Stemming the Tide of Plastic Marine Litter: A Global Action Agenda

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 A version of this Article previously appeared as Mark Gold, Katie Mika, Cara Horowitz, Megan Herzog & Lara Leitner, *Pritzker Environmental Law and Policy Briefs, Stemming the Tide of Marine Litter: A Global Action Agenda*, UCLA SCH. OF LAW (Oct. 2013), http://cdn.law.ucla.edu/SiteCollectionDocuments/Centers%20and%20Programs/Emmett%20Center%20on%20Climate%20Change%20and%20the%20Environment/Pritzker%20Paper%205.pdf.

* Mark Gold is the Associate Director of the UCLA Institute of the Environment and Sustainability. The authors are grateful to numerous reviewers for invaluable support and advice, including Ellik Adler, Meg Caldwell, Richard G. Hildreth, Ljubomir Jeftic, Leila Monroe, Edward Parson, and Alexander Tkalin. We are also indebted to Xiao Zhang for her insights and editing help. These individuals did not necessarily review the document in its entirety. Listing does not imply that an individual or organization or its affiliates endorse the recommendations contained in this Article. Any errors are our own.

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I. INTRODUCTION

Marine litter is one of the most significant problems facing the world's oceans and seas—and the communities and economies that depend on them. Plastic marine litter presents a particularly significant environmental threat—as well as a considerable regulatory challenge. It has been estimated that 20 million tons of plastic marine litter enter the ocean each year.[1] Plastic marine litter forms a large portion of our waste stream, does not typically biodegrade in marine environments, and has especially deleterious impacts on ocean wildlife, coastal economies, fisheries, and even human health. Manufacturers increasingly are incorporating hardy plastic material into single-use items and other products that are a part of our daily lives. Global mismanagement of ubiquitous plastic materials has fueled the growing international marine litter problem.

1. *See* Raveender Vannela, *Are We "Digging Our Own Grave" Under the Oceans?: Biosphere Level Effects and Global Policy Challenge from Plastic(s) in Oceans*, 46 ENVTL. SCI. & TECH. 7932, 7932 (2012).

What Is Plastic Marine Litter?
Marine litter, also called marine debris or solid marine pollution, includes all human-generated solid articles and materials that are discarded, disposed of, or lost into the ocean and remain there. **Plastic marine litter** includes all marine litter composed of one of a collection of artificial materials (commonly, petroleum-based compounds) that we broadly refer to as "plastic" (e.g., polystyrene, polyethylene, and polyester). Plastic marine litter includes consumer items (such as plastic bags, food packaging, cups, bottles, and balloons), industrial components, and items related to fisheries or aquaculture.

For these reasons, drastically reducing the current rate of ocean plastics disposal and loss is a key step in stemming the tide of global marine litter. Over the last decade, researchers and international governmental and nonprofit organizations have published dozens of reports on the marine litter problem and offered a range of recommendations.[2] There is general agreement about the need for robust, consistent funding for cleanup efforts, better infrastructure to encourage proper waste management, and, most importantly, reductions in the sources of marine litter—especially single-use plastics. Yet, no one has

2. *See, e.g.*, MARINE DEBRIS PROGRAM, NAT'L OCEANIC & ATMOSPHERIC ADMIN., HAWAI'I MARINE DEBRIS ACTION PLAN (2012), *available at* http://marinedebris.noaa.gov/sites/default/files/FINAL_HI-MDAP_2012-2013_web.pdf; RICHARD C. THOMPSON ET AL., SCI. & TECHNICAL ADVISORY PANEL, MARINE DEBRIS AS A GLOBAL ENVIRONMENTAL PROBLEM: INTRODUCING A SOLUTIONS BASED FRAMEWORK FOCUSED ON PLASTIC (2011), *available at* http://www.carrcu.org/images/meeting_docs/img15/lbs_cop1/reference_documents/STAP%202011.pdf ; NAT'L OCEANIC & ATMOSPHERIC ADMIN. & U.N. ENV'T PROGRAMME, THE HONOLULU STRATEGY: A GLOBAL FRAMEWORK FOR PREVENTION AND MANAGEMENT OF MARINE DEBRIS (2011) [hereinafter THE HONOLULU STRATEGY], *available at* http://marinedebris.noaa.gov/sites/default/files/honolulustrategy.pdf; U.N. ENV'T PROGRAMME, UNEP YEAR BOOK: EMERGING ISSUES IN OUR GLOBAL ENVIRONMENT (2011) [hereinafter UNEP YEAR BOOK], *available at* http://www.unep.org/yearbook/2011/pdfs/UNEP_YEARBOOK_Fullreport.pdf; GRAEME MACFADYEN ET AL., U.N. ENV'T PROGRAMME & FOOD & AGRIC. ORG. OF U.N., ABANDONED, LOST OR OTHERWISE DISCARDED FISHING GEAR (2009), *available at* http://www.unep.org/regionalseas/marinelitter/publications/docs/Marine_Litter_Abandoned_Lost_Fishing_Gear.pdf; ANTHONY CHESHIRE ET AL., UNEP/IOC GUIDELINES ON SURVEY AND MONITORING OF MARINE LITTER (2009), *available at* http://www.unep.org/regionalseas/marinelitter/publications/docs/Marine_Litter_Survey_and_Monitoring_Guidelines.pdf; COMM. ON THE EFFECTIVENESS OF INT'L & NAT'L MEASURES TO PREVENT & REDUCE MARINE DEBRIS & ITS IMPACTS, NAT'L RESEARCH COUNCIL, TACKLING MARINE DEBRIS IN THE 21ST CENTURY (2009), *available at* http://www.nap.edu/openbook.php?record_id=12486; Chelsea M. Rochman et al., *Classify Plastic Waste as Hazardous*, 494 NATURE 169 (2013); Vannela, *supra* note 1; J. Brown et al., Inst. for European Envtl. Pol'y & Poseidon Aquatic Res. Mgmt. Ltd., *Ghost Fishing by Lost Fishing Gear*, EUROPEAN COMM'N (Aug. 2005), http://ec.europa.eu/fisheries/documentation/studies/ghostfishing_en.pdf; Miriam Gordon, Cal. Coastal Comm'n, *Eliminating Land-Based Discharges of Marine Debris in California: A Plan of Action from the Plastic Debris Project*, PLASTIC DEBRIS, RIVERS TO SEA (June 2006), http://www.plasticdebris.org/CA_Action_Plan_2006.pdf.

proposed an overarching action plan that would effectively address the plastic marine litter problem.

Like the waste itself, however, awareness of the plastic marine litter problem is on the rise. International volunteer events such as International Coastal Cleanup Day and images of the "Pacific Garbage Patch," a gyre larger than the size of Texas that is polluted with a diffuse soup of plastic objects and fragments, have captured the world's attention. The international community is also engaged in intently tracking the estimated 5 million tons of marine litter (including plastics) swept out to sea by the Japanese tsunami in 2011.[3] Significantly, "Rio+20" United Nations Conference on Sustainable Development in 2012 recognized marine litter as a major environmental issue that the world must address.[4] The parties to the Rio+20 Conference "note[d] with concern that the health of oceans and marine biodiversity are negatively affected by . . . marine debris, especially plastic" and called for action by 2025 to "achieve significant reductions in marine debris to prevent harm to . . . coastal and marine environment[s]."[5] How to achieve those reductions for the category of plastic marine litter is the subject of this Article.

We begin by summarizing the latest information on the sources and impacts of plastic marine litter. Next, we describe why existing international legal mechanisms are inadequate to address the problem. We then offer international, regional, national, and subnational policy recommendations to address plastic marine litter, including suggestions of ways to improve existing international legal mechanisms. As a first priority, we call upon the global community to develop a new international agreement with a global reach commensurate with the scale of the plastic marine litter problem. Ultimately, we believe the world may only be able to reach the Rio+20 goal through an aggressive, new international regime that incorporates enforceable marine pollution standards as well as strong tracking, monitoring, reporting, and enforcement mechanisms. International law is not likely to solve the plastic marine litter problem independent of domestic efforts, however. Smaller-scale policies and programs should be rapidly scaled up as a partial solution to the problem. We conclude with our top ten list of

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3. *Japan Tsunami Marine Debris FAQs*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. MARINE DEBRIS PROGRAM, http://marinedebris.noaa.gov/tsunamidebris/faqs.html (last visited Mar. 2, 2014).

4. *See* U.N. Conference on Sustainable Development, Rio de Janeiro, Braz., June 20-22, 2012, *Report of the United Nations Conference on Sustainable Development*, ¶ 163, U.N. Doc. A/CONF.216/16 (2012) [hereinafter U.N. Conference].

5. *Id.*

recommended actions to implement by 2025 in order to begin stemming the global tide of plastic marine litter.

II. THE PLASTIC MARINE LITTER PROBLEM

In recent years, global concern about ocean health has keyed in on the growing problem of plastic marine litter. There is a lot we do not know about plastic marine litter; for instance, there is no hard data on exactly how much plastic is in the marine environment. It has been estimated that 20 million tons of plastic marine litter enter the ocean each year.[6] We do know that, at some locations, the majority of all observed marine litter tends to be plastic items.[7] For instance, one beach litter monitoring pilot project found plastics to comprise an average of 75% of all beach litter on reference beaches in eight Northeast Atlantic countries.[8] Temporal trends also remain unclear; however, because plastics production increases by almost 5% annually,[9] and because most plastics do not biodegrade in marine environments,[10] it is likely that the concentration of plastics in the ocean has been increasing and will continue to increase over time.

Furthermore, it is not clear what proportion of plastic marine litter originates from land-based versus ocean-based sources. Some estimates suggest that 60% to 80% of plastic marine litter derives from land-based sources[11] such as waste sites, litter, untreated sewage and stormwater

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6. Vannela, *supra* note 1.

7. CHARLES MOORE, PLASTIC OCEAN: HOW A SEA CAPTAIN'S CHANCE DISCOVERY LAUNCHED A DETERMINED QUEST TO SAVE THE OCEANS 285 (2011); José G.B. Derraik, *The Pollution of the Marine Environment by Plastic Debris: A Review*, 44 MARINE POLLUTION BULL. 842, 843 tbl.1 (2002); Juliana A. Ivar do Sul & Monica F. Costa, *Marine Debris Review for Latin America and the Wider Caribbean Region: From the 1970s Until Now, and Where Do We Go from Here?*, 54 MARINE POLLUTION BULL. 1087, 1088-90 (2007); Isaac R. Santos et al., *Marine Debris Contamination Along Undeveloped Tropical Beaches from Northeast Brazil*, 148 ENVTL. MONITORING & ASSESSMENT 455, 458 (2009).

8. OSPAR COMM'N, OSPAR PILOT PROJECT ON MONITORING MARINE BEACH LITTER: MONITORING OF MARINE LITTER IN THE OSPAR REGION 5, 9 (2007), *available at* http://qsr2010.ospar.org/media/assessments/p00306_Litter_Report.pdf.

9. *Plastics—The Facts 2011: An Analysis of European Plastics Production, Demand and Recovery for 2010*, PLASTICSEUROPE 5 (2011), http://www.plasticseurope.org/documents/document/20111107101127-final_pe_factsfigures_uk2011_lr_041111.pdf.

10. *See* Anthony L. Andrady, *Microplastics in the Marine Environment*, 62 MARINE POLLUTION BULL. 1596, 1599 (2011).

11. *See* Rho-Taek Jung et al., *Practical Engineering Approaches and Infrastructure to Address the Problem of Marine Debris in Korea*, 60 MARINE POLLUTION BULL. 1523, 1524 (2010); Santos et al., *supra* note 7, at 461; *see also* Peng Zhou et al., *The Abundance, Composition and Sources of Marine Debris in Coastal Seawaters or Beaches Around the Northern South China Sea (China)*, 62 MARINE POLLUTION BULL. 1998, 2000 (2011) (noting that the contribution of land-based sources can be higher in certain areas, up to 95%).

outfalls, poorly managed industrial and manufacturing sites, and tourist activities. Land-based plastic litter commonly found in the marine environment includes everything from single-use packaging to industrial "nurdles" (preproduction pellets). Ocean-based sources such as ships, oil and gas platforms, and aquaculture facilities[12] account for plastic marine litter items such as fishing nets, floats, traps, pots, lines, and other aquaculture components.[13] Ocean-based litter also includes lost cargo containers. Hundreds or perhaps thousands of shipping containers and their contents, including plastics, are lost at sea each year due to accidents, storms, or poor management practices.[14] Notably, ships are not required to report or clean up lost cargo unless the contents are hazardous.

Once plastic litter enters the marine environment, the natural motion of wind and ocean currents push the litter around, sometimes over long distances,[15] resulting in greater concentrations of plastic in certain areas. For instance, plastic litter tends to concentrate in the *gyres*, the five regions of the ocean where currents come together.[16] Alarmingly, plastic marine litter can be found in ocean waters worldwide,[17] as well as in seafloor sediments[18] and coastal sands.[19] Litter may be found throughout the ocean column both because plastics are manufactured at many different densities and because "biofouling," the growth of marine organisms on floating plastics, can cause the plastics to sink.[20]

Left in the marine environment, chemical reactions combined with the motion of wind and currents gradually break larger plastic items

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12. *See* MOORE, *supra* note 7, at 209.

13. *See* Jung et al., *supra* note 11, at 1523.

14. *See Containers Lost at Sea*, WORLD SHIPPING COUNCIL 1 (Aug. 2011), http://www.worldshipping.org/industry-issues/safety/Containers_Overboard__Final.pdf; Janice Podsada, *Lost Sea Cargo: Beach Bounty or Junk?*, NAT'L GEOGRAPHIC NEWS (June 19, 2001), http://news.nationalgeographic.com/news/2001/06/0619_seacargo.html.

15. *See, e.g.*, Monica F. Costa et al., *On the Importance of Size of Plastic Fragments and Pellets on the Strandline: A Snapshot of a Brazilian Beach*, 168 ENVTL. MONITORING & ASSESSMENT 299, 301 (2010) (describing how plastic pre-production pellets known as nurdles can be carried to almost every habitat by ocean currents and wind.).

16. *See* MOORE, *supra* note 7, at 54; Kara Lavender Law et al., *Plastic Accumulation in the North Atlantic Subtropical Gyre*, 329 SCIENCE 1185, 1186 (2010).

17. *See* THOMPSON ET AL., *supra* note 2, at 5.

18. *See* F. Galgani et al., *Litter on the Sea Floor Along European Coasts*, 40 MARINE POLLUTION BULL. 516, 516-17 (2000); B.S. Galil et al., *Litter at the Bottom of the Sea: A Sea Bed Survey in the Eastern Mediterranean*, 30 MARINE POLLUTION BULL. 22, 24 (1995).

19. *See* Mark Anthony Browne et al., *Accumulation of Microplastic on Shorelines Worldwide: Sources and Sinks*, 45 ENVTL. SCI. & TECH. 9175, 9178 fig. 2 (2011); Karla J. McDermid & Tray L. McMullen, *Quantitative Analysis of Small-Plastic Debris on Beaches in the Hawaiian Archipelago*, 48 MARINE POLLUTION BULL. 790, 792 (2004).

20. *See* Matthew Cole et al., *Microplastics as Contaminants in the Marine Environment: A Review*, 62 MARINE POLLUTION BULL. 2588, 2592 (2011).

down into smaller particles.[21] Most plastics never biodegrade in the ocean, but rather continue to break down into tiny particles (i.e., particles smaller than 1 millimeter (mm)) called *secondary microplastics*. Notably, *primary microplastics*—plastic particles that are already tiny—also can enter the ocean. Common sources of primary microplastics include microplastic spills from industrial processing sites or ships,[22] facial scrubs and cosmetic products containing plastic microbeads,[23] industrial spraying and scrubbing of boat hulls,[24] and plastic-based clothing.[25] Microplastics are ubiquitous in marine and coastal environments and are a growing cause of environmental concern.[26]

Plastic marine litter has wide-ranging adverse environmental, public health, and economic impacts. Marine litter's most visible environmental impact is harming and killing wildlife through entanglement and ingestion.[27] A 2012 study reported that marine litter had previously impacted 663 species, and more than half of impacted species ingested or were entangled by plastic.[28] Entanglement can cause death by drowning or strangulation, inflict wounds, or result in other harm, such as decreased ability to catch food or avoid predators.[29] Lost or abandoned fishing nets and lines adrift in the ocean can cover long distances and

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21. *See id.* at 2589-90; Richard Thompson et al., *Lost at Sea: Where Is All the Plastic?*, 304 SCIENCE 838, 838 (2004); Murray R. Gregory & Anthony L. Andrady, *Plastics in the Marine Environment*, *in* PLASTICS AND THE ENVIRONMENT 379, 389-90 (Anthony L. Andrady ed., 2003).

22. *What's Plastic Resin Pellet?*, INT'L PELLET WATCH, http://www.pelletwatch.org/en/what.html (last visited Mar. 2, 2014); Cole et al., *supra* note 20, at 2590-91.

23. *See* Lisa S. Fendall & Mary A. Sewell, *Contributing to Marine Pollution by Washing Your Face: Microplastics in Facial Cleansers*, 58 MARINE POLLUTION BULL. 1225, 1225 (2009).

24. David K.A. Barnes et al., *Accumulation and Fragmentation of Plastic Debris in Global Environments*, 364 PHIL. TRANSACTIONS ROYAL SOC'Y B 1985, 1994 (2009).

25. *See* Browne et al., *supra* note 19, at 9176.

26. *See id.* at 9175; Mark A. Browne et al., *Microplastic—An Emerging Contaminant of Potential Concern?*, 3 INTEGRATED ENVTL. ASSESSMENT & MGMT. 559, 559 (2007); Amandine Collignon et al., *Neustonic Microplastic and Zooplankton in the North Western Mediterranean Sea*, 64 MARINE POLLUTION BULL. 861, 861 (2012); Costa et al., *supra* note 15, at 301, 303; Juliana A. Ivar do Sul, Ângela Spengler & Monica F. Costa, *Here, There and Everywhere. Small Plastic Fragments and Pellets on Beaches of Fernando de Noronha (Equatorial Western Atlantic)*, 58 MARINE POLLUTION BULL. 1236, 1236 (2009).

27. *See generally* Monterey Bay Aquarium Research Inst., *Trash in the Deep Sea: Bringing a Hidden Problem to Light*, YOUTUBE (June 5, 2013), http://www.youtube.com/watch?v=mOZngsJU2k0.

28. *CBD Technical Series No. 67, Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions*, SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY 9 (2012), http://www.cbd.int/doc/publications/cbd-ts-67-en.pdf.

29. Derraik, *supra* note 7, at 846 (discussing several studies examining the detrimental effects of entanglement).

continue to entangle marine wildlife indiscriminately for years in a process often referred to as "ghost fishing."[30]

Organisms of all sizes, from small marine invertebrates to whales, have been found to ingest plastics.[31] Ingestion can cause choking, starvation, and other harm, such as reduced appetite, digestive tract blockages, and internal injuries.[32] Although the full range of consequences of plastic ingestion for wildlife is not yet fully understood, studies have shown that plastic ingestion negatively impacts overall organism health and reproductive rates.[33] Smaller plastics increase the potential threat to the marine environment because a wide range of organisms can ingest them in huge quantities.[34] As an illustration, a recent study estimated that a single population of fish in the North Pacific Subtropical Gyre consumed 12,000 to 24,000 tons of plastic.[35]

Using Fulmars To Track Plastic Marine Litter
Researchers frequently use a seabird called the **fulmar** to study and track plastic marine litter.[36] Up to 94% of analyzed fulmars contain plastic in their stomachs.[37] Seabirds like fulmars commonly ingest plastic they confuse with prey, or consume prey that has itself ingested plastic.[38] The plastic found in fulmar stomachs provides some insight into regional and temporal trends in plastics composition. For example, while the typical amount of plastic in fulmar stomachs has remained roughly the same since

30. *See* MOORE, *supra* note 7, at 200.

31. *See id.* at 222-23; Mark A. Browne et al., *Ingested Microscopic Plastic Translocates to the Circulatory System of the Mussel,* Mytilus edulis *(L.)*, 42 ENVTL. SCI. & TECH. 5026, 5026 (2008); Thompson et al., *supra* note 21.

32. *See* JORT HAMMER ET AL., PLASTICS IN THE MARINE ENVIRONMENT: THE DARK SIDE OF A MODERN GIFT 24-27 (2012); Sci. for Envtl. Policy, *Directorate—Gen. Env't, Plastic Waste: Ecological and Human Health Impacts*, EUROPEAN COMM'N 17 (Nov. 2011), http://ec.europa.eu/environment/integration/research/newsalert/pdf/IR1.pdf [hereinafter *Plastic Waste*]; *see also* Christiana M. Boerger et al., *Plastic Ingestion by Planktivorous Fishes in the North Pacific Central Gyre*, 60 MARINE POLLUTION BULL. 2275, 2277 (2010) (noting that, among other harms, plastic ingestion could increase fish buoyancy, making it more difficult for fish to descend to deeper waters).

33. *See* Jörg Oehlmann et al., *A Critical Analysis of the Biological Impacts of Plasticizers on Wildlife*, 364 PHIL. TRANSACTIONS ROYAL SOC'Y B 2047, 2057 (2009).

34. *See* Collignon et al., *supra* note 26, at 861; Peter Davison & Rebecca G. Asch, *Plastic Ingestion by Mesopelagic Fishes in the North Pacific Subtropical Gyre*, 432 MARINE ECOLOGY PROGRESS SERIES 173, 178 (2011); Boerger et al., *supra* note 32, at 2276-77; Thompson et al., *supra* note 21; *see also* C.J. Moore et al., *A Comparison of Plastic and Plankton in the North Pacific Central Gyre*, 42 MARINE POLLUTION BULL. 1297, 1299 (2001).

35. *See generally* Davison & Asch, *supra* note 34.

36. *See, e.g.*, *Plastic Waste*, *supra* note 32, at 14.

37. *Litter in the Marine Environment—Plastic Particles in Fulmar Stomachs*, OSPAR COMM'N (2013), http://www.ospar.org/html_documents/ospar/html/data/assessment_fact_sheets/ospar_assessment_sheet_fulmar_2013.pdf.

38. *Plastic Waste*, *supra* note 32, at 13.

the 1980s, the composition of plastic types has shifted over time from mostly industrial plastics (e.g., plastic pellets) to mostly consumer plastics (e.g., bottle caps).[39] Fulmars also demonstrate some of the biological processes that transform and redistribute plastics; fulmars break down ingested plastics in their stomachs and then excrete smaller plastics.[40] Amazingly, it is estimated that fulmars annually reshape and redistribute 6 tons of plastic.[41]

Given these characteristics, seabirds like fulmars show promise as an indicator to track the effectiveness of plastic marine litter policies. For instance, the OSPAR Commission, which implements the OSPAR Convention to Protect the Marine Environment of the North-East Atlantic, uses northern fulmars to track regional efforts to reduce plastic marine litter.[42] The Commission has set a policy objective that no more than 10% of a certain category of fulmars should have more than 0.1 grams of plastic particles in their stomachs.[43] Unfortunately, no area in the Northeast Atlantic currently meets this objective.

Plastic marine litter also could have harmful chemical impacts on wildlife, ecosystems, and human health. We know that plastics in the marine environment can absorb many contaminants already present in seawater, including agricultural, industrial, and pest control chemicals such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and aqueous metals.[44] These contaminants have been linked to disease, reproductive abnormalities, and other health impacts in wildlife as well as humans.[45] Plastics can contain up to one million times more PCBs than their surrounding waters, which potentially increases the exposure of marine wildlife to these chemicals.[46]

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39. *Id.* at 14.
40. *Id.* at 7.
41. *Id.*
42. *See Litter in the Marine Environment—Plastic Particles in Fulmar Stomachs*, *supra* note 37.
43. *Id.*
44. Yukie Mato et al., *Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment*, 35 ENVTL. SCI. & TECH. 318, 318 (2001).
45. Charlotte Stevenson, Univ. of S. Cal. Sea Grant, *Plastic Debris in the California Marine Ecosystem: A Summary of Current Research, Solutions and Data Gaps*, CAL. OCEAN SCI. TRUST 23 (2011), http://calost.org/pdf/science-initiatives/marine%20debris/Plastic%20Report_10-4-11.pdf.
46. *Marine Debris Impacts*, EPA, http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm (last updated Mar. 6, 2012); *see also Marine Debris in the North Pacific: A Summary of Existing Information and Identification of Data Gaps*, EPA 9-10 (Nov. 2011), http://www.epa.gov/region9/marine-debris/pdf/MarineDebris-NPacFinalAprvd.pdf (summarizing the chemical impact of plastic debris).

Chemicals added to plastics as part of the production process pose an additional concern.[47] Additives such as bisphenol A (BPA), plasticizers (phthalates), and flame-retardant chemicals (polybrominated diphenyl ethers, or PBDEs) are linked to endocrine disruption in wildlife and humans.[48] These additives can dissociate from plastics in the environment and contaminate seawater, or contaminate organisms that ingest plastic litter.[49] Plastic ingestion by smaller organisms leads to a greater potential for bioaccumulation of contaminants, potentially impacting the entire food chain.[50] While further research is needed to determine the proportion of organismal chemical loads that stems from plastics as well as what levels of these chemicals pose a threat to humans, it is clear that an increasing amount of plastic marine litter increases potential risks to humans and wildlife.[51]

Plastic marine litter also degrades marine habitats by introducing foreign substrates and exotic organisms. For example, abandoned nets can strand onto sensitive coral reef habitats,[52] and hard-surfaced shipping containers can land on the soft-bottom seafloor and disrupt soft-bottom populations.[53] Plastic marine litter is even beginning to form its own habitat, the "Plastisphere," which supports communities of organisms that differ from those in the surrounding ocean environment.[54] Plastics

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47. *See generally* Richard E. Engler, *The Complex Interaction Between Marine Debris and Toxic Chemicals in the Ocean*, 46 ENVTL. SCI. & TECH. 12,302 (2012).

48. Stevenson, *supra* note 45, at 24, 26-27; Chris E. Talsness et al., *Components of Plastic: Experimental Studies in Animals and Relevance for Human Health*, 364 PHIL. TRANSACTIONS ROYAL SOC'Y B 2079, 2079 (2009).

49. *See* MOORE, *supra* note 7, at 254, 268; *see also* Hideshige Takada, *Microplastics and the Threat to Our Seafood*, OCEAN HEALTH INDEX (May 10, 2013), http://www.oceanhealthindex.org/News/Microplastics (describing a recent study determining that two types of flame retardant chemicals found in seabirds likely originated in ingested plastics).

50. MOORE, *supra* note 7, at 252-53; *see also* JOINT GRP. OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE ENVTL. PROT. (GESAMP), REPORTS & STUDIES NO. 82, PROCEEDINGS OF THE GESAMP INTERNATIONAL WORKSHOP ON MICROPLASTIC PARTICLES AS A VECTOR IN TRANSPORTING PERSISTENT, BIO-ACCUMULATING AND TOXIC SUBSTANCES IN THE OCEANS 18 (Tim Bowmer & Peter Kershaw eds., 2010), *available at* http://www.gesamp.org/data/gesamp/files/media/Publications/Reports_and_studies_82/gallery_1510/object_1670_large.pdf (suggesting that wildlife ingestion of microplastics could lead to greater contaminant exchange because microplastics have a high surface-area-to-volume ratio).

51. *See Plastic Waste*, *supra* note 32, at 20-21; Engler, *supra* note 47, at 12,308-09; Talsness et al., *supra* note 48, at 2090.

52. MOORE, *supra* note 7, at 206; *see* THE HONOLULU STRATEGY, *supra* note 2, at 6.

53. *See* THE HONOLULU STRATEGY, *supra* note 2, at 6.

54. Erik R. Zettler et al., *Life in the "Plastisphere": Microbial Communities on Plastic Marine Debris*, 47 ENVTL. SCI. & TECH. 7137, 7140-41 (2013); *see also* Miriam C. Goldstein et al., *Increased Oceanic Microplastic Debris Enhances Oviposition in an Endemic Pelagic Insect*, 8 BIOLOGY LETTERS 817, 817-18 (2012) (finding that increasing microplastic concentrations over the last forty years in the North Pacific Subtropical Gyre has increased available habitat in the water for a species of pelagic insect to lay eggs and resulted in increased egg density).

also are a potential vector for invasive species or other harmful species such as spores of harmful algal blooms.[55] Furthermore, plastic marine litter is responsible for ocean collisions that have resulted in human injuries and deaths.[56]

For all of these reasons and more, plastic marine litter has significant economic impacts. Marine litter imposes costs on industries, governments, and individuals through cleanup activities,[57] tourism losses, damage to commercial and recreational vessels,[58] and lost fishing revenue.[59] For example, a recent report from the Asia Pacific Economic Cooperation found that its member economies lost more than $1 billion per year to marine litter impacts such as cleanup and damage to vessels.[60] A recent study estimates that communities in Oregon, California, and Washington are spending $13 per resident per year to combat and clean up trash, which translates to an estimated annual combined expenditure of $520 million.[61] Smaller plastics and microplastics can complicate the efficacy and increase the cost of cleanup efforts because they become thoroughly intermingled with beach sands and cannot be removed

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55. *See generally* Mercedes Masó et al., *Drifting Plastic Debris as a Potential Vector for Dispersing Harmful Algal Bloom (HAB) Species*, 67 SCIENTIA MARINA 107 (2003); GESAMP WORKING GROUP 40, SOURCES, FATE & EFFECTS OF MICRO-PLASTIC IN THE MARINE ENVIRONMENT: A GLOBAL ASSESSMENT 17 (2012), *available at* http://www.plasticseurope.org/cust/documentrequest.aspx?DOCID=53872 (noting that microplastic is an emerging issue in need of study, particularly with regard to its abilities to serve as new habitat for alien species and transport exotic diseases and anthropogenic chemical compounds).

56. MOORE, *supra* note 7, at 205.

57. *See generally* John Mouat et al., *Economic Impacts of Marine Litter*, KOMMUNENES INTERNASJONALE MILJØORGANISASJON (Sept. 2010), http://www.kimointernational.org/WebData/Files/Marine%20Litter/Economic%20Impacts%20of%20Marine%20Litter%20Low%20Res.pdf.

58. MOORE, *supra* note 7, at 321; *see, e.g.*, Dong-Oh Cho, *Challenges to Marine Debris Management in Korea*, 33 COASTAL MGMT., 389, 394 (2005); Alistair McIlgorm et al., *The Economic Cost and Control of Marine Debris Damage in the Asia-Pacific Region*, 54 OCEAN & COASTAL MGMT. 643, 644 (2011); Suichi Takehama, *Estimation of Damages to Fishing Vessels Caused by Marine Debris, Based on Insurance Statistics*, *in* PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE ON MARINE DEBRIS 792, 799 (R.S. Shomura & M.L. Godfrey eds., 1990), *available at* http://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-154_P792.PDF.

59. *See* Dong-Oh Cho, *The Incentive Program for Fisherman To Collect Marine Debris in Korea*, 58 MARINE POLLUTION BULL. 415, 415 (2009); UNEP YEAR BOOK, *supra* note 2, at 28 (reporting that marine litter costs the Scottish fishing industry between $15 million and $17 million annually, which represents 5% of total revenue).

60. *See* McIlgorm et al., *supra* note 58, at 647.

61. Kier Assocs., *The Cost to West Coast Communities of Dealing with Trash, Reducing Marine Debris*, EPA 1 (Sept. 2012), http://www.epa.gov/region9/marine-debris/pdf/WestCoastCommsCost-MngMarineDebris.pdf; *see also* Mouat et al., *supra* note 57, at 39-40 (noting that in some United Kingdom municipalities, the inflation-adjusted cost of cleaning up marine litter has increased 38% over the past ten years and that United Kingdom municipalities now spend an estimated combined $23 million annually to clean up marine litter).

effectively by traditional beach grooming techniques such as raking or sieving.

Plastic litter also is partially responsible for substantial lost tourism revenue because tourists pay fewer visits to beaches heavily polluted by marine litter. Studies have estimated that tourism is depressed on the Skagerrak coast of Bohuslan in Sweden by 1% to 5% as a result of beach litter, resulting in a calculated annual loss of approximately £15 million ($23.4 million).[62] Additionally, communities incur costs due to loss of ecosystem services such as healthy fisheries and the aesthetic appeal of clean beaches. Further research into quantifying the economic benefits of healthy coastal and ocean ecosystems would aid in the creation of cost-benefit analyses that accurately reflect the cost of environmental degradation associated with plastic marine litter.

III. THE LIMITS OF EXISTING INTERNATIONAL LAW IN ADDRESSING PLASTIC MARINE LITTER

The problem of plastic marine litter has obvious international dimensions. Plastic litter often affects the marine environment of the high seas outside the jurisdiction of any one nation or group of nations. Because wind and ocean currents can transport plastic marine litter over long distances, areas most plagued by litter often have very little control over the production or disposal of that litter. Sources of plastic litter are spread across the globe, and absent a coordinated international response, efforts to restrict plastic production or disposal in one area may be undermined by "leakage" of those sources in an unregulated area.

We surveyed multilateral environmental instruments and institutions and assessed their sufficiency to address the problem of plastic marine litter. Several international agreements designed to address marine pollution are potentially relevant to reducing plastic marine litter, including the United Nations Convention on the Law of the Sea (UNCLOS), the International Convention for the Prevention of Pollution From Ships (MARPOL), and the Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter, also known as the London Dumping Convention. Some of the most promising regionally focused agreements and directives include the European Marine Strategy Framework Directive, Barcelona Convention, Cartagena

62. TIM FANSHAWE & MARK EVERARD, MARINE POLLUTION MONITORING MGMT. GRP., THE IMPACTS OF MARINE LITTER 16 (2002), *available at* http://www.scotland.gov.uk/Uploads/Documents/Impacts%20of%20Marine%20Litter.pdf.

Convention, Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), and Helsinki Convention.

Though each of the international instruments mentioned above is potentially helpful, collectively their shortcomings make them unlikely to lead to significant reductions of plastic marine litter. Overall, as we discuss in further detail below, their insufficient scope with respect to the main sources of plastic pollution, lack of enforceable standards, and insufficient penalties mean that no existing agreement comprehensively addresses the problem of plastic marine litter.

Table 1. Selected International Instruments Relevant to Plastic Marine Litter

Agreement	Scope of Regulation	Enforcement & Dispute Resolution
International Convention for the Prevention of Pollution from Ships (MARPOL)	Pollution and dumping from ships due to operational losses or accidents.[63]	Flag state responsible for imposing fees and fines.[64]
MARPOL Annex V[65]	Plastics disposed at sea; port reception facilities.	
U.N. Convention on the Law of the Sea (UNCLOS)[66]	Prevention of pollution from ships;[67] land-based sources of pollution;[68] dumping and pollution transfer from one nation to another.[69]	Members can settle disputes by any peaceful means chosen by them; if no settlement is reached, compulsory procedures available are (a) the International Tribunal for the Law of the Sea; (b) the International Court of

63. International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M. 1319, *modified by* Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, Feb. 17, 1978, 1340 U.N.T.S. 62 [hereinafter MARPOL Annex V].

64. International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M. 1322, art. 4.

65. MARPOL Annex V, *supra* note 63.

66. United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

67. *Id.* art. 211.

68. *Id.* art. 207.

69. *Id.* art. 208.

Agreement	Scope of Regulation	Enforcement & Dispute Resolution
		Justice; or (c) arbitral tribunals.[70]
London Dumping Convention	Land-based waste on ships for deliberate at-sea disposal.[71]	Each member regulates discharges of waste on its own ships.[72]
Barcelona Convention	Land- and ocean-based waste from dumping, runoff, and discharges (including plastics) in the Mediterranean Sea region.[73]	Negotiated settlement preferred; if no agreement is reached, an arbitral tribunal of three members elected by the parties or appointed by the U.N. Secretary-General will be used.[74]
Cartagena Convention	Pollution from ships; dumping at sea; land-based sources of pollution in the Wider Caribbean Region.[75]	United Nations, as secretariat, can initiate limitations and deadlines; monitor waste management infrastructure.[76]
European Marine Strategy Framework Directive	All litter in European Union seas based on where it is found (e.g., washed ashore, in water column, ingested by marine animals) and type (e.g., microplastics).[77]	Members must implement cost-effective programs in compliance with other sea treaties by 2016 to achieve good environmental status by 2021.[78]

70. *Id.* pt. XV.

71. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter art. III, Dec. 29, 1972, 26 U.S.T. 2407.

72. *Id.* art. VI.

73. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean arts. 5-8, June 10, 1995, 1102 U.N.T.S. 27.

74. *Id.* art. 28.

75. Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region arts. 5-7, Mar. 24, 1983, 1506 U.N.T.S. 157 [hereinafter Cartagena Convention].

76. *Id.* art. 15.

77. Council Directive 2008/56/EC, 2008 O.J. (L 164) 19, 36-37 (establishing a framework for community action in the field of marine environmental policy) (Marine Strategy Framework Directive). *See generally* Ángel Borja, *The New European Marine Strategy Directive: Difficulties, Opportunities, and Challenges*, 52 MARINE POLLUTION BULL. 239 (2006).

78. Council Directive 2008/56/EC, *supra* note 77, art. 13, at 29; Borja, *supra* note 77, at 240 tbl.1.

Agreement	Scope of Regulation	Enforcement & Dispute Resolution
Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)	Land-based pollution from rivers, estuaries, and storm drains.[79]	Nonbinding framework provides guidance only.
Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)	European ship discharges; lost and discarded fisheries materials from vessels; land-based wastes from coastal or riverine disposal; recreational littering.[80]	Negotiated settlement preferred; if no agreement is reached, an arbitral tribunal of three members elected by the parties or appointed by the U.N. Secretary-General will be used.[81]
Helsinki Convention	Marine pollution from all sources (including point source or diffuse inputs from all land-based sources; pollution from tunnels or pipelines deliberately discharged into waterways).[82]	Members must establish legislation for prevention and abatement of marine pollution;[83] disputes should be submitted to an arbitration tribunal or the International Court of Justice.[84]

79. Intergovernmental Conference To Adopt a Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities, Washington, D.C., Oct. 23-Nov. 3, 1995, *Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities* 54-56, U.N. DOC. UNEP(OCA)/LBA/IG.2/7 (Dec. 5, 1995).

80. Convention for the Protection of the Marine Environment of the North-East Atlantic arts. 3-5, Sept. 22, 1992, 2354 U.N.T.S. 67, 32 I.L.M. 1069 [hereinafter OSPAR].

81. *Id.* art. 32.

82. Convention on the Protection of the Marine Environment of the Baltic Sea Area art. 2, Apr. 9, 1992, 1507 U.N.T.S. 167.

83. *Id.* annex IV.

84. *Id.* art. 26.

***Soft Law* versus *Hard Law*: Understanding International Agreements and Programs**[85]
Generally speaking, international instruments addressing marine litter can be divided into two categories: *soft law* and *hard law*. Soft law describes nonbinding arrangements between parties (e.g., the GPA). Soft law agreements include regional strategic **action plans**, **declarations**, and **resolutions** adopted by conferences, intergovernmental organizations, and international institutions. In contrast, hard law describes legally binding contracts, often called **conventions**, with compulsory requirements or legal operations (e.g., UNCLOS). Hard law agreements generally apply to a specific land area and jurisdictional area of the marine environment, as determined by parties. Hard law agreements often refer to a **protocol** that provides detailed information on legal standards the parties must meet. Protocols may address topics such as emergency plans, integrated coastal zone management, and regulation of land-based activities. Because protocols are legally binding, they may require many years of negotiation to alter. Where marine litter falls under an existing protocol, the existing protocol can serve as a legally binding foundation for the development of new action plans to address issues such as strategic monitoring and assessment of marine litter. Existing protocols can also support multiple **annexes** that provide additional details about factors such as permitting, criteria to establish and address priority pollutants, and how to apply the protocol to a specific pollution source. Unfortunately, many hard law agreements and protocols are neither implemented nor enforced. Additionally, although annexes to protocols can be legally binding, parties to a convention often are allowed to pick and choose which annexes they want to sign.

85. *See generally* U.N. ENV'T PROGRAMME, IMPLEMENTATION OF THE GPA AT REGIONAL LEVEL: THE ROLE OF REGIONAL SEAS CONVENTIONS AND THEIR PROTOCOLS (2006), *available at* http://www.unep.org/pdf/GPA/The_Role_of_Regional_Seas_Conventions_and_their_Protocols.pdf (discussing sources of law in international pollution control).

What Is the Regional Seas Programme?[86]

The United Nations Environment Programme (UNEP) established its **Regional Seas Programme** in 1974 to foster the development of environmental management plans for water bodies shared by two or more countries.[87] Today, more than 143 countries participate in one of eighteen regional seas and partner programs covering: the **Antarctic**, **Arctic**, **Baltic Sea**, **Black Sea**, **Caspian Sea**, **Eastern Africa**, **East Asian Seas**, **Mediterranean**, **Northeast Atlantic**, **Northeast Pacific**, **Northwest Pacific**, **Pacific**, **Red Sea & Gulf of Aden**, **Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area**, **South Asian Seas**, **Southeast Pacific**, **Western Africa**, and **Wider Caribbean**.[88]

The majority of the regional programs are implemented by member states through action plans, which set forth both the operative legal framework for the program and a comprehensive environmental management strategy. Thirteen of the regional programs have adopted legally binding conventions detailing actions member states must take to implement those action plans[89] (e.g., the Barcelona Convention and Cartagena Convention), and most of these conventions are supplemented by protocols addressing specific marine degradation concerns. Action plans and conventions are tailored to the particular environmental characteristics and restoration needs of the region.

In comparison to broader international agreements, the regional programs tend to address plastic pollution issues with less ambiguity by taking into account the ecological and economic climate of the region at issue. However, the potential of the Regional Seas Programme to stem the tide of plastic marine litter is limited. Currently, some regions of the world's oceans are not covered by a regional program (e.g., the Southeast Atlantic). Also, as described above, some regional seas programs have created more meaningful, enforceable standards than others. Even where a legally binding convention exists, it is not always clear how an action plan relates to the convention or its protocol. Furthermore, the terms of regional conventions must be incorporated into a party's domestic law in order for the party to enforce the agreement against violators. To date, no regional seas program has been used in any significant way to enforce prohibitions on marine

86. *See generally id.*; Matthew Schroeder, Comment, *Forgotten at Sea—An International Call To Combat Islands of Plastic Waste in the Pacific Ocean*, 16 SW. J. INT'L LAW 265 (2010); P. Akiwumi & T. Melvasalo, *UNEP's Regional Seas Programme: Approach, Experience and Future Plans*, 22 MARINE POL'Y 229 (1998); *Regional Seas Programme: Background*, REGIONAL SEAS PROGRAMME, U.N. ENV'T PROGRAMME, http://www.unep.org/regionalseas/about/background/default.asp (last visited Mar. 3, 2014); *Regional Seas Conventions*, U.N. ENV'T PROGRAMME, http://www.unep.org/regionalseas/programmes/conventions/default.asp (last visited Mar. 3, 2014).

87. *Regional Seas Programme: About*, U.N. ENV'T PROGRAMME, http://www.unep.org/regionalseas/about/default.asp (last visited Mar. 3, 2014).

88. *Id.*

89. *Regional Seas Programme: Background*, *supra* note 86.

debris. And no regional seas program currently provides for sanctions against violating parties. Nonetheless, some countries are starting to publicize violations to gain public support for marine litter programs.

A. Existing International Agreements Have Limited Jurisdiction over the Main Sources of Plastic Pollution

Most troublingly, existing international agreements largely neglect land-based sources of plastics, which are estimated to be responsible for the majority of plastic litter in oceans.[90] The London Dumping Convention, for example, regulates only land-based waste loaded onto ships for purposes of at-sea disposal.[91] Those instruments that do speak to land-based sources are largely nonbinding or limited in scope.[92] For instance, UNCLOS acknowledges the existence of land-based sources but simply requests that countries address the problem through domestic means.[93]

Furthermore, the various exemptions and opt-out provisions in existing international treaties perpetuate the problem of careless handling of plastics at sea and further limit the treaties' effectiveness. No agreement covers all of the main sources of plastic marine litter, and many agreements make express exemptions for major sources.[94] For instance, UNCLOS does not penalize ships for the "incidental" loss of otherwise prohibited waste.[95] The London Dumping Convention does not regulate ship-generated waste and expressly permits disposal "incidental to, or derived from the normal operation of vessels."[96] Annex V of MARPOL, which broadly prohibits the "disposal into the sea of all plastics,"[97] nonetheless exempts accidental loss or disposal of plastic resulting from damage to the ship or its equipment.[98] The United States Coast Guard's interim rule implementing Annex V also exempts warships, naval auxiliary, and other state-operated ships from Annex V's requirements, leaving navy ships and crew members free to discharge

90. *See* Derraik, *supra* note 7, at 843-44.

91. *See* Yale Lewis, Comment, *Cargo Residues & Cargo-Associated Garbage: Are They Regulated by the Ocean Dumping Act or the Act To Prevent Pollution from Ships?*, 14 U.S.F. MAR. L.J. 269, 273-76 (2002).

92. *See* Schroeder, *supra* note 86, at 276.

93. UNCLOS, *supra* note 66, art. 207.

94. *See* Paul E. Hagen, *The International Community Confronts Plastics Pollution from Ships: MARPOL Annex V and the Problem That Won't Go Away*, 5 AM. U. INT'L L. REV. 425, 445, 447-48 (1990).

95. *Id.* at 447 n.136.

96. Lewis, *supra* note 91, at 275; Hagen, *supra* note 94, at 445-46.

97. MARPOL Annex V, *supra* note 63, reg. 3(1)(a).

98. *Id.* reg. 6(b).

waste without restriction.[99] Moreover, several parties to MARPOL have not yet ratified Annex V.

In addition, even where an existing international treaty includes a clear standard, jurisdictional limitations may inhibit enforcement. Generally, when a ship flying a foreign flag violates an existing international treaty, only the foreign-flag state has jurisdiction to investigate the violation and impose penalties.[100] Sometimes, treaties authorize coastal states to penalize foreign-registered or -flagged vessels traveling in the state's territorial waters or exclusive economic zone (EEZ), which encompasses waters within 200 nautical miles off the coast—but even those powers are limited.[101] Under MARPOL, for example, coastal states responding to alleged violations in their territorial waters or EEZ have few avenues of recourse other than demanding information from the suspect vessel.[102] If the suspect vessel does not supply the requested information, the coastal state may physically inspect and prosecute a vessel only if it anticipates an imminent threat to the state's coastline, which is a very high burden to meet.[103] Regional treaties contain better enforcement mechanisms, but they typically apply only to the EEZ.[104] And while UNCLOS extends to the high seas and external waters, its enforceability provisions apply only to willful dumping of waste at sea.[105]

B. Existing International Agreements Lack Enforceable Standards

Another common problem with existing agreements is their lack of enforceable standards.[106] UNCLOS, for example, requires only that nations "shall endeavor" to use the "best practical means" to reduce marine pollution "in accordance with their capabilities."[107] Similarly, the Helsinki Convention asks contracting parties to take "all appropriate . . .

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99. Implementation of MARPOL Annex V Amendments, 78 Fed. Reg. 13,481, 13,491 § 151.51 (Feb. 28, 2013) (to be codified at 33 C.F.R. 151.51).

100. *See* Jeffrey S. Dehner, Comment, *Vessel-Source Pollution and Public Vessels: Sovereign Immunity v. Compliance, Implications for International Environmental Law*, 9 EMORY INT'L L. REV. 507, 514 (1995).

101. *See* Hagen, *supra* note 94, at 448 n.143.

102. *Id.* at 476.

103. *Id.*

104. Ted L. McDorman, *Port State Enforcement: A Comment on Article 218 of the 1982 Law of the Sea Convention*, 28 J. MAR. L. & COM. 305, 307 (1997).

105. *See* Hagen, *supra* note 94, at 447-48.

106. *See* Dehner, *supra* note 100, at 535.

107. *Id.*

measures to prevent and eliminate pollution."[108] The OSPAR Convention and the Cartagena Convention go further, instructing parties to take "all possible steps" and "all appropriate measures," respectively, to prevent and control pollution—a much stronger mandate, but one that obviously is still difficult to define and enforce.[109] Indeed, it is hard to know what the phrases "best practical means," "all appropriate measures," or even "all possible measures" require of countries with differing legal systems, environmental circumstances, and capacities.

C. Existing International Agreements Have Insufficient Enforcement Mechanisms

Penalties imposed under existing international marine pollution treaties are often insufficient to deter unlawful behavior. MARPOL, for example, does not require the imposition of specific penalties for violations.[110] Instead, the agreement instructs each party to establish its own penalty framework through domestic enabling legislation.[111] Where individual countries have constructed MARPOL penalty schemes, the penalties are insufficient to deter violators. The United States has one of the strongest and most comprehensive domestic implementing laws under MARPOL: The Act To Prevent Pollution from Ships.[112] Yet, according to the United States General Accounting Office, as of 1995, less than 10% of cases brought under MARPOL Annex V had resulted in penalties against the violating party.[113] Most often, the Coast Guard settles MARPOL violations with a warning, dismissal, or referral of the case to the ship's flag state.[114] Those parties that were penalized were fined an average of $6200 per case, an amount that is far too low to serve as an effective deterrent.[115]

The difficulty of identifying ocean-based sources of illegal disposal further complicates enforcement.[116] To enforce obligations under

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108. Convention on the Protection of the Marine Environment of the Baltic Sea Area, *supra* note 82, art. 3.

109. OSPAR, *supra* note 80, arts. 3-5; Cartagena Convention, *supra* note 75, arts. 5-7.

110. *See* Dehner, supra note 100, at 541.

111. HOLLY R. KOEHLER ET AL., LEGAL INSTRUMENTS FOR THE PREVENTION AND MANAGEMENT OF DISPOSAL AND LOSS OF FISHING GEAR AT SEA 6, *available at* http://hawaiihumpbackwhale.noaa.gov/graphics/special_offerings/Issue_Paper_1.pdf; *see also* Dehner, *supra* note 100, at 537 ("[T]he laws of the vessel's flag state define the scope of such fines and penalties.").

112. *See* Lewis, *supra* note 91, at 290-94.

113. U.S. GEN. ACCOUNTING OFFICE, ENFORCEMENT UNDER MARPOL V CONVENTION ON POLLUTION EXPANDED, ALTHOUGH PROBLEMS REMAIN 5 (1995).

114. *Id.* at 6.

115. *See id.* at 5.

116. Schroeder, *supra* note 86, at 275.

UNCLOS, for example, a state must witness a violator in the overt act of illegally disposing waste or must acquire sufficient evidence to warrant investigation of the suspect vessel.[117] However, without tracking systems, it is extremely difficult to link waste disposal to a particular ship.[118] While some agreements require vessel record keeping systems to assist in tracking illegal disposals, most do not.[119] The tracking systems that do exist are not comprehensive. Annex V of MARPOL, for instance, requires vessels that are 400 tons or more, or certified to carry fifteen or more passengers, to maintain a "Garbage Record Book,"[120] but it is challenging to verify whether ships are truthful in their assertions that they previously disposed of their waste at other incineration or port facility sites.[121]

IV. RECOMMENDATIONS

For the reasons described above and more, existing international legal mechanisms are inadequate to address the plastic marine litter crisis fully. New international legal mechanisms in tandem with regional, national, and subnational programs are required to realize significant reductions in plastic marine litter. We have examined current and historical efforts to address plastic marine litter, including both domestic and international programs, in order to draw lessons about which policy approaches are most likely to be successful.

As a first priority, given that the scope of existing international law fails to match the scale and severity of the plastic marine litter problem, we urge the global community to develop a new multilateral agreement on the scale and scope of the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol). This new agreement should incorporate enforceable marine litter standards as well as strong tracking, monitoring, reporting, and enforcement mechanisms, including adequate penalties and the establishment of jurisdiction for party dispute resolution at an international tribunal.

Acknowledging the long and uncertain path to a new agreement, we also recommend policy actions to extend the reach of existing international law and improve enforcement of existing obligations.

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117. *See id.*

118. *See* Hagen, *supra* note 94, at 474-75.

119. *See* Dehner, *supra* note 100, at 536, 545.

120. Int'l Maritime Org. [IMO], *Amendments to the Annex of the Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, 1973*, IMO Marine Env't Prot. Comm. Res. MEPC.201(62) (July 15, 2011), *available at* http://www.imo.org/blast/blastDataHelper.asp?data_id=30760&filename=201(62).pdf.

121. *See* Dehner, *supra* note 100, at 546-47; Schroeder, *supra* note 86, at 274.

International law can be strengthened in important respects to better support individual states with the political will to tackle this problem aggressively; however, in our view, international law is not likely to solve the plastic marine litter problem independent of domestic actions. Smaller-scale policies and programs should be scaled up rapidly at the regional, national, and local levels as partial solutions to the plastic marine litter problem. We list some of the most promising of these policies and programs below.

A. Develop a New International Agreement Targeted to the Plastic Marine Litter Problem

Ultimately, the world may only be able to reach the Rio+20 goal of "achiev[ing] significant reductions in marine debris to prevent harm to the coastal and marine environment" through an aggressive new international regime on the same scale as and with the efficacy of the Montreal Protocol.[122] The new agreement should be based in the recognition that ill-managed plastic litter is harmful to people, economies, and the environment. Additionally, the new agreement should address all of the main sources of plastic pollution and strictly regulate disposal of plastic litter from both ocean- and land-based sources, perhaps drawing from the land-based pollution standards of the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA).

The new agreement should incorporate strong tracking, monitoring, reporting, and enforcement mechanisms, including adequate penalties and the establishment of party dispute resolution before an international tribunal. Taking cues from the success of the Montreal Protocol, while recognizing the differences between this challenge and the one presented by ozone depletion, the new agreement should ban altogether the most common or damaging types of plastic marine litter (e.g., microbeads and fish-egg-sized nurdles) and support the development of and transition to product substitutes. For example, the new agreement could call for a phase-out of all plastics that are not recycled at a rate of 75% or higher by a certain date.

The process of developing a new agreement and cultivating the political will to adopt it likely would take years or decades. But because a new agreement will become increasingly necessary as the problem of plastic marine litter worsens, we believe that the world community must begin now to lay a framework for agreement. For countries with the

122. U.N. Conference, *supra* note 4.

capacity and political will to initiate the process toward a new agreement, immediate steps could include:

- Convening an international body of scientific experts to publish periodic assessments of current knowledge about the problem.
- Ramping up international public education efforts.
- Convening international leadership through the G8, G20, or the United Nations to begin developing a legal framework for a new agreement.
- Funding a data collection network to gather better information about the sources and effects of plastic marine litter, including economic, human health, and wildlife impacts and the efficacy of abatement programs. Given that the global scientific community already knows enough about the plastic marine litter problem to take immediate action, however, additional data collection should not be seen as a prerequisite for a proactive policy response.

Ultimately, we hope that the community of nations, with support from nongovernmental advocates, businesses, regional organizations, and local governments, and with better information about the plastic marine litter problem, will lead the way in negotiating a new agreement.

B. Amend Existing International Law To Narrow Exceptions and Improve Enforcement

Acknowledging the long and uncertain path to a new agreement, we recommend in the near term that treaty parties amend existing international legal obligations in useful, if incremental, ways. Small modifications could help eliminate some of the gaps in existing laws that have become apparent through the last decade of monitoring. Potential actions include the following:

- The parties to MARPOL should amend the current vessel size and tonnage limitations in Annex V for requirements respecting placards, garbage management plans, and garbage record keeping, so that fewer vessels are exempted.
- The parties to MARPOL should develop stronger qualitative and quantitative standards for port reception facilities, so that ships are more reliably and easily able to discharge their waste at ports worldwide.
- The parties to MARPOL should clarify the circumstances in which loss of fishing gear is prohibited by defining in Annex V when an

"accidental loss" will be deemed to have occurred despite "all reasonable precautions."

- Regional fisheries management organizations (RFMOs) should adopt management standards to minimize the impacts of gear loss. Standards should address reducing gear; minimizing gear loss; minimizing the impacts of lost gear; and improving gear marking, tracking, and recovery. Certification and tracking programs for fishing and aquaculture operations should require logs to track lost fishing gear, require traceable tags on nets, and encourage the use of more sustainable materials in aquaculture gear.
- RFMOs should move toward the replacement of plastic and synthetic gear with biodegradable nets and traps to minimize ghost fishing and entanglement.
- RFMOs should develop and incentivize gear-recovery programs that encourage fishing-for-gear programs.

In addition, we have identified several instances where current enforcement mechanisms and penalty structures could be improved. In general, all international agreements with enforceable standards relevant to plastic marine litter should require more thorough data collection through mechanisms such as vessel-tracking databases, port incineration logs, and waste disposal logs. Collected data should be made widely available online to the general public as well as to treaty parties. Improved data collection and publication not only could improve enforcement of treaty obligations but also could enhance the ability of states and advocates to pressure routine violators through public campaigns, political dialogue, consumer boycotts, transboundary lawsuits, and other means. Furthermore, we recommend imposing stiffer penalty schedules under MARPOL and all other agreements with enforceable standards.

Could Transboundary Adjudication Help Address the Plastic Marine Litter Crisis?
A state looking to take progressive action on the international stage to bring attention to the plastic marine litter crisis could seek redress for litter-related damages in **the International Court of Justice**, which is increasingly open to resolving transboundary environmental disputes.[123] In general, the International Court of Justice would be more likely to hear a dispute where a

123. *See, e.g.*, Aerial Herbicide Spraying (Ecuador v. Colom.), 2008 I.C.J. 174 (May 30).

regional seas program addresses sources of plastic marine litter and grants the Court jurisdiction over resolution of regional disputes.[124]

To use a real-world example, Japan potentially could seek redress for the ecological and economic damage to areas on its west coast caused by plastic litter originating in the Republic of Korea. Korean plastic litter is known to impact Japanese shores based on the direction of the winds and currents between the two countries. Every winter, twenty-liter plastic containers drift onto the Japanese coast, many with Korean lettering.[125] Although this example potentially constitutes a case that Japan could take to the International Court of Justice, the two countries thus far have relied on bilateral compacts and diplomacy to address the issue. Japan and Korea are member states of the Northwest Pacific Action Plan (NOWPAP), a regional seas program. One of the NOWPAP priorities is to prepare and implement a marine litter action plan.[126]

C. Strengthen New and Existing Regional Seas Programs with Substantive Requirements and New Research Programs

With the recognition that the United Nations Environment Programme (UNEP) is currently focusing on strengthening regional efforts rather than creating a new global agreement, we recommend that existing and new regional seas programs could be strengthened in the following ways:

- Agreements should cover inland activities throughout the entire watershed of the protected waterbody, not just specific areas such as coastlines or territorial seas.
- Marine litter should be included explicitly.
- The scope of application should include activities that generate plastic marine litter (e.g., river discharge, outfalls, and water-courses) as well as its sources.
- Agreements should, to the extent possible, contain narrowly drafted language with timelines, enforcement, third-party assessment, and a funding mechanism.
- Parties should outline clear procedures to assist countries with domesticating the international legal framework, thereby increasing

124. *See How the Court Works*, INT'L COURT OF JUSTICE, http://www.icj-cij.org/court/index.php?p1=1&p2=6 (last visited Mar. 3, 2014).

125. Yuji Adachi, Section Chief, Global Envtl. Issues Div., Global Envtl. Bureau, Jap. Ministry of the Env't, *Overview of Marine Litter Problems and Measures in Japan*, U.N. ENV'T PROGRAMME, http://www.unep.org/regionalseas/marinelitter/publications/workshops/nowpap/0072.asp (last visited Mar. 20, 2014).

126. *Regional Seas Programme: Northwest Pacific*, U.N. ENV'T PROGRAMME, http://www.unep.org/regionalseas/programmes/unpro/nwpacific/default.asp (last visited Mar. 3, 2014).

countries' abilities to enforce the agreement. Alternatively, a regional third-party organization should be established and funded to ensure compliance.

We also note that improved information about plastic marine litter could help galvanize support for stronger policies and help policy makers all over the world focus their efforts. For example, improved information might empower developing countries to begin requiring importers of goods packaged in plastic to fund a program for properly handling that waste at the end of its life. Requiring importers to contribute to end-of-life reuse or recycling programs as a condition of import would provide a sorely needed funding source for cleanup programs and would incentivize importers to minimize plastic imports. We recommend that a research institution or nongovernmental organization assess each of the regional seas programs to determine where strengthened language could improve enforcement of substantive marine litter standards. Additionally, such entities should secure funding through UNEP or another international body to develop and disseminate better information on plastic marine litter's impacts to human health, the economy, and the marine environment; better information on the origin and point-of-sale of plastic marine litter around the world; and better guidance for states and other jurisdictions seeking to strengthen domestic approaches to the problem.

D. Create an "Ocean-Friendly" Certification Program

The primary focus of efforts to reduce plastic marine litter should be decreasing the fraction of the estimated 265 million tons of plastic generated annually that ends up in the marine environment.[127] One way to reduce both the generation of plastic and its improper disposal is to create strong, consumer-driven incentives for corporations to align with plastic reduction goals. Companies are already beginning to react to an increased consumer interest in sustainability through participation in programs such as the Forest Sustainability Council, which promotes sustainable wood harvesting, and the Marine Stewardship Council, which promotes sustainable fishing practices. Companies also are increasingly incorporating recycled materials into their products, then touting those products as environmentally friendly through labeling. Additionally, some companies and restaurants are beginning to offer biodegradable or compostable packaging and take-out containers. Incentivizing and

127. *Plastics—The Facts 2011*, *supra* note 9, at 5.

standardizing the production of more sustainable products and packaging would aid and grow these nascent corporate efforts, and would help an increasingly educated consumer population to make ocean-friendly choices.

We propose the creation of a corporate certification program aimed at reducing the amount of land-based plastic litter in our oceans. The program should be open to all plastic products commonly found in the marine environment but should impose tough standards for labeling conforming products as ocean-friendly. To achieve certification, companies should satisfy requirements related to product design, manufacture, composition, labeling, and life-cycle handling.

Ocean-Friendly Certification Requirements Could Include the Following Common-Sense Standards:
• Plastic products should be designed to minimize waste by ensuring that no loose plastic pieces can escape into the environment (e.g., beverage bottles should include a "lid leash" attaching lids to bottles, and juice boxes should eliminate separate straws). • New products should incorporate some minimum high percentage of recycled plastics. • The materials used to make disposable plastic products, particularly single-use products, should be standardized to encourage the use of materials that are easily recycled and have large markets (e.g., polyethylene terephthalate and high-density polyethylene, which have recycling codes of 1 and 2, respectively). • Products and packaging should be labeled to allow for tracking, showing where products were both manufactured and sold. This critical information would allow policy makers and advocates to target education, publicity, or regulatory enforcement funds toward the highest volume contributors to plastic marine litter. • Because many varieties of biodegradable and oxy-degradable plastics do not degrade as easily in marine waters as they do in industrial composting or landfill conditions,[128] plastics should only be labeled as biodegradable or compostable if they degrade completely and without adverse environmental impacts under normal environmental conditions in a short timeframe.

Inevitably, there will be some hurdles to overcome in developing the ocean-friendly certification program. For example, there is, as of yet, no

128. *See generally* J.H. Song et al., *Biodegradable and Compostable Alternatives to Conventional Plastics*, 364 PHIL. TRANSACTIONS ROYAL SOC'Y B 2127 (2009); Jun Xu & Bao-Hua Guo, *Poly(butylene succinate) and Its Copolymers: Research, Development and Industrialization*, 5 BIOTECHNOLOGY J. 1149 (2010).

complete standard for the degradation of plastic in a marine environment.[129] Further, a standard definition for bio-based plastic does not yet exist, nor are any of the currently available bio-based plastic alternatives fully sustainable.[130] For these reasons, consumers must be correctly informed about the environmental impact of these alternative plastics as we try to find suitable replacements for the varied uses of plastics in our daily lives. Despite the current lack of a perfect replacement material, and even though no existing standards or management tools are sufficient to address the plastic marine litter problem effectively, many existing programs incorporate valuable elements that should be included and strengthened in an ocean-friendly certification program. For instance, the International Organization for Standardization (ISO) recently released a suite of international standards related to product packaging, including standards and measurement information for source reduction, reuse, recycling, energy recovery, chemical recovery, and composting. However, the ISO standards do not define success or failure. The certification program we propose should incorporate and expand upon these ISO guidelines and other relevant standards to include assessment mechanisms to gauge compliance and programmatic success, as well as indicators, metrics, third-party monitoring programs, and enforcement mechanisms.

Another promising model for the certification program is the Sustainable Packaging Coalition's Comparative Packaging Assessment (COMPASS), an Internet-based design software program that combines life-cycle analysis and regional solid waste modeling to address the most likely end-of-life scenarios in a given region.[131] Incorporation of life-cycle analysis into product design allows product developers to evaluate environmental costs as well as economic factors. Our proposed certification program could draw upon such models to help companies identify the least expensive supply chain changes required to reduce marine litter substantially and quickly.

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129. ASTM International released the first attempt at such a standard, but the standard does not require the measurement of chemicals released by the process of plastic degradation or an assessment of whether the plastic has fully degraded to organic components versus merely decreasing in size. *ASTM D6691-09: Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in the Marine Environment by a Defined Microbial Consortium or Natural Sea Water Innoculum*, ASTM INT'L, http://www.astm.org/Standards/D6691.htm (last visited Mar. 3, 2014).

130. *See generally* Clara Rosalía Álvarez-Chávez et al., *Sustainability of Bio-Based Plastics: General Comparative Analysis and Recommendations for Improvement*, 23 J. CLEANER PROD. 47 (2012).

131. *About COMPASS*, COMPASS COMPARATIVE PACKAGING ASSESSMENT, https://www.design-compass.org/about.gsp (last visited Mar. 3, 2014).

The ocean-friendly certification program also could draw upon some of the voluntary corporate sustainability frameworks developed by nonprofit and corporate organizations. For instance, the Global Reporting Initiative, a nonprofit organization, has developed a sustainability-reporting framework with a robust list of performance indicators[132] that could be modified to certify an ocean-safe product. The Consumer Goods Forum, an industry network, has published a "global language for packaging and sustainability" that includes packaging- and industry-specific metrics and goals.[133] Another useful tool is the Plastics Scorecard, which rates a plastic's environmental impact using a life-cycle analysis approach.[134] Combining metrics from these voluntary frameworks and others could contribute to the creation of a robust, easily measurable program to certify products as ocean-friendly.

E. Improve Plastics Management Through Extended Producer Responsibility Programs and Requiring Redemption Fees upon the Return of Plastic Beverage Containers

Extended producer responsibility (EPR) programs can play an important role in preventing land-based plastic pollution from entering the marine environment. EPR programs hold manufacturers responsible for the handling of their products and product packaging through the end of a product's life. EPR programs also incorporate fee schemes to ensure that manufacturers pay for waste management at the end of their supply chain and to capture additional waste for recycling and reuse. In general, a manufacturer's fee rate rises with the amount of waste generated; thus, EPR programs incentivize companies to reduce the amount of packaging on their products. Although fees typically only amount to a price per unit that is similar to California's bottle redemption value of 5 to 10 cents or less, EPR programs can result in high overall recycling or reuse rates.[135] Additional economic analysis is needed to determine effective fee rates to incentivize companies to reduce plastic packaging, minimize illegal

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132. *Reporting Framework Overview*, GLOBAL REPORTING INITIATIVE, https://www.globalreporting.org/reporting/reporting-framework-overview/Pages/default.aspx (last visited Mar. 3, 2014).

133. *See A Global Language for Packaging and Sustainability: A Framework and a Measurement System for Our Industry*, THE CONSUMER GOODS FORUM 13-14 (Sept. 2011), http://globalpackaging.mycgforum.com/allfiles/FinalReport_2011.pdf.

134. *Plastics Scorecard: Grading Criteria—Introduction*, CLEAN PRODUCTION ACTION, http://www.cleanproduction.org/static/ee_images/uploads/resources/plastics_scorecard_intro.pdf (last visited Mar. 3, 2014).

135. *See, e.g.*, ARGUS, *Final Report on European Packaging Waste Management Systems*, EUROPEAN COMM'N 29 (Feb. 2001), http://ec.europa.eu/environment/waste/studies/packaging/epwms.pdf.

dumping to avoid fee payments, and provide sufficient funding for effective enforcement.

Currently, EPR programs exist mainly in Europe[136] and Canada.[137] In the United States, a nonprofit organization called Recycling Reinvented is working to increase recycling rates of waste packaging through an EPR model.[138] More jurisdictions should adopt EPR programs to improve management of land-based plastic pollution.

Another good way to boost recycling rates is to provide a redemption fee upon the return of plastic beverage bottles and cans to designated facilities for recycling. Many such programs exist in the United States, but they could be improved and more widely adopted globally. Current redemption fees should be altered to better protect the environment by requiring the return of both bottle and cap, as bottle caps are among the most frequent types of waste found during beach cleanups and are often discovered in the stomachs of large sea birds such as albatrosses.[139] Bottle redemption fee models also could be extended to fishing nets, fishing lines, and aquaculture components to encourage the return of these items to shore facilities for proper disposal.

We recognize that EPR and recycling redemption fee programs have their limits. Even programs that achieve very high recycling rates still fail to capture a significant portion of potential marine pollution. For instance, even if 70% of plastic waste was recycled worldwide—an optimistic rate that has never been achieved on a wide scale—that still would fail to account for about 80 million tons of plastic waste per year that could end up in the marine environment.[140] The good news is that the options for reuse or transformation of traditionally nonrecyclable plastics are expanding. New technologies have the power to incentivize the

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136. Megan Short, Comment, *Taking Back the Trash: Comparing European Extended Producer Responsibility and Take-Back Liability to U.S. Environmental Policy and Attitudes*, 37 VAND. J. TRANSNAT'L L. 1217, 1225 (2004) (noting that in France, more than 90% of consumer products utilize the "green dot" symbol on their packaging materials as part of an EPR program).

137. *Packaging and Printed Materials Stewardship Program—Manitoba*, ENV'T CAN., http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=F78AE1E1-1 (last updated July 12, 2013); *Packaging and Printed Materials Stewardship Program—Ontario*, ENV'T CAN., http://www.ec.gc.ca/gdd-mw/default.asp?lang-En&n=FAA9FD12-1 (last updated July 12, 2013); *Packaging and Printed Materials Stewardship Program—Quebec*, ENV'T CAN., http://www.ec.gc.ca/gdd/mw/default.asp?lang=En&n=DB7979F8-1 (last updated July 12, 2013).

138. *About*, RECYCLING REINVENTED, http://www.recycling-reinvented.org/about (last visited Mar. 3, 2014).

139. John Klavitter, *Discarded Plastics Distress Albatross Chicks*, OPEN SPACES: A BLOG OF THE FISH & WILDLIFE SERV. (Oct. 24, 2012, 10:22 AM), http://www.fws.gov/news/blog/index.cfm/2012/10/24/Discarded-plastics-distress-albatross-chicks.

140. Calculation is based on the estimation that 265 million tons of plastic are produced annually worldwide. *Plastics—The Facts 2011*, *supra* note 9.

collection of nonrecyclable plastics by increasing their monetary value. For example, Korea now recycles its aquaculture floats into combustible fuel rods, and Method soap brand is using collected marine litter to manufacture some of its soap bottles. The British company Cynar plans to open ten new fuel plants, each capable of transforming 20 tons of nonrecyclable plastic trash into fuel per day.[141] One advantage of EPR and recycling redemption programs is that they provide a source of well-sorted plastics for innovative efforts like these.

Principles for Effectively Harnessing EPR To Address Land-Based Sources of Plastic Marine Litter[142]
1. Extend producer responsibility to cover all primary sources of disposal, including street trash pickup, direct disposal by consumers, and disposal at stores.
2. Include measurable targets for successful capture of material—not just target recycling rates.
3. Impose a variable-materials fee on top of poundage recycling fees to ensure that disposing of more environmentally harmful materials costs more. This materials fee should be steeply tiered to incentivize use of sustainable materials.
4. Separate recycling rates into subcategories (e.g., plastic, cardboard, etc.) so that high recovery rates for materials like cardboard do not mask low recovery rates for products that are highly impactful to the marine environment.
5. Develop product design and packaging criteria to discourage the use of virgin materials.
6. Include requirements for local reuse and recycling of collected products. Fund any relevant infrastructure through the EPR program.

F. Target Policies to Ocean-Based Sources of Plastic Marine Litter

Ocean-based sources of plastic marine litter require specially targeted policies. In addition to the amendments to existing international laws that we mentioned above, we support the creation of a certification and tracking program for fishing ships and aquaculture. This

141. Bettina Wassener, *A Plan To Go Halfway Around the World, Fueled by Plastic Trash*, N.Y. TIMES (Oct. 15, 2012), http://www.nytimes.com/2012/10/16/business/energy-environment/halfway-around-the-world-fueled-by-plastic-trash.html?pagewanted=all.

142. These recommendations are informed by discussions during the EPR sessions of the United Nations Environment Programme Regional Office of North America Marine Litter Workshop for North America: Legal, Policy and Market-Based Approaches To Preventing Marine Litter at the Source, held on December 3, 2012. *See generally UNEP RONA Marine Litter Workshop for North America*, U.N. ENV'T PROGRAMME REG'L OFFICE FOR N. AM., http://www.rona.unep.org/about_unep_rona/marine_litter/index.html (last visited Mar. 3, 2014).

certification program should require the tracking of fishing gear in vessel logs to determine how much gear is "lost" overboard, with effective third-party monitoring, assessment, and penalties for any excessive losses. Fishing nets should be tagged so that they can be easily located in and removed from the ocean before they damage delicate habitats or contribute to ghost fishing. The certification program also should mandate the use of sustainable aquaculture facility materials such as the use of bamboo instead of polyvinyl chloride (PVC) pipes and the use of glass floats rather than expanded polystyrene foam. Much like the ocean-friendly certification program that we propose above, this certification program could expand upon existing standards and establish measurable indicators and targets to determine compliance.

Additionally, we urge coastal jurisdictions to be mindful of well-intentioned recycling policies such as bans on plastic in landfills that create a disposal problem for derelict fishing nets. Jurisdictions with such policies should amend them to ensure that vessels can easily dispose of fishing nets onshore.[143]

G. Expand the Use of the Most Successful Domestic Management Models

National, state, and local governments around the world should ban the most common and damaging types of plastic marine litter, such as microbeads, fish-egg-sized nurdles, single-use plastic bags, and polystyrene foam food packaging. At least thirty countries, including Ireland, China, Bangladesh, and Ethiopia, and hundreds of state and local governments, including Mexico City, Washington, D.C., and Delhi, have adopted single-use plastic bag or polystyrene foam restrictions with extraordinary success.[144] Examples of effective bag bans from jurisdictions around the world demonstrate that such policies can alter consumer behavior and meaningfully prevent plastic marine litter. For instance, in the first year of implementation of China's policy banning ultra-thin plastic bags and requiring retailers to charge consumers for thicker plastic bags, overall plastic bag use decreased by two-thirds, or forty billion bags.[145] Similarly, a single-use plastic bag ban in Los

143. *See* Short, *supra* note 136, at 1227.

144. *See Retail Bags Report Maps and Related Detailed Lists*, FLA. DEP'T OF ENVTL. PROT., http://www.dep.state.fl.us/waste/retailbags/pages/mapsandlists.htm (last updated Sept. 9, 2013); Jennie R. Romer & Shanna Foley, *A Wolf in Sheep's Clothing: The Plastics Industry's "Public Interest" Role in Legislation and Litigation of Plastic Bag Laws in California*, 5 GOLDEN GATE U. ENVTL. L.J. 377, 412 (2012).

145. Romer & Foley, *supra* note 144, at 389.

Angeles County, California, has resulted in litter reduction and healthier beaches and waterways.[146]

In addition to banning common types of plastic marine litter, U.S. coastal jurisdictions should harness tools in the federal Clean Water Act to address plastic marine litter. Several local governments have begun to use the Clean Water Act tool of Total Maximum Daily Loads (TMDLs) to limit plastic and trash pollution. TMDLs for trash set a numeric goal for the amount of trash (including plastic trash) in a trash-impaired waterbody by a certain date (e.g., zero trash by 2023). To achieve the TMDL, the local government must implement trash reduction measures in the watershed.

Cities in California and Maryland have led the way in developing TMDLs for California's Los Angeles River, Ballona Creek, and Santa Monica Bay, and Maryland's Anacostia River.[147] The Los Angeles-area TMDLs have resulted in the installation of nearly 100,000 full capture devices, which filter litter 5 mm in diameter or greater out of stormwater runoff before it enters the waterbody. The California State Water Resources Control Board is currently in the process of creating a statewide trash policy that builds upon the innovative trash control measures of local governments like Los Angeles. The goal of the statewide policy is to target land uses that produce high volumes of trash with control requirements ranging from full capture systems to street-sweeping and educational campaigns. California will implement these requirements through the National Pollutant Discharge Elimination System (NPDES) permits it issues under the Clean Water Act.[148]

What Are TMDLs?
Under the **Clean Water Act**, states are required to establish water quality standards for each waterbody in the state.[149] Water quality standards designate uses for the waterbody (e.g., recreation, public water supply, or aquatic life) and set criteria necessary to protect those uses. Any waterbody

146. *See About the Bag*, L.A. CNTY. DEP'T OF PUB. WORKS, http://ladpw.org/epd/about the bag (last visited Mar. 3, 2014).

147. *See* Cal. Reg'l Water Quality Control Bd., L.A. Region, *Trash Total Maximum Daily Loads for the Los Angeles River Watershed*, EPA (July 27, 2007), http://www.epa.gov/waters/tmdldocs/34863-RevisedStaffReport2v2.pdf; Md. Dep't of the Env't & D.C. Dep't of the Env't Natural Res Admin., *Total Maximum Daily Loads of Trash for the Anacostia River Watershed*, MD. DEP'T OF THE ENV'T (Aug. 2010), http://www.mde.state.md.us/assets/document/Anacostia_Trash_TMDL_PN.pdf.

148. *See generally Control of Trash Entering Waterways in California*, STATE WATER RES. CONTROL BD., CAL. ENVTL. PROT. AGENCY, http://www.waterboards.ca.gov/water_issues/programs/trash_control/ (last visited Mar. 3, 2014).

149. 33 U.S.C. § 1313 (2006).

> that receives a pollution load that prevents the attainment of its water quality standards is listed as "impaired." To address the impairment, regulators are required to develop **TMDLs**, which specify the maximum amount of a pollutant that the impaired waterbody can receive without violating its water quality standards.[150]

Regulators in coastal watersheds across the United States should develop similar TMDLs for plastic marine litter, using the programs in California and Maryland as models. Coastal areas outside of the United States should use the TMDL system as a model for similar regulatory programs in their jurisdiction. Regulators adopting similar programs should collect local data in order to identify and target the greatest contributors to the pollution problem. Prioritizing high-use generators, such as high-density urban developments or industrial facilities with existing stormwater permits, allows for a rapid initial decrease in marine litter, after which a program can then pursue smaller generators.[151] In most cases, TMDL programs should address floating litter, trash, and litter discharges, as well as the issue of legacy litter on river bottoms or the ocean floor.

H. Expand Plastic Marine Litter Cleanup Programs

While there is certainly a need to continue researching the issue of plastic marine litter to further understand the scale and scope of its impacts, we have enough information to know that we need to begin cleaning up existing plastic marine litter now. Cleanup efforts should focus on all regions of the marine environment that are affected by plastic marine litter, including coastlines, coral reefs, the seafloor, and the deep ocean. Capturing plastic litter from the marine environment is a complex proposal, given the costs of marine litter retrieval and the need for sufficient on-shore disposal sites. Despite these complexities, many excellent existing programs could be expanded and adapted.

For instance, "Fishing for Litter" programs provide trash bags and easy onshore disposal options to incentivize fishermen to dispose of litter captured in fishing nets properly. Such programs can also incentivize the return of plastic litter through per-item or per-weight payments.[152] Some

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150. *Id.* § 1313(d).

151. These recommendations are informed by discussions during the EPR sessions of the United Nations Environment Programme Regional Office of North America Marine Litter Workshop for North America: Legal, Policy and Market-Based Approaches to Preventing Marine Litter at the Source, held on December 3, 2012. *See UNEP RONA Marine Litter Workshop for North America*, *supra* note 142.

152. *See* Cho, *supra* note 59, at 416.

existing programs even have established partnerships with local residents to repurpose collected plastic marine litter into art, which serves to educate the public about the plastic marine litter problem.[153] Additionally, derelict fishing gear removal projects, which encourage ocean users to recycle and report lost gear, have been successful in several regions of the United States. Since 2006, California's Lost Fishing Gear Recovery Project has retrieved over 60 tons of gear from California's coastal ocean and over 1400 pounds of gear from public fishing piers.[154] Additionally, as of 2013, the Northwest Straits Derelict Fishing Gear Removal Program has removed 4605 nets, 3173 crab pots, and 47 shrimp pots from Puget Sound.[155]

Marine litter cleanup program managers should consider investing limited program funds into emerging technologies to increase the efficiency of cleanup activities. For example, overlaying maps of marine debris concentrations and maps of marine animals could help identify ocean areas that should be prioritized for cleanup efforts. Additionally, plastics surveys could be added onto planned marine organism studies, archived samples could be checked for plastic concentrations, old video and photographic footage of the deep sea floor could be analyzed, and remote sensing could be employed to identify existing plastic marine litter hot spots.[156] Web-based forums where interested parties can post and obtain information about plastic marine debris, such as the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Clearing House,[157] also can help researchers identify hot spots.

In addition to marine cleanup efforts, capturing litter at river mouths and on land in ocean-connected watersheds can prevent plastics from reaching the ocean.[158] Through one of the largest annual beach cleanup events, International Coastal Cleanup Day, nearly 9 million volunteers from 152 countries have removed 145 million pounds of trash from

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153. *See, e.g.*, *2012 Annual Report*, GHOSTNETS AUSTL. 10-11, http://www.ghostnets.com.au/pdf/2012%20ANNUAL%20REPORT_final_090413.pdf (last visited Mar. 7, 2014).

154. *California Lost Fishing Gear Recovery Project*, SEADOC SOC'Y, http://www.seadocsociety.org/california-lost-fishing-gear-removal-project/ (last visited Mar. 3, 2014).

155. NW. STRAITS DERELICT FISHING GEAR REMOVAL PROGRAM, http://www.derelictgear.org (last visited Mar. 3, 2014).

156. *See, e.g.*, *O-05: Remote Sensing of Plastic Debris*, AM. GEOPHYSICAL UNION SCI. POL'Y CONFERENCE, http://spc.agu.org/2013/eposters/eposter/o-05/ (last visited Mar. 3, 2014).

157. *Marine Debris Clearinghouse*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://clearinghouse.marinedebris.noaa.gov/ (last visited Mar. 3, 2014).

158. *See, e.g.*, C.J. Moore et al., *Quantity and Type of Plastic Debris Flowing from Two Urban Rivers to Coastal Waters and Beaches of Southern California*, 11 J. INTEGRATED COASTAL ZONE MGMT. 65, 68 (2011) (suggesting that 2.3 billion plastic pieces that comprised more than 30 metric tons were removed from two rivers during a rainstorm over the course of 72 hours).

shorelines over the past 25 years.[159] Expansion of voluntary programs like this to incorporate more regular cleanup events in urban watersheds would decrease the amount of litter entering the marine environment and, more importantly, educate the populace to change harmful waste disposal behaviors. It is also critical that cleaning up coastlines be incorporated into municipal responsibilities in the same manner as park and street maintenance so that beach users can share cleanup costs.

A problem on the scale of plastic marine litter cannot be tackled without viable, consistent sources of funding for cleanup efforts. On a subnational or local scale, governments can raise funds for marine litter cleanup efforts through fees or taxes imposed on plastic products. Such fees should be designed to reflect the product's disposal and environmental costs accurately. One local model that could be scaled up internationally is the City of Oakland's litter tax on fast-food establishments, the revenues of which fund cleanup programs.[160] As another example, in 2010, Washington, D.C., instituted a 5-cent fee on disposable plastic bags, 1 cent of which is returned to the store while the other 4 cents fund environmental programs such as Anacostia River cleanup efforts and education and outreach programs.[161] This program generates around $2 million per year[162] and has resulted in a 60% reduction in bag use in the area.[163] In the first month of implementation, bag use in the area dropped from 22.5 million bags per month to 3 million bags.[164] Yet another option is to impose a small fee or tax on nonbiodegradable plastics only, the revenues of which could be used to fund marine litter cleanup efforts. This approach would encourage the use of ocean biodegradable plastics by making ocean biodegradable plastics cost-competitive with petroleum-based plastics.[165]

On a larger scale, imposing a nominal fee on shipping containers exported through port facilities would create a large fund for marine

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159. *See* OCEAN CONSERVANCY, TRACKING TRASH: 25 YEARS OF ACTION FOR THE OCEAN 1 (2011), *available at* http://act.oceanconservancy.org/pdf/Marine_Debris_2011_Report_OC.pdf.

160. Gordon, *supra* note 2, at 38.

161. *Plastic Bag Report 2012 Update*, METRO. WASH. COUNCIL OF GOV'T 10-11 (Nov. 5, 2012), https://www.mwcog.org/uploads/pub-documents/p15dWl820121105113857.pdf.

162. *Id.* at 11.

163. *Bag Law Survey Overview*, D.C. DEP'T OF THE ENV'T 2, http://www.ddoe.gov/sites/default/files/dc/sites/ddoe/documents/0%20BL%20Survey%20Overview%20Fact%Sheet.pdf (last visited Mar. 21, 2014).

164. *Plastic Bag Report 2012 Update*, *supra* note 161, at 11.

165. Polyhydroxyalkanoate plastic costs $2.25 to $2.75 per pound compared to the $.60-per-pound cost of petroleum-based plastics. Caroline Winter, *Keeping the Sea Safe from Plastic*, BUSINESSWEEK (Jan. 9, 2012), http://www.businessweek.com/magazine/keeping-the-sea-safe-from-plastic-01052012.html.

pollution cleanup programs. A $1 fee per shipping container would be very small relative to the average value of the goods within the container, but could generate substantial revenue for cleanup efforts. For instance, a $1-per-loaded-container fee would have produced $4.7 million of funding at the Port of Los Angeles in 2013 alone.[166] Expanded internationally, a $1-per-loaded-shipping-container fee would generate $114 million annually for the top twenty importers of shipping containers, based on 2010 numbers.[167]

I. Develop and Expand Education and Awareness Programs

Educational programs targeted to the global public, youth, boaters, civil society organizations, religious groups, and the plastic, fishing, and aquaculture industries are important parts of the plastic marine litter solution. The extension of existing citywide antilitter campaigns and local beach cleanups would contribute to raising public awareness of the plastic marine litter problem. Incorporating litter and marine litter curricula into primary education also would help. Example curricula include the "Save Our Seas" and "Waves, Wetlands, and Watersheds" programs developed by the California Coastal Commission.[168] Local events are another important vehicle to promote awareness of recycling and reducing; when events themselves are zero-waste, they both increase awareness and limit litter.

Industrial education efforts also have contributed to the growing global awareness of the problem. One such example is the Society of Plastics Industry and the American Plastics Council's "Operation Clean Sweep," which informs employees at a plastic pellet manufacturing facility of the importance of preventing pellet loss.[169] In 2011, plastics organizations signed a declaration to address the problem of marine litter through a suite of actions including education programs.[170] Global educational programs and programs targeting the fishing and aquaculture industries, however, must be greatly expanded and improved. Few

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166. *See TEU Statistics (Container Counts)*, PORT L.A., http://www.portoflosangeles.org/maritime/stats.asp (last visited Mar. 3, 2014).

167. *See Trade Statistics*, WORLD SHIPPING COUNCIL, http://www.worldshipping.org/about-the-industry/global-trade/trade-statistics (last visited Mar. 3, 2014).

168. *Resources for California Educators*, CAL. COASTAL COMM'N, http://www.coastal.ca.gov/publiced/directory/educate.html (last visited Mar. 3, 2014).

169. *Overview*, OPERATION CLEAN SWEEP, http://www.opcleansweep.org/overview (last visited Mar. 3, 2014).

170. *Declaration of the Global Plastics Associations for Solutions on Marine Litter*, MARINE DEBRIS SOLUTIONS, http://www.marinedebrissolutions.com/global (last visited Mar. 3, 2014).

examples of targeted educational campaigns about the effect of derelict fishing gear exist, although programs that encourage fishermen to capture and return marine litter they encounter have provided some benefits. Similarly, targeted educational programs centered on high-use areas such as ports, boat rental facilities, and boat launch ramps would help increase awareness of plastic marine litter among recreational and professional boaters.

V. CONCLUSION

Plastic marine litter is far more than an aesthetic problem. Increasing harm to marine wildlife and rising economic costs provide an enormous incentive to tackle the global plastic marine litter problem more aggressively. Although plastic marine litter has grown into a high-profile international environmental issue over the last two decades, efforts to address it so far have not adequately protected water quality or the health of the marine environment. Significantly, the many existing international treaties relevant to plastic marine litter lack the scope, standards, and penalties necessary to address the problem comprehensively. We suggest that attaining the Rio+20 goal of "achiev[ing] significant reductions in marine debris" by 2025 will require not one "silver bullet" action but rather a panoply of international, regional, national, and local policies and programs.

Below, we have included a list of our top ten plastic pollution prevention actions. Implementation of all ten measures by 2025 would drastically reduce the current rate of ocean plastics disposal. Stemming the tide of plastic pollution is a first and important step, but additional efforts will be required to address the millions of tons of plastic litter already present in the ocean. It is our hope that collaborative work toward reducing plastic marine litter disposal will lay a foundation for increased and continued global cooperation on marine health issues.

Top Ten Plastic Marine Litter Prevention Actions
1. Develop a new international plastic marine litter treaty of the scale and scope of the Montreal Protocol. The agreement should incorporate enforceable marine litter standards as well as strong tracking, monitoring, reporting, and enforcement mechanisms, including adequate penalties and the establishment of jurisdiction for party dispute resolution before an international tribunal.
2. Through a new international treaty and regional and domestic action, ban the most common and damaging types of plastic marine litter (e.g., microbeads, fish-egg-sized nurdles, single-use plastic bags, and

polystyrene foam food packaging), and phase out all plastics that are not recycled at a rate of 75% or more by a certain date. Support the development of and transition to substitutes.

3. Create and implement a voluntary ocean-friendly certification program for all plastic products that commonly result in marine litter. The program should include common-sense certification standards for minimum recycled plastic content, incorporation of easily recyclable plastic, sustainable single-use packaging design, ocean plastic degradability, and phase-out particularly harmful manufacturing materials such as nurdles.
4. Expand EPR programs, with the stipulation that such programs must be designed to result in high recovery rates of plastics and the phase-out of environmentally harmful materials.
5. Expand and strengthen existing regional agreements and other international agreements relevant to plastic marine litter by incorporating enforceable marine litter standards, closing loopholes, strengthening penalties, and supporting improved enforcement.
6. Create and implement certification and tracking programs for fishing and aquaculture operations through regional fisheries management organizations and other relevant institutions. Programs should require logs to track lost fishing gear, require traceable tags on nets, and encourage the use of more sustainable materials in aquaculture gear.
7. Establish funding sources for marine litter remediation through product redemption fees and shipping container fees, such as a port fee of $1 per shipping container. Impose fees or taxes on the most common types of plastic marine litter (e.g., single-use plastic bags, cigarettes, and expanded polystyrene foam).
8. Expand the use of "zero trash" TMDLs or similar requirements within urban coastal watersheds in the United States and internationally. Sources of marine litter should be identified and assigned a waste load allocation of zero trash to be achieved within a decade.
9. Accelerate efforts to clean up beaches and existing marine litter. Cleanup efforts should focus on plastic marine litter hot spots and all regions of the marine environment that are affected by plastic marine litter, including coastlines, coral reefs, the seafloor, and the deep ocean.
10. Improve our understanding of the plastic marine litter problem by funding research and data collection regarding the main sources of plastic marine litter; its effects on human health, the environment, and the economy; and the most effective means of control. Expand public education programs to raise awareness of the plastic marine litter crisis.