbage, which may be challenging for many developing States.

C *Land-based marine pollution*

In addition to the general obligation in Article 194, UNCLOS also refers specifically to land-based marine pollution. UNCLOS requires States to adopt laws, regulations and

[21] *Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter*, opened for signature 29 December 1972, 1046 UNTS 120 (entered in force 30 August 1975) (London Convention).

[22] *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, opened for signature 11 July 1996, 36 ILM 1 (entered into force 24 March 2006).

[23] *International Convention for the Prevention of Pollution from Ships* (1973) and the 1978 *Protocol* are read as a single instrument known as MARPOL, opened for signature 17 February 1978, 17 ILM 246 (entered into force 2 October 1983).

[24] For example, Madeleine M Jones, 'Fishing debris in the Australian marine environment' (1995) 30(1) *Marine Pollution Bulletin* 25.

other measures 'to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures'.[25] Furthermore, States are to adopt and enforce national laws and implement international standards 'to prevent, reduce and control pollution of the marine environment from land-based sources'.[26] Although two international conventions prevent dumping of garbage (including plastics) from ships,[27] and regulate the transboundary movement of plastic waste,[28] the only land-based marine pollution instrument remains soft law.[29] The *Global Programme of Action for the Protection of the Marine Environment from Land-based Activities* (1995) focuses on identifying the sources of pollution, priorities in any given context, management objectives, strategic options and impacts.[30] In addition, national programmes of action are required. Regional Seas Programmes operate in different areas around the world, and the first regional land-based pollution agreement related to the Mediterranean was adopted in 1980: *Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-based Sources*.[31] Others have since followed.[32] Given that one of the most significant sources of marine debris is from the land, the lack of a global, binding treaty that would set standards for waste management and alternative disposal, and obligations to prevent land-based marine pollution, is concerning.

D *Alien and invasive species*

Other relevant UNCLOS provisions include Article 196, which calls upon States to

> take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from … the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes.

Again, this has resulted in domestic legal developments but no focused international instrument. Instead, the global community has adopted the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (*Ballast Water Convention*), which is aimed at preventing the spread of harmful organisms by establishing standards and procedures for the management and control of ships' ballast

[25] UNCLOS Article 207 (n 20).
[26] UNCLOS Article 213 (n 20).
[27] London Convention (n 21).
[28] *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*, opened for signature 22 March 1989, 1673 UNTS 57 (entered into force 5 May 1992) (Basel Convention).
[29] *Global Programme of Action for the Protection of the Marine Environment from Land-based Activities*, 1995.
[30] United Nations Environment Programme, 'The Global Programme of Action for Protection of the Marine Environment from Land-based Activities' (Presentation) <https://wedocs.unep.org/bitstream/handle/20.500.11822/11144/wbrs18_pre_%20%288%29.pdf?sequence=1&isAllowed=y>.
[31] *Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-based Sources*, opened for signature 17 May 1980, 19 ILM 869 (entered into force 11 May 2008).
[32] For an excellent analysis see Daud Hassan, 'Regional Frameworks for Land Based Sources of Marine Pollution Control: A Legal Analysis on the North East Atlantic and the Baltic Sea Regions' (2004) 4(1) *QUT Law and Justice Journal* 1.

water.[33] Under the Convention, all international shipping is required to manage ballast water and sediments to a certain standard (phased in over time), applying a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. Eventually, most ships will need to install an on-board ballast water treatment system, but initially ships will exchange ballast water mid-ocean.

No such binding regime has emerged for alien invasive species in general, nor bio-fouling in particular. In addition to the UNCLOS provisions above, Article 8(h) of the *Convention on Biological Diversity* requires States as far as possible and as appropriate, to 'prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species'.[34] In addition, the IUCN has developed Guidelines that focus on raising awareness, identifying management options, implementing legal frameworks and undertaking further research on alien invasive species.[35] Several other relevant instruments have been adopted, but the only binding law regulates the use of anti-fouling substances, rather than bio-fouling itself.[36] This Treaty regulates anti-fouling systems on ships, and seeks to prevent negative impacts from the use of such systems and biocides, restricting the use of some substances which can leach into seawater and impact on marine species and/or enter the food chain. Whilst the International Maritime Organization (IMO) has adopted some relevant guidelines, again these are not legally binding.[37] The Guidelines draw attention to the importance of implementing a biofouling management plan, including an anti-fouling system and operational maintenance to prevent biofouling. This mix of binding and non-binding instruments is neither comprehensive nor cohesive. There is clearly scope for international hard law to set standards and provide principles as a foundation for the development of domestic law and regional responses.

E *Platforms*

The matter of the disposal of offshore infrastructure at the end of its life has been treated slightly differently. UNCLOS Article 210, outlined above, applies to the deliberate disposal of infrastructure. In addition, Articles 206 and 208 have some application. More specifically, UNCLOS Article 60 provides that any infrastructure which is 'abandoned or disused shall be removed … taking into account any generally accepted international standards established in this regard by the competent international organisation'. UNCLOS does therefore allow for partial removal of offshore installations through the adoption of international standards by the IMO. In 1989 the IMO developed soft law (non-binding) *Guidelines and Standards for the Removal of Offshore Installations*

[33] *International Convention for the Control and Management of Ships' Ballast Water and Sediments*, opened for signature 16 February 2004, IMO Doc. BWM/CONF/36 (entered into force 8 September 2017).

[34] *Convention on Biological Diversity*, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993) (CBD).

[35] International Union for Conservation of Nature, *Guidelines for the Prevention of Biodiversity Loss Caused by Alien Species*, approved by the 51st Meeting of the IUCN Council, Gland Switzerland, February 2000.

[36] *International Convention on the Control of Harmful Anti-Fouling Systems on Ships*, opened for signature 5 October 2001, T.I.A.S. No. 12-11121 (entered into force 17 September 2008).

[37] International Maritime Organization, Marine Environment Protection Committee, *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species*, Resolution MEPC.207(62), 15 July 2011.

and Structures on the Continental Shelf and in the Exclusive Economic Zone.[38] Section 1.1 of the Guidelines repeats the UNCLOS position that offshore installations on any continental shelf or in any EEZ are to be removed, except where non-removal or partial removal is consistent with the Guidelines and Standards. Section 2.1 requires a case-by-case evaluation prior to any decision to allow offshore infrastructure to remain on the sea-bed. Significantly, the evaluation criteria also refer to 'determination of a new use or other reasonable justification for allowing the installation or structure or parts thereof to remain on the sea-bed'. It would appear that where a 'new use' can be identified, State parties to UNCLOS are not obliged to remove all abandoned and disused offshore installations. Section 2.4 refers to the process for allowing an offshore installation or structure to remain *in situ*. Although a detailed process is not included, mention is made of specific plans 'to monitor the accumulation and deterioration of material left on the sea-bed'. It is therefore clear that the international legal regime favours removal of obsolete infrastructure but does not prohibit *in situ* decommissioning.[39]

IV ANALYSIS

The three case studies explored above all relate to a different waste management issue: plastics, alien and invasive species and end-of-life infrastructure. These issues all arise due to anthropogenic processes of globalisation, industrialisation and modernisation, and arguably are a product of the lack of holistic thinking. Too frequently, the law has reacted to an environmental challenge as it arose, rather than incorporating whole-of-lifecycle planning. The legal responses to the three case study challenges have each been different, none is completely satisfactory, and there are remaining gaps and challenges. Whilst it is clear that much less was known about the range and extent of negative impacts in the past, if the law is to keep pace with expanding activities and safeguard environmental health, it must evolve in response.

It is clear that there is no regime governing plastics throughout their whole of lifecycle. Reduction, recycling and re-use is not mandated, and as plastics are cheap and durable their widespread utilisation has resulted in a major pollution problem affecting species, habitats and ultimately human health. Furthermore, the extent of the pollution risk has not been fully considered until recently and the polluter pays principle has not been applied effectively to the manufacturer, waste manager or consumer. Therefore, ways must be found to incentivise a reduction of production, as well as recycling and re-use, and to require those with responsibility for the problem to clean-up and restore the environment. International law has an important role to play here. For example, a global regime could address the governance gap in relation to land-based marine pollution and set standards for waste management more broadly. In addition, specifically responding to the problem of plastics, suggestions include the adoption of a modified version of the *Montreal Protocol* incorporating principles of prevention, precaution and the polluter

[38] International Maritime Organization, *1989 Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone*, IMO Resolution A.672(16), 19 October 1989.

[39] Techera and Chandler (n 19).

pays.[40] As with ozone-depleting substances, the most concerning types of plastics may have substitutes, but industry needs time to invent them and developing countries need a phase-in period. Other options include the creation of a global fund to help governments finance legacy plastics issues,[41] and/or a global extended producer responsibility scheme to engage industry and incentivise recycling.[42]

Alien species transported by vessels on their hulls or in ballast water can devastate local organisms and find their way into the human food chain. The initial responses to the problem, the application of anti-fouling materials to ships' hulls, can create new environmental risks, so prevention of build-up of biological material needs to be encouraged and safe treatment of ballast water and hull maintenance ensured. The *Ballast Water Convention* only came into force in September 2017 and its effectiveness in preventing the introduction of alien species has yet to be seen. Arguably a more comprehensive response is needed which addresses both ballast water and bio-fouling.[43] Given the recent adoption of the *Ballast Water Convention*, an enforceable treaty in relation to bio-fouling could also be developed. In particular, an international treaty could harmonise regional approaches, which are likely to remain important given the problem is largely driven by international shipping trade. Again, a more holistic approach could be taken that requires, for example, those responsible for the introduction of alien species to pay for removal and restoration costs.

The end-of-life disposal of offshore platforms and pipelines were the subject of consideration at the time of approval for construction. Limited knowledge at that time indicated the best approach would require the operator to completely remove the structures, but it now appears that this may not be the best solution. Again, this is an area where law reform is needed, to incorporate new knowledge and novel options for legitimate disposal, including re-use and recycling. Decommissioned offshore infrastructure presents a unique opportunity rather than just being a growing pollution concern. Much offshore infrastructure in Australia and South East Asia is shortly to be decommissioned and, at one level, simply requiring its removal would not be catastrophic for the marine environment. However, given the complexity and cost, there is a risk that some infrastructure would not be removed at all, but left in place in a non-decommissioned state. This outcome is undesirable given the potential damage that may be caused by residual oil and other substances left in pipelines and unplanned erosion of infrastructure. Even where infrastructure is removed, there may be a lost opportunity to enhance the marine environment through partial decommissioning and re-use of equipment as artificial reefs. Therefore, enhanced governance would be valuable, providing greater guidance, more clarity and facilitating sharing of best practice. To deal with the legacy issue, standards could be adopted that set out the circumstances in which partial *in situ* decommissioning could be feasible, detailed processes to be adopted for any such activities and liability options should damage occur. For future offshore infrastructure projects (which could be petroleum or renewable energy-related)

[40] Karen Raubenheimer and Alistair McIlgorm, 'Is the Montreal Protocol a model that can help solve the global marine plastic debris problem?' (2017) 81 *Marine Policy* 322.
[41] Karen Raubenheimer and Alistair McIlgorm, 'Can a global fund help solve the global marine plastic debris problem?' (2018) 5(1) *Journal of Ocean and Coastal Economics*.
[42] Karen Raubenheimer and Niko Urho, 'Rethinking global governance of plastics – The role of industry', (2020) 113 *Marine Policy* 103802.
[43] Bax et al (n 11) 317.

standardised contractual arrangements and model clauses could also be developed.

All three case studies highlight the need for action to address the legacy pollution problems, and to enhance forward planning and future-proofing. The challenges explored arise from industrialisation and utilisation of the oceans and the problems now faced are in part a reflection of the lack of whole-of-lifecycle planning. More holistic approaches would facilitate legal frameworks that are fit for purpose. All three areas have benefited from greater scientific and technological developments since the industries began, and legal frameworks must respond to this new information. Set out above are some options for law reform, but they all require concerted effort by the international community together with considerable political will on the part of national governments.

V CONCLUSION

The three case studies considered above highlight current marine pollution and ocean waste problems. None of these issues are likely to dissipate in the near future and therefore the challenges must be addressed. These are global concerns caused by contemporary industries and modern lifestyles. Solutions will require action by governments, industries and consumers. Solutions are likely also to involve the development of new technologies, acquisition of marine scientific information, sociological research and innovative governance approaches. Although responses from multiple disciplines will be needed, there is a significant role for international law to play in preventing, managing and removing threats and risks, as well as setting new standards and incentivising behavioural change.