

TOWARD A GLOBAL REGIME OF VESSEL ANTI-FOULING

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ABSTRACT

Vessel anti-fouling is key to the efficient operation of ships, and essential for effective control of invasive species introduced through international shipping. Anti-Fouling Systems, however, pose their own threats to marine environments. The Anti-Fouling Convention of 2001 banned the use of organotin compounds such as Tributyltin, and created a system for adoption of alternative anti-fouling biocides. In 2011, the Marine Environmental Protection Committee of the International Maritime Organization (IMO) released guidelines on bio-fouling management record keeping, installation, inspection, cleaning, maintenance, design and construction. Though these Guidelines provide a template for more effective and environmentally sound anti-fouling control and implementation, they are not mandatory. This article proposes that the member states of the IMO adopt the 2011 Guidelines as a mandatory instrument.

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TABLE OF CONTENTS

I. Introduction.....	54
II. 2001 Anti-Fouling Convention	58
III. 2011 Biofouling Guidelines	62
IV. Making the 2011 Guidelines Mandatory.....	65

I. INTRODUCTION

Mariners have long sought effective methods to prevent or reduce biofouling, which occurs when unwanted sea life, such as algae, barnacles, and mollusks, attach to ship surfaces at or below the water line. When unwanted sea life accumulates on a ship's hull, it is specifically known as hull fouling. According to Medieval myth, once barnacles grow to sufficient size, they transform into geese and fly away.¹ These “gooseneck” barnacles can grow to six inches in length.² Scientists can examine the amount of barnacle buildup on the surface of a ship to determine how long and where it has been at sea.³ This “bioaccumulation” is the bane of the ship operator and a perennial problem in the global shipping industry.⁴ Since ninety percent of all foreign trade travels by sea,⁵ finding environmentally responsible solutions to bioaccumulation is a global challenge.

Biofouling adversely affects ship performance.⁶ It creates drag, and increases transit time and fuel costs.⁷ Even a small amount of fouling can increase fuel consumption as much as forty to fifty percent because of water resistance.⁸ Along with the hull surface, the

1. Nathaniel Philbrick, *In the Heart of the Sea: The Tragedy of the Whaleship Essex* 128 (2000).

2. *Id.*

3. *Id.*

4. Yan Ting Cui et al., *Searching for “Environmentally-Benign” Antifouling Bodies*, 15 *Int'l J. Mol. Sci.* 9255, 9256 (2014).

5. Natasha Geiling, *How the Shipping Industry is the Secret Force Driving the World Economy*, *Smithsonian.com* (Oct. 15, 2013), <http://www.smithsonianmag.com/innovation/how-the-shipping-industry-is-the-secret-force-driving-the-world-economy-1950979/?no-ist>.

6. Biofouling Prevention Coatings, <http://www.onr.navy.mil/media-center/fact-sheets/biofouling-prevention.aspx> (last visited Sep. 15, 2015).

7. *Id.*

8. Woods Hole Oceanographic Inst., *Marine fouling and its prevention* 5–6 (1952) (hereinafter “Woods Hole”); Michael A. Champ, *A Review of Organotin Regulatory Strategies, Pending Actions, Related Costs and Benefits*, 258 *Sci. Total Environ.* 21, 52 (2000); Eugene C. Fischer et al., *Technology for Control of Marine Biofouling—A Review*, in *Marine Biodeterioration: An Interdisciplinary Study* 261, 265–66 (J.D. Costlow & R.C. Tipper eds., 1984).

anchor well, anchor, bilge, sewage tanks, cooling pipes, deck fittings, water inlets and outlets, grills, sea chests, grates, rudder, and propeller are vectors for the introduction of aquatic invasive species into the marine environment.⁹

Biofouling can have profound effects on aquatic ecology by transplanting nonindigenous organisms into new marine environments. For example, approximately ninety percent of the 343 marine alien species in the waters surrounding Hawaii were likely introduced by hull fouling.¹⁰ Some experts believe that hull fouling is responsible for approximately thirty-six percent of the non-native coastal marine species in continental North America, while ballast water is thought to account for a smaller but substantial portion.¹¹

In order to prevent or diminish the incidence of hull fouling, ship operators and ship owners use anti-fouling paints, surfaces, or treated surfaces that are designed to maintain an inhospitable growth environment, which prevents attachment of unwanted organisms.¹² For the last 75 years, commercial antifouling methods have knowingly and unknowingly (in the case of organotin ablative polymers) used broad spectrum biocides released from coatings.¹³ The coatings have advanced from resin rosin systems to ablative (self-polishing) polymers and ablative copolymers, which are complex multilayered systems that have essential physical and anticorrosive properties.¹⁴ The most damaging biocides were banned over time as scientists recognized the effects of biocides on human health and the environment.¹⁵ The list of banned ingredients includes heavy metals

9. See generally Lynn Jackson, *Marine Biofouling and Invasive Species: Guidelines for Prevention and Management*, The Global Invasive Species Programme & The UNEP Regional Seas Programme (2008), <http://www.issg.org/pdf/publications/GISP/Resources/BiofoulingGuidelines.pdf> (“After a protracted stay in port, it is common for all areas of an underwater hull to have accumulated some level of marine growth. . . . These areas include: rudder[,] seawater inlets and outlets[,] and sounder/speed log farings.”).

10. Madhu Joshi et al., Control of Biocorrosion to Prevent the Propagation of Invasive Species 1 (Sept. 2010).

11. See Melissa A. Frey et al., *Fouling Around: Vessel Sea-Chests as a Vector for the Introduction and Spread of Aquatic Invasive Species*, 5 *Mgmt. Bio. Invasions* 21, 27 (2014) (explaining vessel biofouling accounts for more than forty percent of all marine invasions).

12. *Anti-fouling Systems: Background*, International Maritime Organization [IMO] (2015), <http://www.imo.org/en/OurWork/Environment/Anti-foulingSystems/Pages/Default.aspx>.

13. Iwao Omae, *Organotin Antifouling Plants and Their Alternatives*, 17 *Appl. Organometal. Chem.* 81, 84–91 (2002).

14. *Id.* at 86.

15. See K.V. Thomas & S. Brooks, *The Environmental Fate and Effects of Antifouling Paint Biocides*, 26 *Biofouling* 73, 76 (2009) (presenting a summary of biocide use and restrictions).

like lead, arsenic, and most recently, organotins.¹⁶

One of the biocides, TBT, was famously described as one of the most toxic substances ever deliberately introduced into the ocean.¹⁷ In the 1990s, TBT levels in global shipping lanes reached fifty nanograms per liter.¹⁸ For reference, TBT concentrations as low as 10 nanograms per liter can cause female snails to grow a penis, bivalve mollusks to change sex,¹⁹ and behavioral sterility.²⁰ Consequently, lauding TBT as an industry standard for performance without considering the environmental damage it causes establishes an unrealistic performance baseline for alternatives.²¹

Existing laws in many countries limit release of biocides like copper from coatings.²² Use of copper as a biocide is now restricted in many countries and is being regulated in ports in the United States through the Clean Water Act.²³ As a consequence, many coatings now contain a second biocide, usually a long-lived broad spectrum organic biocide to increase effectiveness of the coatings while releasing less copper.²⁴ Although the majority of commercial coatings are still copper-based, the addition of organic cobiocides that work

16. IMO, AFS/CONF/26, *Adoption of the Final Act of the Conference and any Instruments, Recommendations, and Resolutions Resulting from the Work of the Conference: International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001* (Oct. 18, 2001); International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001, adopted October 5, 2001; entered into force September 17, 2008; effective January 1, 2008, T.I.A.S. No. 12-11121 [hereinafter “AFC”].

17. S. M. Evans et al., *Tributyltin Pollution: A Diminishing Problem Following Legislation Limiting the Use of TBT-Based Anti-fouling Paints*, 30 *Marine Pollution Bull.* 14, 14 (1995).

18. See David Santillo et al., *Tributyltin (TBT) Antifoulants: A Tale of Ships, Snails and Imposex*, in 22 *European Environmental Agency (EEA), Environmental Issue Report 135*, 135–38 (2001) (explaining concentrations above 100 nanograms/liter were encountered outside marinas, and higher within them).

19. Eva Oberdörster & Ann Oliver Creek, *Gender Benders at the Beach: Endocrine Disruption in Marine and Estuarine Organisms*, 20 *Environ. Toxicol. Chem.* 23, 25 (2001) (“[A] few studies have documented changes in steroid hormone metabolism and titers toward androgenization in bivalves.”).

20. Jessica Straw & Dan Rittschof, *Responses of Mud Snails From Low to High Imposex Sites to Sex Pheromones*, 48 *Marine Pollution Bulletin* 1048, 1052 (2004).

21. Dan Rittschof, *Trends in Marine Biofouling Research*, in *Advances in Marine Antifouling Coatings and Technologies* 725, 726 (Claire Hellio & Diego Yebra eds., 2009); Dan Rittschof, *Research on Practical Environmentally Benign Antifouling Coatings*, in *Biofouling* 396, 400 (Simon Dürr & Jeremy C. Thomason eds., 2010).

22. Mridula Srinivasan & Geoffrey W. Swain, *Managing the Use of Copper-Based Antifouling Paints*, 39 *Environ. Manage.* 423, 425 (2007).

23. Lena Gipperth, *The Legal Design of the International and European Ban on Tributyltin Antifouling Paint: Direct and Indirect Effects*, 90 *J. Environ. Mgmt.* S86, S91 (2009).

24. Dr. Geoffrey Swain, *Redefining Antifouling Coatings*, JPCL-PMC, 27 (Sept. 1999).

with copper to kill biofoulers has reduced copper release.²⁵ As the field advances, organic biocides with short half-lives and consequently less environmental impact are replacing long-lived biocides that cause environmental damage and build up in the environment.²⁶

Biocides are effective anti-fouling agents because they are actively taken up by the organisms attaching to the ship, killing them.²⁷ Initially, biocides leach rapidly. However, for many coatings, release declines over time, and anti-fouling performance is compromised.²⁸ Biofouling is a particular problem for ships spending a lot of time at the pier.²⁹ Because existing biocides are broad spectrum and work by being released into the environment, there is a continuous interplay between effectiveness of the biocide and environmental damage it causes.³⁰

As cobioicide coatings gain market share, the organic biocides are building up in environments with unknown consequences.³¹ For example diurone and irgarol bind to particulate organic matter and are reaching levels in confined spaces like the Sea of Japan, where if they were free they would shut off photosynthesis.³² New regulations can help ensure that organic biocides are properly risk-assessed.³³ Environmentally friendly fouling management coatings should be pursued to enable us to continue to produce and consume food from the ocean.³⁴

25. *Id.* at 32–33.

26. *See* Dow Chem. Co., DOW Antimicrobial 7287 and DOW Antimicrobial 8536: The Fast-Acting, Broad-Spectrum Biocides with Low Environmental Impact 1, 2 (2002) (“DOW Antimicrobial 7287 and DOW Antimicrobial 8536 decompose rapidly in aquatic environments, and are environmentally safe.”).

27. IMO, *supra* note 12.

28. Katherine A. Dafforn et al., *Antifouling Strategies: History and Regulation, Ecological Impacts and Mitigation*, 62 *Marine Pollution Bull.* 453, 455 (2011).

29. *See* Jackson, *supra* note 9, at 5 (“[D]iversity of a fouling community typically increases on surfaces which are subject to long periods of immobility.”).

30. *Id.* at 23.

31. Thomas and Brooks, *supra* note 15, at 73.

32. Rosângela A. Devilla et al., *Impact of Antifouling Booster Biocides on Single Microalgal Species and on a Natural Marine Phytoplankton Community*, 286 *Marine Ecology Progress Series* 1, 6–8 (2003); Thomas & Brooks, *supra* note 15, at 74.

33. Gipperth, *supra* note 23, at S93–94.

34. *See* Rittschof, *Research on Practical Environmentally Benign Antifouling Coatings*, *supra* note 21.

II. 2001 ANTI-FOULING CONVENTION

Uniform and global standards for marine environmental protection were adopted in Part XII of the 1982 United Nations Convention on the Law of the Sea (UNCLOS).³⁵ The Convention entered into force in 1994, and has become the “constitution” for the world’s oceans because it apportions rights and duties among flag states, coastal states, and port states concerning virtually every activity at sea.³⁶ Today, UNCLOS is “the legal framework within which all activities in the oceans and seas must be carried out.”³⁷ The environmental standards in UNCLOS, however, are quite aspirational; they lack specificity, and typically require adoption and implementation of follow-on standards or agreements.³⁸ All international efforts to improve marine environmental protection are conducted under the umbrella of UNCLOS, including the work of member states of the IMO.³⁹

The IMO is the United Nations specialized agency for maritime matters.⁴⁰ It is comprised of 170 Member States that work to develop uniform standards for safe, efficient, and environmentally sound shipping throughout the world.⁴¹ IMO conventions, codes, and guidelines are reducing the environmental impacts of global shipping.

As early as 1989, the IMO began to appreciate the harmful environmental effects of organotin compounds.⁴² In 1990, the IMO Marine Environment Protection Committee (MEPC) recommended that states eliminate the use of anti-fouling paint containing TBT on non-aluminum hulled vessels of less than 25 meters in length, and stop the use of anti-fouling coatings with a leach rate of more than four micrograms of TBT per square cm per day.⁴³

35. See United Nations Convention on the Law of the Sea, art. 192–96, Dec. 10, 1982, 1833 UNTS 397 (stating general provisions).

36. Tommy T.B. Koh, President of the Third United Nations Conference on the Law of the Sea, Remarks at final session of the Conference at Montego Bay (Dec. 6 and Dec. 11, 1982).

37. U.N. GAOR, 68th Sess., 63rd plen. mtg. at 1, U.N. Doc. A/68/PV.63 (Dec. 9, 2013).

38. See *id.* at 3 (“The Convention embodies the aspiration of the international community to a just international legal order for the oceans.”).

39. See *id.* at 1 (“The draft resolution recognizes that UNCLOS is ‘the legal framework within which all activities in the oceans and seas must be carried out.’”).

40. *About IMO*, International Maritime Organization (Sept. 15, 2015), <http://www.imo.org/en/About/Pages/Default.aspx>.

41. *Id.*

42. *Anti-Fouling Systems*, *supra* note 12.

43. Marine Env'tl. Prot. Comm., annex 19, Res. 46(30), *Measures to Control Potential Adverse Impacts Associated with Use of Tributyltin Compounds in Anti-Fouling Paints* (Nov. 16, 1990).

Two years later, in 1992, the issue of harmful anti-fouling compounds was addressed during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil.⁴⁴ Chapter 17 of Agenda 21, the nonbinding action plan adopted by the Conference, calls on states to “take measures to reduce pollution caused by organotin compounds used in anti-fouling systems.”⁴⁵

On November 25, 1999, the IMO Assembly adopted a resolution that called on the MEPC to negotiate a legally binding instrument to restrict the use of anti-fouling on ships.⁴⁶ The resolution sought a global prohibition on the application of organotin compounds that act as biocides in anti-fouling systems on ships by January 1, 2003, and a complete prohibition by January 1, 2008.⁴⁷ In order to meet these goals, the IMO member states negotiated the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001 (Anti-Fouling Convention).⁴⁸

Adoption of the Anti-Fouling Convention by the IMO Assembly opened the instrument for ratification by states.⁴⁹ The treaty entered into force twelve months after twenty-five states that comprised twenty-five percent of world tonnage ratified it.⁵⁰ This milestone was reached with Panama’s ratification in September 2007, and the Anti-Fouling Convention entered into force on September 17, 2008.⁵¹ The United States became a party to the Convention in 2012.⁵²

The Anti-Fouling Convention banned the use of organotin compounds in anti-fouling systems.⁵³ The term “anti-fouling system”

44. Rep. of the U.N. Conference on Env’t and Dev., Agenda 21 (Jun. 3–14, 1992).

45. *Id.* at 17.32.

46. IMO, Res. A.895(21), at 2 (Nov. 25, 1999).

47. *Id.*

48. See AFC, *supra* note 16 (recognizing the need to hold the convention in order to advance the goal of global prohibition on organotin compounds).

49. *Id.* at art. 17.

50. *Id.* at art. 18.

51. *Id.*

52. See Transmission by the President of the United States of America to the Senate (Jan. 22, 2008) (approving of the treaty’s ratification), available at <http://www.gpo.gov/fdsys/pkg/CDOC-110tdoc13/pdf/CDOC-110tdoc13.pdf> (It was reported favorably by the Senate Committee on Foreign Relations July 29, 2008.); see generally S. Rep. No. 110-19 (2008) (with advice and consent to ratification by the Senate on September 26, 2008), United States Senate Committee on Foreign Relations, Foreign.Senate.gov, <http://www.foreign.senate.gov/treaties/110-13>. It was ratified by the President August 3, 2012, ratification of the United States of America deposited August 21, 2012, and entered into force for the United States November 21, 2012. National Oceanic and Atmospheric Administration Office of the General Counsel, NOAA.gov, http://www.gc.noaa.gov/gcil_mp_antifouling.html.

53. AFC, *supra* note 16, at Annex 1.

is defined by the treaty as “a coating, paint, surface treatment, surface or device that is used on a ship to control or prevent attachment of unwanted organisms.”⁵⁴ Annex I of the Convention mandates that “all ships shall not apply or re-apply organotin compounds, which act as biocides in anti-fouling systems,” beginning on January 1, 2003. By January 1, 2008, ships shall either: “(1) . . . not bear such compounds on their hulls or external parts or surfaces; or (2) . . . shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.”⁵⁵

Thus, by the end of 2008, all anti-fouling paint on hulls containing organotin compounds were either removed or coated with a sealant to keep them from leaching into the environment.⁵⁶ At the same time that the IMO Assembly adopted the Anti-Fouling Convention, the member states also adopted a short series of accompanying resolutions.⁵⁷ Resolution 3 authorizes states to approve, register, or license anti-fouling systems, and encourages them to work through international organizations to harmonize biocide test methods and performance standards for anti-fouling systems.⁵⁸

The Anti-Fouling Convention applies to all ships that are registered to a member state of the IMO or that operate under the authority of a member state, as well as ships that enter into the port, shipyard, or offshore terminal of a states' Party.⁵⁹ Implementation and enforcement of the provisions of the Anti-Fouling Convention are primarily the responsibility of the flag state, but this obligation is shared by coastal states as part of their role in port state control monitoring and enforcement.⁶⁰ For example, while flag states are responsible for certifying ship compliance, such as issuance of an International Anti-Fouling System Certificate (IASC), such documentation may be examined as a condition of port entry by port states when ships enter into foreign ports.⁶¹

54. *Id.* at Annex, Article 2.

55. *Id.* at Annex 1.

56. *See* AFC, *supra*, note 16, art. 4 (prohibiting the application of harmful anti-fouling systems on all ships under the authority of a party to the treaty).

57. IMO, Focus on IMO 1, 15 (2002), *available at* <http://www.imo.org/en/OurWork/Environment/Anti-foulingSystems/Documents/FOULING2003.pdf>.

58. *Id.*

59. AFC, *supra* note 16, at Annex, art. 3.

60. *See id.* at Annex, art. 1 (“Parties shall endeavor to cooperate for the purpose of effective implementation, compliance and enforcement of this Convention.”).

61. *See id.* at Annex, art. 3 (explaining the convention applies to “ships that enter a port,

Ships weighing more than 400 gross tons engaged in international commerce are subject to an initial survey before they enter into service or before an IASC is issued for the first time.⁶² A new survey is conducted whenever anti-fouling systems are changed or replaced.⁶³ Ships of at least 24 meters in length, but displacing less than 400 gross tons and engaged in international voyages must carry a Declaration on Anti-Fouling Systems signed by the shipowner or authorized agent.⁶⁴

The treaty also regulates anti-fouling paints on offshore fixed or floating platforms, floating storage units (FSUs), and floating production storage and off-loading units (FPSOs) used in the offshore oil industry that were constructed prior to January 1, 2003 and that have not been in dry-dock on or after January 1, 2003.⁶⁵ The application of the treaty to FSUs and FPSOs is an example of the broadening out of rules designed to curb vessel-source pollution being applied to maritime infrastructure associated with ships.⁶⁶

The Anti-Fouling Convention may be updated through an amendment process. As new anti-fouling compounds are invented or enter into use, they are subject to a two-step review process by the IMO MEPC.⁶⁷ The Convention operates under a tacit amendment procedure so that controls on new compounds enter into force without states having to replicate the original lengthy ratification process.⁶⁸ Tacit amendment is also a more flexible approach than formal treaty revision, since it permits parties to the treaty to elect, at the time of initial ratification of the Anti-Fouling Convention, the method whereby amendments to Annex I enter into force for them—either automatically, or only upon formal notification of acceptance. The United States, for example, elected to adopt the latter procedure to permit time for participation in subsequent updates to the Convention by the public by Congress.⁶⁹

shipyard, or offshore terminal of a Party”).

62. Marine Envtl. Prot. Comm., Annex, 1.3, Res. 102(48), *Guidelines for Survey and Certification of Anti-Fouling Systems on Ships*, (Oct. 11, 2002).

63. *Id.* at Annex, 3.3.

64. AFC, *supra* note 16, Reg. 5 (“The Declaration will have to be accompanied by appropriate documentation such as a paint receipt or contractor invoice.”).

65. AFC, *supra* note 16, at Annex 1.

66. *See id.* at Annex, art. 2 (designating FSUs and FPSOs as ships).

67. *See id.* at Annex, art. 6 (stating that a proposed amendment must undergo both an initial and a technical review).

68. *See id.* at Annex, art. 16 (detailing the tacit amendment process).

69. The current U.S. standards implement the Anti-Fouling Convention through The Coast Guard Authorization Act of 2010, 111 P.L. 281, 124 Stat. 2905 (2010), signed into law by

III. 2011 BIOFOULING GUIDELINES

The need for effective anti-fouling measures to reduce the incidence of marine invasive species in the environment is balanced with global standards for reducing the toxicity of anti-fouling coating systems. Since the Anti-Fouling Convention entered into force, the IMO has adopted several follow-on resolutions that help states implement their obligations set forth in the treaty.⁷⁰ Detailed guidelines for inspection of anti-fouling systems were adopted in 2003.⁷¹ For example, the guidelines suggest that during port inspections, port state control officers examine a vessel's IAFS Certificate and Declaration of Anti-Fouling System, and the attached Record of Anti-Fouling Systems, as appropriate.⁷² Inspection may also include a brief sampling of the ship's anti-fouling system, so long as it does not affect the structure, integrity, or operation of the system.⁷³

If the initial inspection "leads to clear grounds" to believe that a ship is in violation of its anti-fouling system, a more thorough inspection may be conducted.⁷⁴ Such inspection may include examination of the ship's logs, including entries regarding date of last repair, dry-dock or time that the anti-fouling system was applied, date of departure from the previous location, current port and date of arrival, and the ship's position at or near the time of boarding.⁷⁵

While these earlier guidelines were helpful in acclimating the industry to new standards, in 2011 the MEPC adopted refined guidelines for better control and management of bio-fouling.⁷⁶ The 2011 Guidelines pay special attention to niche areas, such as sea chests, bow thrusters, propeller shafts, inlet gratings, dry-dock support strips and other areas more susceptible to bio-fouling due to

President Obama on October 15, 2010. The United States initially regulated TBT through the Organotin Anti-Fouling Paint Control Act of 1987, 100 P.L. 333, 102 Stat. 605 (1988). The OAPCA was repealed by Pub. L. 111-281, Oct. 15, 2010, 124 Stat. 3032.

70. See, e.g., IMO, *Guidelines for Inspection of Anti-Fouling Systems on Ships*, Res. MEPC 105(49), Annex 10 (July 18, 2003); IMO, *Guidelines for Brief Sampling of Anti-Fouling Systems on Ships*, Res. MEPC 104(49), Annex 9 (July 18, 2003); IMO, *2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species*, Res. MEPC 207(62), Annex 26 (July 15, 2011).

71. IMO, Res. MEPC 105(49), *supra* note 70.

72. *Id.* at pt. 1, para. 1.1.

73. *Id.* at pt. 2; see also, IMO, Res. MEPC 104(49), *supra* note 70 (detailing the procedure for brief sampling of anti-fouling systems on ships).

74. IMO, Res. MEPC 105(49), *supra* note 70, at pt. 2, para. 1.

75. *Id.* at pt. 2, para. 2.

76. IMO, Res. MEPC 207(62), *supra* note 70.

different hydrodynamics or wear or damage to the coating.⁷⁷ Under the Guidelines, ships should maintain a Biofouling Management Plan that, among other things, addresses details of the anti-fouling system, hull locations susceptible to biofouling, and detail on the operating conditions suitable for the particular system and safety information.⁷⁸ Ships should also maintain a Biofouling Record Book that details the record of inspections and biofouling management measures undertaken on the ship, including dates and locations of dry-dockings and slippings, date and location of in-water inspections, and detail on inspection and maintenance of internal seawater cooling systems.⁷⁹

Specific measures should be undertaken upon installation, re-installation, or repair of the anti-fouling system.⁸⁰ Surface preparation is essential to ensure that biofouling residue, flaking paint, and surface contamination are removed.⁸¹ Niche areas are particularly susceptible to biofouling growth.⁸² The 2011 Guidelines contain special provisions for management of niche areas, including dry-docking support strips, bow and stern thrusters, edges and welded joints, recesses within rudder hinges and stabilizer fin apertures, propellers and shafts, exposed sections of stern tube seal assemblies and internal surfaces of rope guards.⁸³ Properly sealed cathodic protection anodes can protect surfaces, but also attract marine life.⁸⁴ Pitot tube housings and openings to sea inlet pipes and overboard discharges are also vulnerable.⁸⁵ The 2011 Guidelines are to be updated to reflect scientific and technological advances.⁸⁶ Finally, the 2011 Guidelines stipulate in-water inspections, cleaning, and maintenance protocols.⁸⁷

Combating biofouling is typically most effective at the design and construction phase. Utilizing advanced naval architecture can help to

77. *Id.* at pt. 2, para. 2.1.

78. *See id.* at pt. 5, para. 5.3 (listing six areas on which management plans should focus).

79. *Id.* at pt. 5, para. 5.5–5.7.

80. *Id.* at pt. 6.

81. *Id.* at pt. 6, para. 6.6.

82. *Id.*

83. *See id.* at pt. 6, para. 6.8 (outlining multiple niche areas susceptible to biofouling growth).

84. *See id.* at pt. 6, para. 6.7 (stating procedures to minimize biofouling on cathodic protection anodes).

85. *See id.* at pt. 6, para. 6.8–6.9 (addressing pitot tube housings and sea inlet pipes).

86. *Id.* at pt. 1, para. 1.6.

87. *Id.* at pt. 7.

avoid biofouling problems throughout a ship's service life.⁸⁸ Specific solutions such as the rounding and beveling of corners, the ability to blank off sea chests and moon pools, floodable docks and other free flood spaces can be engineered into the ship to facilitate treatment and cleaning.⁸⁹ Furthermore, these standards can be promulgated by the classification societies to ensure industry uniformity.⁹⁰

Member states should take "urgent action" to make sure the rules are implemented.⁹¹ Flag states, port states, and coastal states each play a role in this comprehensive approach.⁹² Under UNCLOS, flag states are responsible for ensuring that ships that fly their flag meet internationally accepted standards of construction, design, equipping, and manning.⁹³ The regulatory competence of the flag state extends to all aspects of ship standards for environmental protection, including compliance and enforcement of rules concerning anti-fouling systems.⁹⁴ The foremost responsibility to implement the standards falls on flag states, which are obligated to ensure that ships have a biofouling management plan that includes a description of the anti-fouling system and operational profile of the ship, and identifies areas particularly susceptible to biofouling, and any management actions taken, such as inspections, cleaning, and maintenance.⁹⁵ Flag state authority is the most powerful mechanism for effective implementation of anti-fouling standards since initial ship design and construction is the most important tool to minimize ship bio-fouling risks.⁹⁶

Port states may exercise jurisdiction over commercial ships that have entered their roadsteads, ports, or harbor works.⁹⁷ Since these

88. *Id.* at pt. 8.

89. *Id.* at pt. 8, para. 8.1.2.

90. *See id.* at pt. 2, para. 2.2(e) (explaining that any supporting evidence of the actions taken when certain parts of the ship have been inspected should be recorded in the Biofouling Record Book).

91. *Id.* at para. 2.

92. *Id.* at pt. 1, para. 1.6.

93. *See* United Nations Convention on the Law of the Sea, *supra* note 35, at art. 94, para. 1 ("Every state shall effectively exercise its jurisdiction and control over administrative, technical, and social matters over ships flying its flag.").

94. *See id.* at art. 217 (stating that flag states shall adopt necessary laws and measures to reduce marine pollution).

95. *See* IMO, Res. MEPC 207(62), *supra* note 70, at 17–21 (detailing the format and content of biofouling management plans).

96. *See id.* at pt. 8, para. 8.1 (asserting that "initial ship design offers the most comprehensive, effective, and durable means by which to minimize ship biofouling risks").

97. *See* IMO Doc. A.787(19), Procedures for Port State Control, Nov. 23, 1995 (referring to ships in a "port or offshore terminal").

facilities lie entirely within the sovereignty and jurisdiction of a port state's territory, port states may exercise wide discretion over ships that enter voluntarily.⁹⁸ By complementing the authority of flag states, port states help facilitate compliance with international shipping regulations.⁹⁹ Port states may prescribe conditions for port entry that include participation in environmental treaties.¹⁰⁰ For example, port states aid compliance with the Marine Pollution Convention 73/78 through port inspections and port state enforcement proceedings.¹⁰¹

In recent years, regional memoranda of understanding (MOUs) have facilitated the complementary actions of port states by recognizing wide-ranging jurisdiction among regional states to make inquiries and conduct inspections of each other's ships that enter into their respective ports.¹⁰² For example, the first of these agreements, the Paris MOU, was adopted in 1983 and now has 26 party states.¹⁰³ MOUs have also been negotiated in Central and South America, the Caribbean, the Indian Ocean, the Atlantic Ocean, the Pacific Ocean, and the Persian Gulf.¹⁰⁴

IV. MAKING THE 2011 GUIDELINES MANDATORY

The 2011 Guidelines under the Anti-Fouling Convention are designed to help ship operators and shipowners implement industry best practices, but they are not mandatory.¹⁰⁵ The next step forward is to make the 2011 Guidelines mandatory, thus providing a compulsory mechanism for legal commitment by flag states and port states, including authority for enforcement action. Flag states would benefit

98. See UNCLOS, art. 218, para. 1 (giving port states powers over vessels that voluntarily enter the state's port).

99. See *id.* at pt. 2, para. 2.1 (stating that port states have the authority to verify compliance of shipping measures).

100. See Tatjana Keselj, *Port State Jurisdiction in Respect of Pollution from Ships: The 1982 United Nations Convention on the Law of the Sea and the Memoranda of Understanding*, 30 *Ocean Dev. & Int'l Law* 127, 132 (2010) (discussing port states' rights to adopt standards relating to shipping and pollution).

101. See UNCLOS, art. 218 (describing general port inspection procedure).

102. See Keselj, *supra* note 100, at 142 (explaining that MOU provisions allow the port state to exercise certain enforcement powers against all vessels).

103. *Id.*; see also Memorandum of Understanding on Port State Control in Implementing Agreements on Maritime Safety and Protection of the Marine Environment, 21 *I.L.M.* 1-4 (1982).

104. See Keselj, *supra* note 100, at 141 (listing the regional expansions of MOUs).

105. See IMO, *2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species*, Res. MEPC 208(62), Annex 26 (July 15, 2011), at 11 (explaining the sampling of anti-fouling systems as a two-stage analysis where exchange of information between port states is done to exchange best practices).

from acceptance of concrete and legally binding commitments, whereas port states would accrue expanded authority to implement the standards in their port state control measures.

Mandatory Guidelines would leverage the particular legal competencies of flag states and port states. Flag states and port states possess complementary prescriptive and enforcement jurisdiction over ships.¹⁰⁶ These states should work through the IMO to revise the 2011 Guidelines on anti-fouling systems and convert them into a mandatory obligation, either through amendment to the Anti-Fouling Convention itself, or through another legal instrument, such as MARPOL.

The Anti-Fouling Convention already sets forth the process for amending the standards for anti-fouling systems under the treaty, and any party may propose an amendment.¹⁰⁷ Initial proposals are submitted to the MEPC of the IMO in accordance with Annex 2 of the Anti-Fouling Convention.¹⁰⁸ The Initial Proposal shall contain, *inter alia*, the name of the active ingredients and Chemical Abstract Registry (CAS) number of the compound, as applicable, and identify components that are suspected to cause adverse effects.¹⁰⁹ The Initial Proposal is also required to characterize any information that suggests the anti-fouling system “may pose a risk to human health or may cause adverse effects in non-target organisms at concentrations likely to be in the environment.”¹¹⁰ Characterization should be supported by toxicity studies on representative species or bioaccumulation data. Finally, proponents should include a preliminary recommendation on the type of restrictions that could reduce the risks associated with the anti-fouling system.¹¹¹

Upon consideration of the Initial Proposal, the MEPC decides whether the anti-fouling system in question “warrants a more in-depth review,” and if so, invites the proposing state to submit a Comprehensive Proposal.¹¹² The Comprehensive Proposal shall contain additional data “on environmental or ecological exposure and any estimates of environmental concentrations developed through the

106. See Paul Stephen Dempsey, *Compliance and Enforcement in International Law –Oil Pollution of the Marine Environment by Ocean Vessels*, 6 *Nw. J. Int'l L. & Bus.* 459, 538 (1984) (explaining that some nations report as both flag and port states).

107. AFC, art. 6(1).

108. *Id.* at art. 6(2).

109. AFC, Annex 2, para. (1)(a).

110. *Id.* at para. (1)(b).

111. *Id.* at para. (1)(e).

112. AFC, art. 6.

application of measurements of concentrations or mathematical models, using all available environmental fate parameters, preferably those [that] were determined experimentally, along with an identification or description of the modeling methodology.”¹¹³

Data on “environmental fate and effect” include modes of degradation and dissipation, such as hydrolysis, photodegradation, and biodegradation persistence in relevant media such as the water column, sediments and biota, leaching rates of the active ingredient, mass balance, bioaccumulation, partition coefficient, octanol-water coefficient (K_{ow}), and any novel reactions on release or other interactive effects.¹¹⁴

Furthermore, the Comprehensive Proposal shall include summaries of studies already conducted, a summary of any monitoring conducted, and a qualitative statement of the level of uncertainty in the evaluation of the adverse environmental effects.¹¹⁵ Data include acute and chronic toxicity, developmental and reproductive toxicity, endocrine disruption, bioavailability, biomagnification and bioconcentration, food web and trophic effects, field observations of fish kills or strandings, tissue analysis, and residue in seafood.¹¹⁶ Finally, the submission should include the physical and chemical properties of the component of concern, such as its melting point, boiling point, density (relative density), vapor pressure, water solubility / pH / dissociation constant (pKa), oxidation and reduction potential, and its molecular structure.¹¹⁷

Articles to the Anti-Fouling Convention can be amended through a separate procedure, which is also managed through the MEPC at IMO. Amendments may be adopted with a two-thirds vote of state parties present and voting in the MEPC, so long as at least one-third of the parties are present.¹¹⁸ An amendment is accepted when two-thirds of the parties notify the IMO Secretary-General of their acceptance of the amendment, and it enters into force six months after acceptance by the requisite number of states.¹¹⁹

The IMO also helps states develop appropriate phase-in standards for older vessels as well as standards for new hulls, as it has

113. AFC, Annex 3, para. (1)(e).

114. *Id.* at para. (1)(b) and (3).

115. *Id.* at para. (1)(f), (g) and (h).

116. *Id.* at para. (3).

117. *Id.* at para. (2).

118. AFC, art. 16, para. (2)(c).

119. *See* AFC, art. 16(e)–(f) (detailing the circumstances of accepting amendments).

done with MARPOL 73/78 and its six annexes.¹²⁰ At IMO, a framework treaty such as MARPOL or the Anti-Fouling Convention is often as flexible as a non-binding instrument since revisions or amendments to these treaties may be made through the tacit amendment procedures, or ratification by party states.¹²¹ In the case of anti-fouling systems, advances in technology are likely to change rapidly from year to year, providing frequent opportunities for states to review best practices and update standards.¹²² However, because of the costs of mistakes with new technology, novel coatings systems are vetted for decades before they are accepted.

Could MARPOL serve as a vehicle for making the 2011 Anti-Fouling Guidelines mandatory? Amendments to MARPOL are made pursuant to Article 16 of the original 1973 Convention, Article VI of the 1978 Protocol, and Article 4 of the Protocol of 1997, which together confer on the IMO the authority to consider and adopt amendments.¹²³ Under Article 16 of MARPOL 1973, proposals for adoption may be submitted by a member state at least six months prior to its consideration.¹²⁴ First, proposed amendments are raised in the MEPC of the IMO. MEPC can adopt amendments with a two-thirds vote of parties present, so long as these states have a combined merchant fleet of not less than 50 percent of the world's gross tonnage.¹²⁵ If proposals are adopted, the Secretary-General of the IMO conveys the amendments to the states for formal acceptance.¹²⁶ Second, the process for amending an existing MARPOL annex is the same as for regular amendments except that a party has the opportunity after adoption to notify the Secretary-General that its

120. International Convention for the Prevention of Pollution from Ships 1973/1978, November 2, 1973, 1340 U.N.T.S. 184.

121. Liu Nengye, *International Legal Framework on the Prevention of Vessel Source Pollution*, China Oceans L. Rev. 238, 241 (2010).

122. See Patrick Hagan et al., *Status of Biofouling Regulations and Compliance Technologies – 2014*, Maritime Envtl. Res. Ctr. at 6 (2014) (explaining that technology will change biofouling policy).

123. See IMO, *Amendments to the Annex of the Protocol of 1997 to Amend the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto*, Res. MEPC 176(58), Annex 13 (Oct. 10, 2008), at 1 (2008).

124. MARPOL – International Convention for the Prevention of Pollution from Ships, 1973, art. 16, available at [http://www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20\(copies\)/MARPOL.pdf](http://www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20(copies)/MARPOL.pdf).

125. Constantinos Kyprou Hadjistassou, *Rethinking Marine Environmental Policy*, Mass. Inst. of Tech. 20–21 (2004).

126. See *Summary of IMO Conventions*, <http://www.uscg.mil/international/affairs/Publications/MMSCCode/english/AppendC.htm> (last visited Sept. 23, 2015).

express approval is required.¹²⁷

Which approach is best for making the 2011 Anti-Fouling Guidelines mandatory? Both alternatives discussed here—the Anti-Fouling Convention and MARPOL—are rather flexible instruments that include an iterative process of amendment; either could be used. Procedurally, the two treaties may be revised through the IMO’s “spirit of cooperation” process, which eschews complex legalistic formulae in favor of streamlined, consensus-driven revisions to existing treaties.¹²⁸

Since the Anti-Fouling Convention and MARPOL both fall within the remit of the MEPC at IMO, the same committee is responsible for changes to both instruments. Because it is a newer instrument, however, the most promising approach is for MEPC to revisit the Anti-Fouling Convention and to consider adding the 2011 Guidelines as a mandatory annex. This new annex would not enter into force without a two-thirds vote of the member states in accordance with the tacit amendment procedures, and its effective date could be projected into 2016 or 2017. This approach allows additional time for flag states and port states to consider methods of implementation in order to maximize compliance.

127. *Id.*

128. James Kraska, *Maritime Power and the Law of the Sea: Expeditionary Operations in World Politics* 104 (2010).