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International Regulation Of Transboundary Pollutants: The Emerging Challenge Of Ocean Noise

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INTERNATIONAL REGULATION OF TRANSBOUNDARY POLLUTANTS: THE EMERGING CHALLENGE OF OCEAN NOISE

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Undersea noise pollution is like the death of a thousand cuts. Each sound in itself may not be a matter of critical concern, but taken all together, the noise from shipping, seismic surveys, and military activity is creating a totally different environment than existed even fifty years ago. That high level of noise is bound to have a hard, sweeping impact on life in the sea. Regulating these sound sources can be difficult, but one has to start somewhere. Every breath we take is dependent on the ocean. And unless we really understand how that vast system works and take better care of it, it isn't just the ocean that's in jeopardy. It's our whole future that's at stake.[1]

- *Dr. Sylvia Earle, former Chief Scientist, National Oceanic and Atmospheric Administration*

I. INTRODUCTION

Transboundary pollution law poses the challenge of addressing environmental problems irrespective of boundaries in an international legal system that values, above all, territorial sovereignty of individual States. Over the years, several international disputes have resulted over damage that occurred when one State's pollutants crossed into another State's

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1. MICHAEL JASNY, SOUNDING THE DEPTHS: SUPERTANKERS, SONAR AND THE RISE OF UNDERSEA NOISE, vii. (Natural Resources Defense Council, 1999). *See also* Dwight Holing, *The Sound and the Fury*, 16 AMICUS J. 18, 19 (1994).

territory. The *Trail Smelter* case of 1941 is considered the landmark case of transboundary pollutant litigation. In this controversy, the United States claimed that damage was caused to the State of Washington by fumes from a smelter located seven miles from the international border in Canada. The U.S. initially rejected the decision of the International Joint Commission and the case was then referred to arbitration under a 1935 treaty. In March 1941, the United States was awarded the arbitral decision which asserted the principle that a State has responsibility for any environmental damage it creates even beyond its territorial limits.[2] Specifically, the tribunal found that based on principles of international law:

> no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or person therein, when the case is of serious consequence and the injury is established by clear and convincing evidence.[3]

The *Trail Smelter* case underscored the fact that ecological effects know no boundaries; they can spill across geopolitical frontiers and cause cumulative externalities worldwide. Perhaps the most significant aspect of the *Trail Smelter* case was that it required States to do more than make reparation for environmental damage—it also recognized the duty of States to take appropriate measures to *protect* the environment.[4] This case gave rise to the concept that even a sovereign nation owes surrounding States some protection from pollution which is created within its jurisdiction. The *Trail Smelter* case was unique in that it was one of the first cases to address an amorphous type of transboundary pollution. In fact, the *Trail Smelter* arbitration remains the only international adjudication on the subject of air pollution.[5]

At the time of the *Trail Smelter* controversy, scientists and legislators could not have anticipated the negative effects from the increasing presence of a similar, and seemingly innocuous type of pollutant—ocean noise. The effects from ocean noise are perhaps subtler and more insidious than the

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2. *See* ZYGMUNT J.B. PLATER ET AL. ENVIRONMENTAL LAW AND POLICY: NATURE, LAW, AND SOCIETY 1186 (2d ed. 1998).

3. Trail Smelter Arbitration (U.S. v. Can.), 3 U.N. Rep. Awards 1905, 1965 (1941), *reprinted in* 35 AM. J. INT'L L. 684, 716 (1941) [hereinafter *Trail Smelter*].

4. *Id.* at 717–26 (stating that operations of the smelter should be subject to some control to avoid future damage).

5. *See* PATRICIA W. BIRNIE & ALAN E. BOYLE, INTERNATIONAL LAW AND THE ENVIRONMENT 394 (1992).

environmental effects of air pollution. These effects are unseen but can constitute an enormous threat to the marine ecosystem.

Noise in the ocean is analogous to the smoke and noxious fumes of *Trail Smelter* in that it can also be considered a form of transboundary pollution.[6] The 1982 United Nations Convention on the Law of the Sea (UNCLOS) defines marine pollution as:

> the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.[7]

Because acoustic emissions involve the introduction of energy into the marine environment and may involve deleterious effects to marine mammals, noise can clearly be considered pollution under UNCLOS. The U.S. National Academy of Sciences has stated that "[n]oise is widely acknowledged to be an environmental pollutant for humans and many other terrestrial species, and it is no doubt a pollutant for marine animals as well."[8]

Underwater sound is created by myriad activities worldwide.[9] Whether it is created intentionally as in the use of sonar or as a by-product of another activity such as shipping, it is estimated that noise in the water has increased in magnitude between 1950 and 1975.[10] The growing use of underwater acoustics for scientific research, defense applications, aquaculture, and seafloor mapping has greatly increased the quantity and intensity of sound in the ocean. This has given rise to issues that have not

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6. *See* Harm M. Dotinga & Alex G. Oude Elferink, *Acoustic Pollution in the Oceans: The Search for Legal Standards*, 31 OCEAN DEV. & INT'L L. 151, 162 (2000) (discussing ocean noise as a pollutant). *See also* Kenneth Brink, *The Silence of the Sea: Noise Pollution May be Fatal to Whales*, THE PROV. J., Sept. 17, 2000, at E13.

7. United Nations Convention on the Law of the Sea, Dec. 10, 1982 art. 1(1)(4), 21 I.L.M. 1261, 1271 (1982) [hereinafter UNCLOS].

8. NATIONAL RESEARCH COUNCIL, LOW-FREQUENCY SOUND AND MARINE MAMMALS: CURRENT KNOWLEDGE AND RESEARCH TRENDS 9 (1994) [hereinafter NAT'L RESEARCH COUNCIL 1994].

9. In this paper no distinction is made between the terms "noise" and "sound". They are often used interchangeably. Noise is a somewhat relative term and has been defined as "sound or a sound that is loud, unpleasant, unexpected, or undesired," and also as "sound or a sound of any kind." THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE, 3d ed., 1996.

10. *See* Donald Ross, *On Ocean Underwater Ambient Noise*, 18 INST. OF ACOUSTICS BULL. 5, 5–8 (1993).

been addressed before. Environmental groups, biologists, and acousticians have raised concerns that man-made noise in the ocean could have adverse environmental effects on marine life. Specifically, it is believed that acoustic emissions affect the behavior of many species of marine mammals and could have effects on humans as well.[11] Future regulation that restricts the use of sonar could have enormous impacts on naval operations, scientific research, oil exploration, fishing and aquaculture. Even unintentional emission of sound in the ocean created as a by-product of other activities such as shipping, recreational boating, and airplanes could be subject to regulation.

Because underwater sound is capable of traveling long distances—thousands of miles—it can be considered a type of transboundary pollution. Presently there is a lack of a coherent policy framework for evaluating the environmental impacts of underwater noise pollution. There are no international treaties or laws that specifically address the operations of sonars or transmission of sound in territorial waters or the high seas.[12]

This paper examines the issue of underwater noise pollution in a global context and identifies the capacity of international instruments to address it. Specifically, it discusses the establishment of regional agreements and conventions that directly address underwater noise pollution. Additionally, recommendations are made for the development of appropriate policy regarding the use of sound in the ocean.

II. BACKGROUND

The benchmark international focusing event that involved underwater sound took place in 1996. On May 12 and 13, twelve Cuvier's beaked whales (*Ziphius Cavirostris*) were stranded alive on a 38-kilometer stretch of beach along the coast of the Kyparissiakos Gulf in Greece.[13] At the same time, the North Atlantic Treaty Organization (NATO) and the U.S. Navy were conducting a joint international experiment using a high-powered, low-frequency sonar. In a correspondence to the journal *Nature* entitled "Does acoustic testing strand whales?" Dr. A. Frantzis of the University of Athens linked the deaths of whales to the use of sonar in the

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11. W. JOHN RICHARDSON ET AL., MARINE MAMMALS AND NOISE 2 (1995). *See also* F. Michael Pestorius, U. Tex. Austin, EFFECTS OF LOW FREQUENCY WATERBORNE SOUND ON DIVERS, Doc. No. ARL-TR-96-5 (1996).

12. JASNY *supra* note 1, at 25.

13. A. Frantzis, *Does Acoustic Testing Strand Whales?* NATURE, Mar. 5, 1998, at 29. *See also* SACLANTCEN, *Press Release, at* http://www.saclantc.nato.int/whales/pressrel.html (last visited Dec. 9, 2000).

area.[14] Because whales employ their own biological form of sonar for hunting, navigating, and communicating, they may be susceptible to physiological or behavioral damage from sonar and other loud sounds in the ocean. Dr. Frantzis pointed out that deep-diving whales seem to be especially affected by low-frequency sounds.[15] His letter created a maelstrom of controversy in the scientific community.

Although scientists were not able to prove a link between the use of sonar and the whales' deaths, the incident acted as a focusing event for the issue of unregulated underwater sound. As a result, in June 1998 an international team of experts met in Italy to discuss possible explanations of the beached whale phenomenon and to develop a NATO policy regarding sonar and marine life.[16]

This incident pointed out the challenges in regulating a transboundary type of "pollutant" in an international arena: the sonar was owned by the U.S. government, the ship flew a German flag, though it was owned by the 16 countries of NATO, and the experiment was carried out in Greek waters. Determining who might possibly regulate the use of the sonar in this scenario was problematic and the international implications were significant. The challenge of regulating ocean noise in an international context became disturbingly evident.

A. The Physics of Underwater Sound

Sound is a form of mechanical energy. It is a vibration that travels as a wave in a fluid. While the ocean is basically opaque to light, it is comparatively transparent to sound.[17] The ocean is an especially effective medium for transmitting sound—of all forms of known radiation, sound travels through the sea the best.[18] It occurs naturally in the marine environ-

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14. *See* Frantzis, *supra* note 13. *See also, Quiet, please. Whales navigating.* THE ECONOMIST, Mar. 7, 1998, at 85 (discussing Frantzis's hypothesis that the May 1996 whale stranding was due to a sonar test by NATO); *Beached Whales and Military Testing*, THE WASH. POST, Mar. 9, 1998, at A2 (citing Frantzis's hypothesis as a possible explanation of the May 12, 1997 whale stranding).

15 Frantzis, *supra* note 13.

16. *SACLANTCEN Summary Record, SACLANTCEN Marine Mammal Environmental Policy and Mitigation Procedures Panel*, La Spezia, Italy, 17–19 June 1998, *at* http://www.saclantc.nato.int/whales/mammal.html (last visited Dec. 9, 2000). *See also Sonar and Marine Research—A Risk for Whales*, CORRIERE DELLA SERA, June 14, 1998 (providing coverage of the SACLANTCEN meeting).

17. *See* COMMITTEE TO REVIEW RESULTS OF ATOC'S MARINE MAMMAL RESEARCH PROGRAM, NAT'L RESEARCH COUNCIL, MARINE MAMMALS AND LOW-FREQUENCY SOUND: PROGRESS SINCE 1994, 1 (2000) [hereinafter NAT'L RESEARCH COUNCIL 2000].

18. ROBERT J. URICK, Principles of Underwater Sound 1 (3d ed. 1983).

ment as a result of wind, waves, and marine life but can also be introduced intentionally or incidentally through human activities such as shipping, construction, and the use of sonar technology. Noise generated from these human activities is known as anthropogenic noise.

Sound waves can differ in wavelength, intensity, and frequency (measured in cycles per second or Hertz). The lower the frequency of a sound, the farther it can travel in the ocean. Sound of frequencies below 1000 Hertz (Hz) is often referred to as low-frequency sound. Low-frequency sound is of greatest concern because of its ability to travel great distances and because many marine mammals use low-frequency sound to communicate and navigate.

The decibel (dB) is the unit used to compare level differences of like quantities of sound—usually intensity or power. Much of the controversy over low-frequency sound in the ocean can be attributed to misuse of the term "decibel". The decibel is not an absolute unit with a physical dimension; it is a relative unit. The term "decibel" is to all intents and purposes useless, unless the standard of comparison is cited.[19] For example, it is important to note that standard reference pressures used in underwater acoustics and in-air acoustics are not the same. The standard reference pressure for ocean sounds is gauged to 1 micro-Pascal (1 μPa) while the standard reference for air-borne sounds is 20 micro-Pascals (20 μPa).[20] It is essential that one not compare air-borne sounds with water-borne sounds directly as has often been erroneously done in the controversy over low-frequency sound.[21] Therefore, one cannot directly compare the output of an underwater sonar with the sound from a jumbo jet.

The decibel scale expresses sounds logarithmically, so the difference between 180 and 190 dB is not 10, but 10 times. Perception must also be considered. For example, in humans, a 10-dB increase in sound may be *perceived* as only twice as loud, not ten-times as loud.[22] Context is important, too. For example, a blue whale call is approximately 190 dB, which would be harmful to humans, but apparently has no effect on blue

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19. For an excellent discussion of the proper use of the term "decibel" see David M.F. Chapman & Dale D. Ellis, *The Elusive Decibel: Thoughts on Sonars and Marine Mammals*, CANADIAN ACOUSTICS, June 1998.

20. This reference pressure in water is normally abbreviated to "dB re: 1 μPa" and will be used throughout this document.

21. For a discussion of the controversy resulting from confusion over underwater acoustical terminology, see John Potter, *ATOC: Sound Policy or Enviro-Vandalism? Aspects of a Modern Media-Fueled Policy Issue*, J. ENV'T. DEV. 1997, at 47.

22. OFFICE OF PROTECTED RESOURCES, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., *The Effects of Manmade Noise on Marine Mammals, Marine Mammal Protection Act Bull.* 2nd/3rd Quarter 2000, at 9 [hereinafter OFFICE OF PROTECTED RES., NOAA].

whales.[23] "There is no clear connection between a harmful sound level for a human in air and that for an animal in water."[24] It is also important to note that a source level (generally evaluated 1 meter from the source) cannot be compared with a received level at an unspecified distance.

Because sound is multi-dimensional, it cannot be characterized by a single measure. When considering the response of a marine mammal species to a particular sound a number of factors must be considered. These include the intensity of the sound, its duration, frequency, bandwidth, duty cycle, rise time, temporal structure, and the similarity of any of these factors to biologically relevant sounds. Additionally, the hearing sensitivity of the species is important. Another problem concerns the difficulties in predicting actual levels of sound received by the animal. Several environmental factors affect transmission loss in the ocean, making it difficult to predict exactly what level of sound an animal is actually exposed to. Sound levels produced by animals, human activities, and other specific sources such as sonars, diminish with increasing distance from the source. The rate of transmission loss, however, is influenced significantly by local conditions. The radius of acoustic influence for a given source can vary by as much as an order of magnitude depending on local propagation conditions.[25] As a result, under optimal conditions even a moderate sound level can often be detected hundreds of kilometers away from the source.[26]

The issue of underwater noise pollution is a contemporary problem that can be attributed to the transboundary nature of ocean sound. To best understand the international implications of underwater noise pollution, it is important to consider the pervasive nature of sound in the ocean, and its ability to travel long distances. Because sound in the oceans is not restricted by national boundaries, acoustic energy cannot be regulated by domestic policy alone.

To complicate matters further, the nature of noise in the water is multi-source. Overall noise in the ocean results from a combination of sources, some man-made (sonar, ships' engines) and some natural (waves, wind, rain, ice). Acoustic transmissions underwater cannot always be considered singularly. All sources of noise must be taken into account. Figure 1 illustrates the broad spectrum of ocean noise and the activities that generate it.

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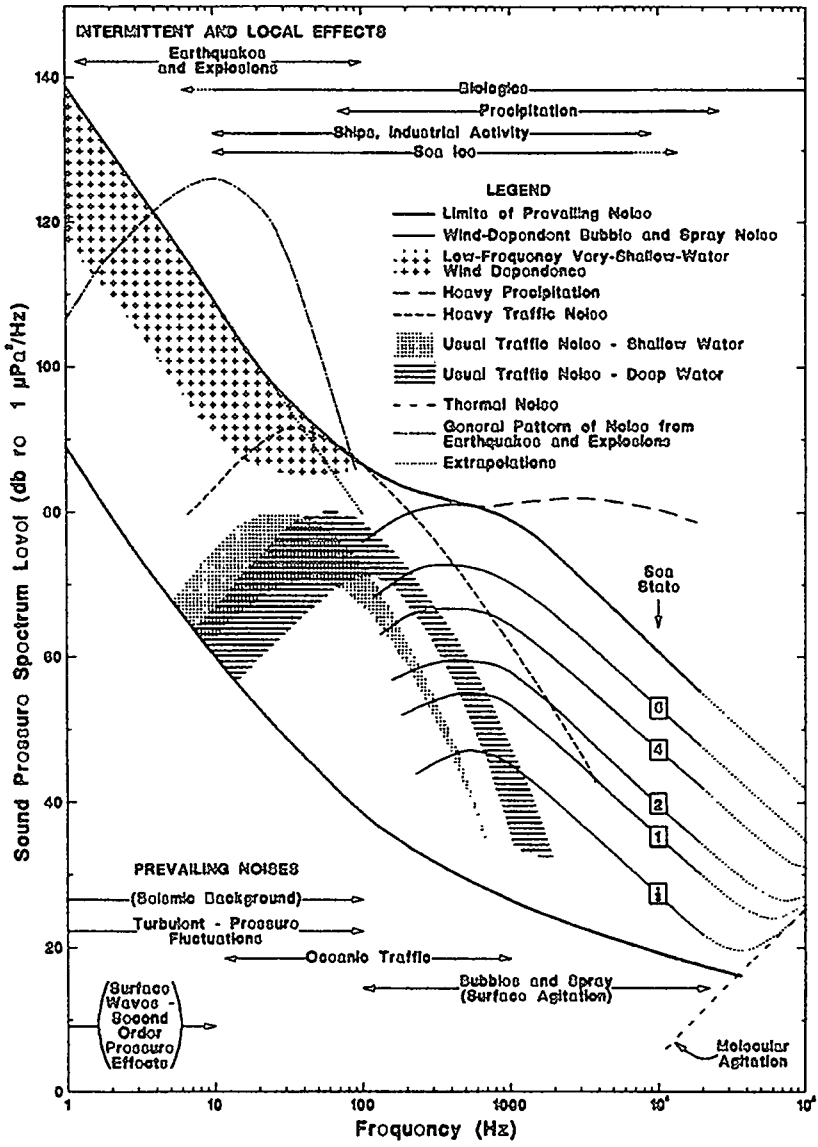
23. *Id.*

24. Chapman and Ellis, *supra* note 19, at 30.

25. RICHARDSON ET AL., *supra* note 11, at 59.

26. For a thorough discussion of transmission loss and the environmental factors that affect sound propagation in the ocean, see RICHARDSON ET AL., *supra* note 11, at 59–83; URICK, *supra* note 18, at 99–197.

Figure 1. Ambient noise spectra.[27]



27. G.M. Wenz, *Acoustic Ambient Noise in the Ocean: Spectra and Sources*, 34 J. ACOUSTICAL SOC. AM. 1936, 1952 (1962).

B. Sources of Anthropogenic Sound in the Water

Much of the concern regarding underwater sound focuses on high powered military sonar systems used in anti-submarine warfare and other acoustic devices that specifically create sound that can travel many hundreds or even thousands of kilometers through the water to acoustically search for enemy submarines. However, military sonars are only part of the problem of noise pollution in the ocean. Sonar is an important tool not just for defense applications, but for scientific research, fishing, mapping, aquaculture, and shipping.

Sonar (derived from SOund NAvigation and Ranging) has been in practical use since the turn of the century.[28] Today, hundreds of thousands of other sources that create sound in the ocean are in use daily throughout the world. They can be found on fishing boats, merchant ships, research vessels, oil rigs, and on commercial fish farms. "Pingers" are used by airlines to locate flight recorders; side-scan sonars are used for locating shipwrecks; multibeam sonars are used to create three-dimensional maps of the ocean floor; acoustic releases are employed by scientists to retrieve oceanographic moorings; and chirp sonars are used to locate methane pockets and determine sediment types in the seabed. Fathometers are used by almost every large ship in the world to locate the bottom; fish-finding sonars are used by commercial and sport fishermen; and deterrent pingers are used by fish farmers to keep predators from their pens.

Other sources of intense noise in the ocean include drilling rigs and airguns used by the offshore oil industry to detect oil and gas deposits beneath the seabed. Even scientific research relies on powerful, low frequency sonars to detect changes in the ocean temperature, a technol-ogy known as acoustic thermometry. Shipping is the greatest source of low-frequency noise in the ocean. Ships create noise in a number of ways: through their engines, bearings, vibration of the hull and through propeller cavitation. The large number of ships worldwide results in shipping being the greatest source of continuous anthropogenic noise in the ocean.[29] There are presently approximately 127 supertankers operating in the world's

28. For an historical overview of the development of man-made sound in the ocean since the time of Leonardo da Vinci, *see* URICK, *supra* note 18, at 2–11.

29. Shipping generally dominates continuous or "ambient" ocean noise in the low-frequency range. For a thorough assessment of continuous shipping noise, see RICHARDSON ET AL., *supra* note 11, at 87–158.

oceans at any one time.[30] The entire sonic acoustic energy generated by this fleet is significant, and most importantly, omnipresent.[31]

Table 1 lists some source levels of common underwater sounds. Table 2 includes several of the frequencies employed by marine mammals as well as the frequencies generated by some common anthropogenic activities.

Table 1. Typical Underwater Sounds[32]

Sound	Source Level (dB re: 1 μPascal at 1 meter)
Seismic airgun	240
NATO low-frequency sonar	230
Beluga whale echolocation call	220
ATOC, supertanker tonal	190
Fin whale call, depth sounders	180
Icebreaker breaking ice	170
Oil drilling from surface ships	150

Table 2. Frequencies Used by Marine Mammals for Communication and Echolocation and Peak Frequencies of Anthropogenic Activities[33]

Source	Frequency (Hz)
Depth Sounder	12,000
5 m. Zodiac inflatable boat	6,300
Icebreaking, supply ship underway	100
ATOC	80

Continued on next page

30. *See* Joel J. Newcomb, *Code 7176, Naval Research Lab, Stennis Space Center, Mississippi, 39529, reported in* NAT'L RESEARCH COUNCIL 1994, *supra* note 8, at 74.

31. For an analysis of the entire energy created by the world's fleet of supertankers, *see* NAT'L RESEARCH COUNCIL 1994, *supra* note 8, at 74–75 . Energy created by the world's fleet of supertankers is compared to the energy created by oceanographic research such as ATOC and found to be significantly greater.

32. These data were compiled from a presentation by D.M. Chapman and D.D. Ellis. SACLANTCEN, *supra* note 16, at B2. For a similar comparison, *see* RICHARDSON ET AL., *supra* note 11, at 18.

33. NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 16. *See also* WHITLOW W. L. AU, THE SONAR OF DOLPHINS (1993); RICHARDSON ET AL., *supra* note 11, at 156–157. Frequencies of marine mammals represent the dominant frequencies of their communication and echolocation. Frequencies of anthropogenic activities are the frequency at the highest 1/3-octave band.

Table 3 - Continued

½ kilogram TNT explosion	21
Humpback whale	120 – 4,000
Sperm whale	2,000 – 16,000
Right whale	50 – 500
Gray Seal	100 – 10,000

The level of this increasing noise in the ocean shows no sign of abating. As global trade intensifies, mineral exploration expands, and the use of sonar as a scientific and military tool increases, the level of noise in the ocean will continue to rise. The international community's response to this rise in noise level and its effects on ocean habitat is a matter of increasing importance.

III. PREVIOUS WORK

Health threats and behavioral effects of sound on humans and marine life are well documented. A large body of literature exists on the effects of underwater noise on marine mammals. As early as 1971, Payne and Webb predicted the potential impact of shipping noise on whales.[34] More recently, entire textbooks on the subject have been published.[35] The National Research Council established a Committee on Low-Frequency Sound and Marine Mammals in 1992 and published their first report on the subject in 1994.[36] A follow-up report was released in 2000.[37]

Jasny and Reynolds acknowledged the rise in undersea noise and focused on the emerging risks of unregulated sound in the ocean.[38] They found the U.S. government's current policy on ocean noise to be "uneven in application, piecemeal in approach, and wholly inadequate to the broad ecological challenge that this kind of pollution poses."[39] Emily Gardner discussed the use of the precautionary principle in regard to acoustic activities in the ocean.[40] She outlined many of the challenges in application

34. ROGER PAYNE & DOUGLAS WEBB, ORIENTATION BY MEANS OF LONG RANGE ACOUSTIC SIGNALING IN BALEEN WHALES 110, at 124-126 (1971).

35. *See e.g.*, Richardson et al., *supra* note 11. *See also* AU, *supra* note 33.

36. NAT'L RESEARCH COUNCIL 1994, *supra* note 8.

37. NAT'L RESEARCH COUNCIL 2000, *supra* note 17.

38. JASNY, *supra* note 1.

39. *Id.* at iv.

40. The precautionary principle aims to establish a bias toward safety and caution in which the environment is always given the benefit of the doubt. EMILY A. GARDNER, *The Precautionary Principle as Applied to Marine Acoustic Activities*, EMERGING ISSUES IN NAT'L OCEAN & COASTAL POL'Y, Nov. 1998 at 9–14.

of the principle particularly in satisfying the burden of proof and in determining the appropriate level of caution to be used in acoustic activities such as scientific research, military operations and oil exploration.

There is significant literature on unilateral legislation to protect marine mammals,[41] but very little on multilateral instruments that address regulation of underwater sound. A recent paper by Dotinga and Elferink discusses the existence of international legal standards, and the framework that applies to the regulation of underwater noise pollution.[42] They determined found that international law already requires States to address aspects of sound in the ocean, and that under the United Nations Convention on the Law of the Sea, ocean noise can be considered a type of pollutant.

IV. EFFECTS OF ACOUSTIC EMISSIONS

A. Health Threat to Humans

In 1980, the U.S. Navy released a memorandum entitled "On the Effects of Exposure to Intense Underwater Sound on Navy Divers."[43] It attempted to determine potential risks to the health of Navy divers from exposure to intense sound in water. The memorandum discussed the effects of sound on marine mammals and the results of tests on human divers as well as animals. It concluded that "[because] it is possible that some long-term health hazard exists it is necessary to formulate an approach to the problem."[44] The report called for further research to establish safe underwater noise dosage levels.

In February 1996, a technical report was released by the University of Texas at Austin that addressed the effects of low-frequency waterborne sound on divers.[45] It presented data from a 30-month study into the effects of sound in the low frequency range (16-320 Hz) on 87 U.S. Navy divers. Data from the study were used to develop a set of guidelines for the exposure of divers to sonar transmissions in the low frequency range. Mathematical modeling and testing of the human subjects showed that the

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41. *See, e.g.*, Marine Mammal Protection Act, 16 U.S.C. §§ 1361–1421 (2000); Australia's Whale Protection Act No. 92 of 6 June 1980; New Zealand's Marine Mammal Protection Act, No. 80, of 20 October 1978.

42. Dotinga & Elferink, *supra* note 6, at 157–160.

43. Memorandum from Paul F. Smith and William L. Hunter, Naval Medical Research and Development Command, on the Effects of Exposure to Intense Underwater Sound on Navy Divers (Feb. 20, 1980).

44. *Id.* at 13.

45. F. MICHAEL PESTORIUS, U. TEX. AUSTIN, EFFECTS OF LOW FREQUENCY WATERBORNE SOUND ON DIVERS, Doc. No. ARL-TR-96-5 (1996).

threshold for biological effects is above 160 dB re: 1 μPa, the limit of the study.

The most recent study was conducted between June 1997 and November 1998 by the Office of Naval Research, the Naval Submarine Medical Research Laboratory, and a consortium of universities. This research was carried out in support of a U.S. Navy Environmental Impact Statement (EIS) and resulted in a report titled, "Summary Report on the Bioeffects of Low Frequency Waterborne Sound."[46] It specifically focused on the effects of low frequency sounds (100–500 Hz) on animals and humans. The goal of the research program was to generate guidelines concerning the use of underwater low frequency sound near recreational divers. The report suggested that it would be "prudent and justifiable" to use a conservative value of 145 dB re: 1 μPa as the maximum permissible intensity of exposure for recreational divers. Furthermore, the report provided a detailed guidance based on a number of interrelated components including frequency, intensity, duration, depth, and duty cycle.[47]

B. Health Threat to Marine Mammals

Most of the public's concern with the use of underwater sound has focused on the potentially damaging effects of sonar on marine mammals. This is due to the fact that marine mammals have a greater potential to be "insonified" and because of the possibility that underwater noise could create interference with the animals' "echolocating sonars" which they rely on to communicate and navigate.

The threats to marine life from loud underwater sounds are serious. There is concern that powerful sound can cause tissue in the lungs, ears, or other body parts to rupture or hemorrhage.[48] Farther away, the same sound could induce hearing loss—either temporary or permanent.[49] Sound can also interfere with marine mammals' ability to detect calls from conspecifics, echolocation pulses, and other important natural sounds. This covering up of one sound by another, called masking, is potentially the most serious effect of low level sound.[50]

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46. EDWARD CUDAHY ET AL., SUMMARY REPORT ON THE BIOEFFECTS OF LOW FREQUENCY WATER BORNE SOUND, DEPARTMENT OF THE NAVY TECHNICAL REPORT 3 (Mar. 1999).

47. These components (including the 145 dB re: 1 μPa maximum permissible exposure intensity) do not stand alone and must be taken together. *Id.* at 29.

48. For a summary of the most recent scientific research on health threats from noise to marine mammals, *see* NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 62–63.

49. NAT'L RESEARCH COUNCIL 1994, *supra* note 8, at 12.

50. OFFICE OF PROTECTED RES., NOAA, *supra* note 22. For a summary of the research carried out on masking, *see generally* NAT'L RESEARCH COUNCIL 1994, *supra* note 8, at 12.

Additionally, anthropogenic noise can affect marine mammal behavior. Mammals' reaction to sound can range from brief interruptions of normal activities, such as feeding, to short- or long-term displacement from noisy areas.[51] A recent study found that man-made noise may interfere with breeding humpback whales by forcing them to increase the length of their mating songs when exposed to low-frequency sonar.[52]

There are dozens of documented behavioral disturbance reactions of marine mammals to human presence and anthropogenic activities such as boating, shipping, oil exploration, aircraft, dredging, icebreaking, and scientific and defense activities.[53] Many of these reports are anecdotal and concerned only short-term behavioral reactions; few long-term studies have been conducted. Furthermore, little of the data were gathered under highly controlled conditions.

Despite these studies, it remains difficult for scientists to agree on exactly what effect anthropogenic sound has on marine mammals. The most recent report from National Academy of Sciences found that "developing an understanding of the effects of low-frequency sound on marine mammals will require a more sustained and integrated approach than has been the case in previous research."[54]

C. Effects on Other Marine Life

An emerging concern relates to the effects of underwater sound on the food chain. One study initially showed reduced growth and reproduction in a variety of marine organisms was related to increases in noise.[55] For example, growth rates in minnows and killifish were lower in aquariums exposed to noise.[56] Shrimp exposed to noise have exhibited reduced reproduction and growth and increased aggression and mortality.[57]

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51. *See* RICHARDSON ET AL., *supra* note 11, at 2.

52. Patrick J.O. Miller et al., *Whale Songs Lengthen in Response to Sonar,* 405 Nature 903 (2000).

53. For a detailed account of anecdotal reports of disturbance reaction and *in situ* and laboratory data, see RICHARDSON ET AL., *supra* note 11, at 241–322. *See also* NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION, UNDERWATER EFFECTS OF SONOBUOYS AND SIGNALS UNDERWATER SOUND CHARGES, Doc. N00174-95-D-008 (1998); R.S. GALES, EFFECTS OF NOISE OF OFFSHORE OIL AND GAS OPERATION ON MARINE MAMMALS – AN INTRODUCTORY ASSESSMENT, TECHNICAL REPORT NO. 844, vols. 1&2 (1982); C.W. TURL, POSSIBLE EFFECTS OF NOISE FROM OFFSHORE OIL AND GAS DRILLING ACTIVITIES ON MARINE MAMMALS: A SURVEY OF THE LITERATURE, NOSC TECHNICAL REPORT 776 (1982).

54. NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 5–6.

55. *Id.* at 60.

56. Arnold Banner & Martin Hyatt, *Effects of Noise on Eggs and Larvae of Two Estuarine Fish,* 102 TRANSACTIONS OF THE AM. FISHERIES SOC'Y 134 (1973).

57. J.P. Lagardere, *Effects of Noise on Growth and Reproduction of Crangon crangon*

Extensive data have shown that low-frequency sounds actually attract sharks,thus creating the potential to redistribute shark populations.[58]

The U.S. National Academy of Sciences has called for additional studies on the effects of low-frequency sound on the food chain. Of particular concern are fish species that are commercially important, endangered, or an essential component of marine mammal food diets.[59]

D. Acoustic Interference

In March 1990, the International Oceanographic Commission (IOC) published a report entitled, "International Workshop on Marine Acoustics."[60] The report duly noted the increase of anthropogenic sound in the ocean, but failed to comment on its effects on marine mammals. However, it did bring to light a different aspect of marine acoustics that could have legal repercussions in international waters: acoustic interference. The report discussed the possibility of establishing of IOC-sponsored voluntary code to reduce inter-equipment interference in the frequency range used by many airlines, fisheries researchers, and oceanographers.[61]

V. FOCUSING EVENTS

In the past, most users of underwater sound have not been adequately prepared to address the many technical, political, and socioeconomic issues related to sound in the water. As a result, international political and legal conflicts have arisen. The controversy over noise pollution in the ocean dates back to experiments conducted by scientists at the Scripps Institution of Oceanography in San Diego in the early 1990s. This innovative global-warming experiment was referred to as Acoustic Thermometry of Ocean Climate (ATOC).[62] It generated intense debate and brought regulation of

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in Rearing Tanks, 71 MARINE BIOLOGY 177 (1982).

58. Arthur A. Myrberg, JR., *Using Sound to Influence the Behavior of Free-Ranging Marine Animals, in* 2 BEHAVIOUR OF MARINE ANIMALS 435 (Howard E. Winn & Bori. L. Olla eds., 1972). *See also* Arthur A Myrberg Jr., *Underwater Sound: Its Effect on the Behavior of Sharks, in* SENSORY BIOLOGY OF SHARKS, SKATES AND RAYS 391 (Edward S. Hodgson & Robert F. Mathewson eds. 1978).

59. NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 61.

60. *International Workshop on Marine Acoustics*, Beijing, China, Mar. 1990, UNESCO-IOC report SC-90/WS-63.

61. *See id.*

62. *See* Walter Munk & Arthur Baggeroer, *The Heard Island Papers*, 96 J. ACOUSTICAL SOC. AM. 2327 (1994) (providing background information on the experiment and its precursor). *See also* EUGENE H. BUCK, ACOUSTIC THERMOMETRY OF OCEAN CLIMATE: MARINE MAMMAL ISSUES, Report for Congress 95-603 (1995); Phillip Yam, *The Man Who Would Hear Ocean Temperatures*, 272 SCI. AM. 38 (1995). More information on ATOC is

underwater sound to the forefront of environmental law.[63] Under a plan by scientists at Scripps, low-frequency sounds would be transmitted over hundreds of kilometers and detected by receivers located around the Pacific Ocean. Because sound travels faster in warmer water, scientists would be able to detect long-term changes in ocean temperatures and gain valuable information about global warming.

Some biologists and environmental groups, however, felt that the sound posed a threat to endangered marine mammal and sea turtle species. They were concerned that the noise could affect the animals' migration patterns. Environmentalists threatened to sue, delaying the experiments, and funding for the project was reallocated from global warming studies to marine mammal studies. At least two U.S. Senators, Barbara Boxer and Dianne Feinstein of California, wrote letters condemning the ATOC program.[64] Some members of Congress threatened the budget of the National Oceanic and Atmospheric Administration (NOAA), Vice President Al Gore received a briefing on the issue and openly hostile crowds attended National Marine Fisheries Service (NMFS) hearings on the ATOC program.[65] Consequently, millions of dollars were diverted from funding the original scientific objective to financing lawsuits, countersuits, and conducting scientific research on the effects of noise on marine mammals.[66]

An ongoing controversy over the use of underwater sound concerns the U.S. Navy's development of a new system that uses loud, low frequency sound to detect submarines. The system, the Surveillance Towed Array Sensor System–Low Frequency Active (SURTASS-LFA), is designed to detect and track diesel and nuclear powered submarine contacts at long range. Environmental groups have insisted that the Navy determine whether the noise might be disturbing endangered marine life, and thus violating federal laws such as the Endangered Species Act[67] and the Marine

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available at http://atoc.ucsd.edu/ (last visited Feb. 5, 2001).

63. *See* Ann Gibbons, *What's the Sound of One Ocean Warming?* 248 SCI. 33 (1990); *See also* Jon Cohen, *Was Underwater "Shot" Harmful to the Whales?* 252 SCI. 912 (1991); Joseph Alper, *Munk's Hypothesis: A Slightly Mad Scheme to Measure Global Warming*, 37 SEA FRONTIERS 38 (1991); Ian Anderson, *Global Hum Threatens to "Deafen" Whales*, 129 NEW SCIENTIST 19 (1991); William J. Broad, *2 Environmental Camps Feud over Noisy Ocean Experiment*, N.Y. TIMES, Apr. 5, 1994, at C4; Forsyth Patterson Kineon, ATOC: A Case Study in the Effect of Political Pressure on Science (1996) (unpublished Master's of Marine Affairs Thesis, University of Washington) (on file with the *Ocean and Coastal Law Journal*); and Potter, *supra* note 21.

64. Potter *supra* note 21, at 56.

65. *Id.* at 56–57.

66. *See* Kineon, *supra* note 63, at 37–50.

67. 16 U.S.C. §§ 1531–1544 (2000).

Mammal Protection Act.[68] As a result, the Navy is presently involved in the creation of a lengthy and controversial Environmental Impact Statement (EIS) process.[69]

Another issue that focused attention on underwater sound was the U.S. National Defense Authorization Act's requirement that new designs for the hulls and other critical components of Navy ships and submarines undergo shock tests before service in the fleet.[70] These "ship shock" tests led to much concern about the effect of underwater explosions and impulses on marine mammals. The shock testing of the U.S.S. *John Paul Jones* and the new Seawolf submarine, in particular, became extremely contentious due to the need for high-powered explosives required to carry out the testing.[71]

The oil and gas industries have also been involved in the furor over underwater sound. Their use of towed arrays of airguns and other devices to generate high-energy seismic waves that can travel long distances can affect the movements and behavior of some animals as far away as 10 km.[72] In the Gulf of Mexico alone, over 900 seismic surveys are conducted each year and over 100 wells are drilled.[73] When Exxon proposed to run high-energy seismic surveys in biologically rich waters off the Channel Islands in California, environmental groups became involved and the oil company was required to modify its initial plan. More recently, whale strandings off the west coast of Ireland may be attributed to increased seismic activity of oil exploration companies.[74]

The use of acoustic deterrents, or "pingers," to prevent marine mammal fishery interactions has also become controversial. Because many species of marine mammals interact with aquaculture operations and commercial

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68. 16 U.S.C. §§ 1361–1421 (2000).

69. *Executive Summary Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System–Low Frequency Active (SURTASS-LFA) Sonar* (1999), *at* http://www.surtass-lfa-eis.com (last visited Feb. 5, 2001). The Natural Resources Defense Council and other environmental groups claimed that the U.S. Navy was violating the Marine Mammal Protection Act. As a result of pressure from environmental groups, the Navy halted the SURTASS program while the Environmental Impact Statement was prepared.

70. *See* Robert Gisiner Ph.D., *Proceedings -Workshop on the Effects of Anthropogenic Noise in the Marine Environment* (Feb. 10–12, 1998), Marine Mammal Science Program, Office of Naval Research, *at* http://www.onr.navy.mil/sci_tech/personnel/Proceed.pdf (last visited Feb. 2, 2001).

71. *See* National Marine Fisheries Service, MMPA of 1972 Ann. Rep. 44 (1998). *See also* U.S. Navy, Final Environmental Impact Statement, *Shock Testing the Seawolf Submarine*, Dept. of the Navy, May 1998, *at* http://www.surtass-lfs-eis.com.

72. *See* MARINE MAMMAL COMM'N, 1998 Ann. Rep. To Congress 169 (Jan. 31, 1999).

73. *Id.* at 170.

74. Eibhir Mulqueen, Whale Strandings Due To 'Seismic Activity,' THE IRISH TIMES, May 6, 2000, at 2.

fisheries, these industries have developed sound generators that prevent marine mammal interactions with fishing gear or aquaculture pens. There are, however, numerous uncertainties concerning the safety and effectiveness of these devices. The use of these pingers is presently unregulated and these deterrents can be employed without prior determination of their impact on marine mammals.[75]

The most recent controversy is still unfolding. Several environmental groups have alleged that the use of military sonar is linked to the deaths of 13 whales that washed ashore at various locations in the northern Bahamas. During the week of March 13, 2000, at least fourteen whales representing four species beached themselves in the Bahamas at the same time that the U.S. Navy was conducting acoustic antisubmarine activities in the area.[76] In response to the incident, a coalition of environmental groups held a press conference in Washington, D.C., and presented evidence that they claimed directly linked the March strandings to the Navy's operations.[77] On May 26, 2000, the Navy announced that tests scheduled for early June of that year off the New Jersey coast would exclude active acoustic sources.[78] Studies are presently underway to determine if a definitive link exists between the Navy's activities and the whale deaths.[79] Similar claims have been made in the United Kingdom. The Ministry of Defence is investigating whether its naval sonars have killed whales off the coast of Scotland's Western Isles.[80]

The use of new sonar technology, in addition to increased activity from shipping, oil exploration, and offshore construction has led to a growing public criticism of all forms of anthropogenic sound in the ocean. This

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75. *Marine Mammal Protection Act of 1972: Hearings before the Subcommittee on Fisheries, Conservation, Wildlife and Ocean of the House Resources Committee on Resources, U.S. House of Representatives* (June 29, 1999) (testimony of Penelope Dalton, Assistant Administrator of NMFS).

76. *Whale Death in Bahamas Prompt Investigation: Navy Denies Connection to Anti-sub Exercises as Biologist Calls for Halt*, Associated Press, Mar. 22, 2000. *See also* Ken Balcomb & Diane Claridge, Bahamas Marine Mammal Survey correspondence to Michael Braynen, Director of Fisheries, Nassau, Bahamas, Mar. 23, 2000.

77. Press release, Animal Welfare Institute, *Navy Denies a Deadly Threat to Whales and Dolphins*, May 9, 2000 (on file with the *Ocean and Coastal Law Journal*).

78. Marc Kaufman, *Navy Drops Criticized Sonar Test Off N.J.; Scientists Say Equipment's Submarine Detection Blasts Can Harm Sea Life*, WASHINGTON POST, May 27, 2000, at A2.

79. *Initial Report Suggests Link Between Navy Sonar, Whale Deaths*, THE PROVIDENCE JOURNAL, June 15, 2000, at A15.

80. In the U.K., several articles have linked Ministry of Defence activities to whale strandings. *See, e.g., MoD Pressed Over Sonar Threat to Whales*, THE HERALD (Glasgow) Jul. 24, 2000, at 5; John Elliot, *New Navy Sonar Linked to Spate of Whale Deaths*, THE SUNDAY TIMES (London), Aug. 27, 2000, at 11.

public concern, coupled with heightened awareness of environmental issues, has resulted in an increased demand for further regulation of underwater acoustics. Due to its transboundary nature, underwater sound must be managed internationally. The following section examines international instruments and their applicability to ocean noise pollution.

VI. EXISTING INTERNATIONAL REGULATORY FRAMEWORK

Presently, there is little guidance for utilizing sound in the ocean. Individual organizations such as the North Atlantic Treaty Organization (NATO), the U.S. Navy, and various university research programs have developed limited guidelines specifically for their operations. It is not clear, however, which guidelines are to be followed during joint experiments or on the high seas. U.S. government ageancies must comply with the National Environmental Policy Act (NEPA),[81] but beyond this broad mandate, there is little policy framework in place. In fact, the greatest source of noise in the ocean, shipping, is presently completely unregulated in regard to noise emissions.

There are no international treaties or laws that specifically address the use of sonar or the emissions of underwater sound in territorial waters or high seas. However, international law does apply to the issue of underwater sound to a limited extent and is subject to extensive interpretation. Thus, a review of some existing treaties and conventions which relate to underwater sound follows.

A. Role of the Law of the Sea Convention

The 1982 United Nations Convention on the Law of the Sea (UNCLOS III) provides the international legal framework for nearly all ocean uses. Its provisions generally represent customary international law.[82] For the first time in any international treaty, UNCLOS III codified law that required States to protect the marine environment and to prevent marine pollution.[83] UNCLOS III includes a number of provisions particularly relevant to anthropogenic noise in the ocean, primarily the definition of marine pollution in Article 1(1)(4). Dotinga and Elferink asserted that although the UNCLOS III definition may not have been drafted with

81. National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4370d (1994).
82. UNCLOS, *supra* note 7.
83. *Id.* arts. 207–212.

acoustic pollution in mind, the use of the term "energy" implies that noise can be considered a form of pollution under the LOS Convention.[84]

UNCLOS III requires States to take all necessary measures "to prevent, reduce and control pollution of the marine environment from any source."[85] Noise pollution prevention is mandated—the manner in which this prevention is accomplished remain to be developed. Clearly, the establishment of international rules and standards is the next step in proper implementation of UNCLOS III in regard to underwater noise pollution.

Article 246 of UNCLOS III addresses the use of explosives during marine scientific research in the exclusive economic zone and on the continental shelf of a coastal State. This is one of the few references in UNCLOS III to the use of noise or explosives. It appears that the only limitation a coastal State may specifically impose on the use of underwater energy concerns the use of explosives. If explosives are used during scientific research, the coastal State may "in their discretion withhold their consent to the conduct of a marine scientific research project of another State or competent international organization."[86] UNCLOS III makes no reference to the use of explosives for any other purpose such as oil exploration or marine construction. There is no other reference to underwater acoustics or the regulation of sonar in UNCLOS III's text.

B. UNCLOS III Treatment of Other Energy Pollutants

UNCLOS III represents one of the most extensive and definitive instruments for States to address all types of marine pollution. Based on the obligation to protect and preserve the environment, the pollution provisions of UNCLOS III are comprehensive as to sources and forms of pollution regardless of whether they are explicitly included.[87] This implies that any type of substance or energy can be considered a pollutant even if not explicitly stated in UNCLOS III. Two types of energy pollutants in the ocean that have been acknowledged in the past are thermal pollution and radioactive pollution.

The increase in nuclear power generating plants has led to concern that heated discharge water from these plants could raise ambient water temperature several degrees and have adverse effects on the ecology of local waters. However, due to the terrestrial location of power plants, the

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84. Dotinga and Elferink, *supra* note 6, at 158.

85. UNCLOS, *supra* note 7, art. 194, para. 1.

86. *Id.* art. 246, para. 5.

87. For a discussion of the comprehensive nature of the UNCLOS III marine pollution regime, see Alan E. Boyle, *Marine Pollution Under the Law of the Sea Convention*, 79 AM. J. INT'L. L. 347, 349–50 (1985).

effects of their discharges are limited and thermal energy generally has not been a concern on the high seas. Most of the legal control of thermal pollution has been at a national level.[88]

Pollution through the ocean dumping of nuclear wastes is an ongoing problem for the international community. Energy pollution from radioactive wastes has been acknowledged within the framework of international law in the past.[89] Article 25 of the 1958 Convention on the High Seas provided that each State "shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations."[90] This treaty also required that "all states shall cooperate with the competent international organizations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents."[91] More specifically, the regime established by the 1972 Ocean Dumping Convention prohibits disposal of high-level radioactive wastes in the ocean and strictly regulates dumping all other radioactive wastes and materials.[92]

Perhaps a bigger issue than the explicit inclusion of types of pollution in UNCLOS III is whether the international community has the ability to effect and enforce the general obligation of States to protect and preserve the marine environment. The establishment of cooperative agreements and international bodies has an important role in this. International organizations, particularly the United Nations Environmental Programme and the International Maritime Organization, are critical to protecting the marine environment as mandated by UNCLOS III.

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88. *See* Max N. Edwards, *Legal Control of Thermal Pollution,* 2 NAT. RESOURCES LAW. 1 (1969); Donald P. de Sylva, *The Unseen Problems of Thermal Pollution,* 1 OCEANS MAGAZINE 38 (1968).

89. E.D. Brown, *International Law and Marine Pollution: Radioactive Waste and "Other Hazardous Substances"* 11 NAT. RESOURCES J. 221 (1971); Jack Wm. Hodges, *International Law and Radioactive Pollution by Ocean Dumping: "With all their Genius and with all their Skill,"* 11 SAN DIEGO L. REV. 757 (1974).

90. Convention on the High Seas, Apr. 29, 1958, art. 25, para. 1, 13 U.S.T. 2312, 2314, 450 U.N.T.S. 6465, 6482.

91. *Id.* para. 2.

92. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, art. IV § 1, 26 U.S.T. 2403, 2407, 11 I.L.M. 1294, 1297.

C. The United Nations Environmental Programme

Because UNCLOS III provides the framework for addressing ocean noise pollution, it follows that United Nations organizations could be involved in development of appropriate policy for its regulation. The movement toward the creation of international solutions for transboundary environmental problems culminated with the creation of the United Nations Environmental Programme (UNEP). It was established by the UN General Assembly in 1972 as a focal point for environmental action and coordination within the UN system. UNEP's mission is to "provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."[93]

Most UNEP documents define a category of "other pollutants" that includes dissolved organic substances, particulate organic matter, particulate inorganic matter, soluble inorganic substances, micro-organisms, and thermal discharges.[94] Underwater sound has not been identified specifically as a pollutant. However, it has been addressed as a threat to marine mammals. In 1985, UNEP published "Marine Mammals: Global Plan of Action," calling for the international community to study the long-term threat of anthropogenic noise in the ocean. Specifically, the report noted the "possibility that underwater noise from vessels and other human activities such as geological surveying by sonic techniques can constitute a form of noise pollution to which the cetaceans may be seriously sensitive on account of their dependence on acoustic processes for such purposes as communication and location of prey."[95] Initially, there was considerable support for the plan. However, although almost $12 million had been anticipated for implementation of the plan, significantly less was allocated.[96]

In 1988, an evaluation was performed on UNEP's global plan of action for marine mammals, and it was found to be "not . . . satisfactory."[97] This

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93. United Nations Environmental Programme Organization, *available at* http://www.unep. org (last visited Jan. 24, 2000) .

94. 25 UNEP REGIONAL SEAS REPORTS AND STUDIES, No. 25, MARINE POLLUTION at 4 (1983).

95. 55 UNEP REGIONAL SEAS REPORTS AND STUDIES NO. 55, MARINE MAMMALS: GLOBAL PLAN OF ACTION at 15 (1985).

96. $11.842 million had been included in the "Draft Financial Plan." *Id.* at 93. A review of UNEP-supported contributions to the implementation of the Global Plan of Action is found in Annex IV of UNEP REGIONAL SEAS REPORTS AND STUDIES NO. 102, MARINE MAMMALS PLAN OF ACTION: EVALUATION OF ITS DEVELOPMENT AND ACHIEVEMENTS at 25 (1988).

97. UNEP REGIONAL SEAS REPORTS AND STUDIES NO. 102, MARINE MAMMALS PLAN

was attributed to changing government priorities, severe budget constraints, a lack of clear framework for action, and insufficient effort by all collaborators.[98] Much of the failure was largely attributed to lack of funding. The evaluation makes no mention of the prior goal for the international scientific community to study the long-term threat of ocean noise.

D. Shipping and the International Maritime Organization (IMO)

The International Convention for the Prevention of Pollution from Ships of 1973, as amended by Protocol of 1978 (MARPOL), is the IMO vehicle that addresses pollution from vessels.[99] However, as defined in Article 2(2) and 2(3) of MARPOL, pollution is considered only as harmful *substances*; energy is not mentioned.[100] A "substance" is defined as "that which has mass and occupies space; matter."[101] For the MARPOL definition of pollution to apply to underwater noise it would have to refer to "energy." Thus it appears that MARPOL, as currently written, does not apply to undersea noise pollution. Furthermore, noise is not addressed in Annexes 1–6 of MARPOL, which specifically identify pollution as oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution.[102]

E. International Whaling Commission

The International Whaling Commission (IWC) has responsibility for the conservation of many species of whales.[103] In recent years, the IWC has addressed threats to whales other than exploitation including the effects of pollution and degradation of habitat. As such, it plays a role in protecting whales from the adverse effects of underwater sound.

Noise and its effects on whales were addressed by the IWC's Scientific Committee at the group's 50th and 51st meetings in the late 1990s. The Standing Working Group on Environmental Concerns brought attention to

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OF ACTION: EVALUATION OF ITS DEVELOPMENT AND ACHIEVEMENTS at 2 (1988).

98. *Id.*

99. International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, T.I.A.S. No. 10561, 12 I.L.M. 1319 [hereinafter MARPOL 73]; Protocol Relating to Intervention on the High Seas in Cases of Marine Pollution by Substances Other than Oil, June 26, 1978, 17 I.L.M. 1100 [hereinafter MARPOL 78].

100. MARPOL 73, *supra* note 99, T.I.A.S. No 10561 at 3409–10, 12 I.L.M. at 1320.

101. THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE 1791 (3rd ed. 1992).

102. MARPOL 73, *supra* note 99, 12 I.L.M. at 1335–1438.

103. International Convention for the Regulation of Whaling, Dec. 2, 1946, 161 U.N.T.S. 72 (entered into force on Nov. 10, 1948).

the potential adverse effects of anthropogenic noise on cetaceans.[104] The report stressed the need for further research and called for measures to mitigate adverse effects of noise wherever possible.

Recognizing that degradation of whale habitat might threaten stocks, the Scientific Committee identified the "effects of environmental change on cetaceans" as one of its major concerns. However, when the committee released its report on pollution initiatives, it identified its two concerns with pollution as PCBs and validation/calibration of sampling techniques; underwater noise pollution was not identified as a priority.[105] To date, no scientific research on the effects of noise on marine mammals has been promulgated by the IWC.

Disturbance of marine mammals by noise generated during whale-watching activities has also been addressed by the IWC. Specifically, the IWC has recommended that:

> (1) vessels, engines, and other equipment should be designed, maintained, and operated during whale-watching, to reduce as far as practicable adverse impacts on the target species and their environment; (2) cetacean species may respond differently to low and high frequency sounds, relative sound intensity or rapid changes in sound; vessels operators should be aware of the acoustic characteristics of the target species and of their vessel under operating conditions; particularly of the need to reduce as far as possible production of potentially disturbing sound; (3) vessel design and operation should minimise the risk of injury to cetaceans should contact occur; for example, shrouding of propellers can reduce both noise and risk of injury.[106]

It was also recommended that operators of whale-watching vessels avoid sudden changes in speed, direction, or noise.[107]

F. International Seabed Authority (ISB)

The International Seabed Authority was established under UNCLOS III to organize and control activities in the seabed, ocean floor, and subsoil

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104. Report of the Scientific Committee, IWC/51/4, para. 11.4.1 and Annex H, para. 7.1 *reprinted in* J. CETACEAN RES. MANAG. 1 (Supp. 1999).

105. Plenary Report of the Scientific Community, IWC/51/4, J. CETACEAN RES. MANAG., 1, 4 (Supp. 1999).

106. *Whale Watching Guidelines*, IWC Resolution 1996-1, IWC CHAIRMAN'S REPORT OF THE 48TH ANNUAL MEETING, June 24–28, 1996, Appendix 2, Principle 2.

107 *Id.* at Principle 3.

beyond the limits of national jurisdiction.[108] Although there have been a number of studies that addressed noise generated from oil and gas operations,[109] There are presently no international legal standards that specifically address noise from these seabed activities. The Legal and Technical Commission and the Office of Resources and Environmental Monitoring are two of the groups within the ISB that may have the potential to address issues of underwater noise pollution generated from seabed mining and oil exploration.

G. Use of Regional Agreements

1. ASCOBANS

In the past, regional agreements have occasionally been used to address underwater noise pollution. Some States have opted to formalize their concerns about the increase in man-made noise in the ocean, particularly from oil and gas mining. Northern European States have created an Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS).[110] This agreement, one of the few regional agreements that *specifically* requires all parties to consider underwater noise pollution, addresses three potential sources of acoustic disturbance: seismic survey, whale-watching, and high-speed ferries. Parties resolve to work towards "the prevention of other significant disturbances [to small cetaceans], especially of an acoustic nature."[111]

2. The Arctic Council

In 1991, Ministers of the eight Arctic countries adopted the Arctic Environmental Protection Strategy (AEPS), a program of the Arctic Council.[112] In the AEPS document, underwater noise was identified as a

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108. Agreement Relating to the Implementation of Part XI of the United Nations Convention on Law of the Sea, G.A. Res. 263, U.N. GAOR, 48th Sess., 101st plen. mtg. U.N. Doc. A/RES/48/263 (1994).

109. *See, e.g.*, R.S. GALES *supra* note 53; C.W. TURL, *supra* note 53.

110. *Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas*, Mar. 17, 1992, *reprinted in*, THE MARINE MAMMAL COMMISSION COMPENDIUM OF SELECTED TREATIES, INTERNATIONAL AGREEMENTS, AND OTHER RELEVANT DOCUMENTS ON MARINE RESOURCES, WILDLIFE, AND THE ENVIRONMENT, at 1612, 1616 (1994).

111. *Id.* arts. 1, 2.

112. Arctic Environmental Protection Strategy, Nov. 1991, 30 I.L.M. 1624 (1991). The eight Arctic countries are: Canada, Denmark, Finland, Iceland, Norway, Sweden, USSR, and the U.S. [hereinafter AEPS].

problem and priority in the Arctic region.[113] Specifically, the AEPS stated that the effects on fish and wildlife of cumulative exposure to noise was largely unknown but that moving sound sources, such as ships, seemed to be more disturbing than stationary sound sources.[114] Actions identified to address the noise pollution issue included: conducting research on marine mammals, developing noise exposure assessment techniques, and incorporating and evaluating the impact of noise on planning and approval processes.[115] However, in a list of gaps in international mechanisms, the AEPS document emphasized that there are no instruments in place for addressing noise in the Arctic environment. In 1998, the Arctic Monitoring and Assessment Programme published an assessment report on the arctic pollution monitoring efforts from 1991–97 that made no mention of any noise pollution monitoring whatsoever.[116]

VII. THE NORTH ATLANTIC TREATY ORGANIZATION (NATO)

Due to the well-publicized and highly controversial deaths of Cuvier's beaked whales in 1996, NATO now has an environmental policy in place that deals specifically with underwater sound. The "SACLANTCEN Human Diver and Marine Mammal Environmental Policy" is a fourteen page document written in response to the strandings of the whales off the coast of Greece.

The policy was developed as a self-regulatory approach and is not legally binding.[117] However, all sixteen NATO nations agreed on the approach to mitigation of harmful effects from hydroacoustics during NATO oceanographic research activities. Additionally, the policy has the potential to set precedence for stricter regulations to be adopted by NATO States. The policy contains specific guidelines for assessing risks to humans and marine mammals from high level sounds during experimental acoustic research, but it does not apply to shipping and other activities.

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113. *Id.* at 1640. Section 3.4 is entitled "Noise" and summarizes many of the concerns with anthropogenic noise in the Arctic.

114. *Id.* at 1641.

115. *Id.* at 1653.

116. *AMAP Assessment Report: Arctic Pollution Issues*, Arctic Monitoring and Assessment Programme, Oslo, Norway (1998), *available at* http://www.amap.no/asess/soaer-cn.htm (last visited Feb. 27, 2001).

117. *Human Diver and Marine Mammal Environmental Policy and Risk Mitigation Rules*, NATO SACLANTCEN Undersea Research Centre, La Spezia, Italy (June 1998), *available at* http://www.soclantc.nato.int/whales/diver.html (last visited Feb. 13, 2001).

A. Involvement of Non-Governmental Organizations

Increasing concern over noise in the ocean has led to a grass roots effort to fight undersea noise pollution. The formation of two new organizations concerned with undersea noise illustrates this awareness. The Silent Oceans Project is a global program of ocean stewardship and education that focuses on the issue of ocean noise pollution. It celebrated its first annual "Silent Oceans Day" in September 1999. According to their web site, this event "marked the beginning of a five-year process of global consciousness-raising, educational programs, and the creation of international standards concerning human-made sound pollution in the ocean."[118] "Silent Oceans Day" called for nine minutes of silence from man-made noise to be observed simultaneously in all the oceans of the world. The organization hopes to focus attention on the issue of ocean noise and propose international standards to address it.[119]

The Quiet Sea Coalition is a group made up of many of the opponents to ATOC and SURTASS-LFA who support scientific studies on the effects of underwater sounds on marine mammals. They have proposed the creation of an international treaty and convention on undersea acoustic pollution and aim to raise public awareness of the effects of noise on marine life and humans.[120] Citizens Opposing Active Sonar Technology (COAST) is another group that recently established a website designed to "inform the public of a nationwide campaign to end the deployment of [sonar] technology and once again restore peace and quiet to the world's oceans."[121] Environmental groups that are specifically concerned with protecting marine mammals from underwater noise include the Natural Resources Defense Council, the Cetacean Society, the Humane Society, the Ocean Mammal Institute, Sea Shepherd, the Great Whales Foundation, and the Animal Welfare Institute.

VIII. DISCUSSION

The environmental impact of ocean noise pollution has been established as a problem that must be addressed internationally. Transboundary environmental problems have significant international implications. The

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118. Silent Oceans, *Silent Oceans Events Calendar* (Sept. 19, 1999), *at* http://www.silent-oceans.org (last visited Nov. 1, 1999).

119. *Id.*

120. Quiet Sea Coalition (Dec. 4, 2000), *at* http://www.maui.net/~mailbot/quietsea.html (last visited Dec. 4, 2000).

121. Citizens Opposing Active Sonar Technology (COAST), *at* http://www.maui muse.com/sonar (last visited Dec. 4, 2000).

solutions to these problems, therefore, are to be found in the international forum. International customary law is inadequate for *preventing* pollution of the oceans. Prevention of ocean noise pollution thus far has been hortatory rather than mandatory; however, with the establishment of new treaties and the incorporation of noise pollution concerns into existing instruments, this may change. The challenge of defining controlling international law however, is exceedingly arduous.

There are several international processes that may be applied to abatement of ocean noise pollution: bilateral negotiation, arbitration, regional agreements, and international institutions. The most extreme totalistic solution would involve the establishment of an international body with the authority to regulate individual States' transboundary noise emissions. This, of course, threatens States' sovereignty. Perhaps the least intrusive mechanism to control noise pollution involves bilateral negotiation—individual States would negotiate claims against one another after the damage had been done. In this case, however, negotiators face the challenge of determining damages and assigning property rights (for example, determining which State owns a particular group of highly migratory species of whales). Between these two extremes are a range of options that include adjudication and arbitration of grievances, and the establishment of regional agreements between two or more States.

To date, there have been few preventative measures taken to control underwater noise pollution. This is largely due to a lack of awareness of the problem and in smaller part due to States' hesitance to cede their national sovereignty. This resistance slows attempts to control pollution through international law. Before any real progress can be made, States must rely more on regional compacts and multilateral designations of protected areas that have the potential to prevent harm rather than just compensating for it after the fact.[122]

A. Establishment of Marine Protected Areas, Sanctuaries, and Ocean Zoning

Perhaps one of the most promising ways to address the complex issue of underwater noise pollution is the establishment of Marine Protected Areas (MPAs). The use of MPAs to protect certain species is well documented.[123] MPAs are defined by the World Conservation Union as

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122. Lettie Wenner, *Transboundary Problems in International Law,* ENVIRONMENTAL POLITICS IN THE INTERNATIONAL ARENA 165, 176 (Sheldon Kamieniecki ed., 1993).

123. *See, e.g.*, M. Tundi Agardy, *Advances in Marine Conservation: The Role of Marine Protected Areas*, 9(7) TRENDS IN ECOLOGY AND EVOLUTION 267 (1994); G.W. Allison et al., *Marine Reserves are Necessary But Not Sufficient for Marine Conservation,* 8(1)

"any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment."[124] They allow policymakers to regulate not only individual species, but also entire habitats or ecosystems. They can be used to improve and strengthen existing protections for marine mammals.

The establishment of MPAs would prevent the disturbance of marine life in sensitive areas both domestically and internationally. These areas would include breeding and feeding grounds, migration paths, and other areas of large populations or critical habitat. Particularly sensitive areas of important marine habitat that are subject to high levels of anthropogenic noise could be identified and protected accordingly. The designation of MPAs could then include provisions that would require the consideration of noise and its effect on the ecosystem.

Areas of important marine habitat have been protected in the past (e.g., Stellwagen Bank off the coast of New England, California's Santa Barbara Channel) and more sanctuaries and MPAs are being established.[125] There has been a subtle shift from a focus on incidental, individual sources of pollution to a more holistic approach that incorporates cumulative and long-term effects. This includes a trend that focuses on preservation of habitat rather than individual animals as evidenced by the establishment of marine mammal sanctuaries in South Africa, Australia, and the U.S. among others. The recently adopted Annex V of the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) addresses ecosystems and provides additional evidence of the trend in addressing pollution and marine mammal conservation using a holistic, ecosystem-based management approach.[126]

Until now, most actions to reduce noise pollution have been directed toward individual and incidental sources of noise, rather than continuous, aggregate sources. Clearly, regulations that incorporate the cumulative,

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ECOLOGICAL APPLICATIONS S79, S79–S92 (Supp. 1998).

124. GRAEME KELLEHER, GUIDELINES FOR MARINE PROTECTED AREAS xi (World Commission on Protected Areas, Best Practice Protected Areas Guideline Series No. 3 (1999).

125. The establishment of MPAs is increasing throughout the world although they currently occupy less than 1% of the marine environment. The comparable figure on land is 9%. *Id.* at xxii.

126. Convention for the Protection of the Marine Environment of the North-East Atlantic, Sept. 22, 1992, (entered into force on Mar. 25, 1998) Annex V. Council Decision 2000/341/EC of 8 May 2000 concerning the approval, on behalf of the Community, of the new Annex V to the Convention for the Protection of the Marine Environment of the North-East Atlantic on the protection and conservation of the eco-systems and biological diversity of the maritime area and the corresponding Appendix 3, 2000 O.J. (L118) 44–47.

long-term impact of all sources of noise on species and habitats are necessary. The United States' National Research Council has urged policymakers to employ a habitat-based approach to the issue of low-frequency sound effects on marine mammals.[127] This method may be preferable to one that only considers the impact of singular sound sources on an individual basis.

The possibility of utilizing "ocean zoning ordinances" to protect marine life from noise pollution should also be considered. Ocean zoning has been proposed to prevent and reduce conflicting uses of ocean space. Zoning aims to balance needs and separate conflicting uses in an orderly, planned way. The NRDC has commented on "how seldom geographic and seasonal restrictions, which are aimed directly at habitat protection, make their way in to permitting letters from wildlife agencies."[128] Zoning that incorporates spatial and temporal restrictions may be desirable for the mitigation of the effects of anthropogenic sound on sensitive species.

The inclusion of some restrictions on noise creating activities in existing MPAs and marine sanctuaries appears imminent. However, there are significant challenges involved in regulating underwater noise through the use of MPAs. Because noise is a transboundary pollutant, its generation may be restricted within the MPAs but there is no way to prevent it from being generated elsewhere and crossing into the MPAs. Should specific activities be proscribed or should specific maximum noise levels be enforced? For example, should drilling or shipping activities be explicitly banned or should specific ordinances be created that prohibit the generation of any sound greater than 200 dB within the sanctuary? Certainly, the legal framework required for the generation of multilateral MPAs and zoning regulations is challenging and problematic, but it would represent a proactive, precautionary approach to the growing problem of underwater noise pollution.

B. International Law for an Emerging Technology

Because the issue of ocean noise pollution is largely a result of new technology (louder sonars, more powerful ships, increased drilling, new types of acoustic research), institutions and laws do not exist. The scientific uncertainty inherent with any emerging technology fuels the controversy surrounding undersea noise. Unanticipated externalities have resulted and government agencies face the challenge of establishing policy in the face of scientific uncertainty. For example, in the United States, the

127. NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 63.
128. JASNY, *supra* note 1, at 16.

"lack of data [on the effects of noise on marine mammals] poses a problem for the National Marine Fisheries Service, which in order to publish noise standards for marine mammals, must base them on established facts."[129] Regulatory agencies must make assessments based on gaps in scientific theory and data that are often incomplete. The U.S. National Academy of Sciences has concluded that "regulation of sound in the ocean is based on inadequate information and that more information needs to be collected."[130]

The creation of most marine pollution is very much a product of modern technology and the applicable law is, therefore, still in a formative stage.[131] However, many international instruments declare that States have an implied duty and a due diligence obligation to ensure that their activities do not cause harm to the environment. The laws that could apply to ocean noise pollution cannot be separated from general environmental protection law. This has led to the ever-increasing emphasis on the principle of precaution.

C. The Importance of Precaution

The late 1980s witnessed the emergence of a regulatory policy known as the precautionary principle.[132] This policy governs the way activities that present a threat to the environment should be addressed in the absence of hard scientific data. The precautionary principle requires that in the face of scientific uncertainty, errors are made on the side of excess environmental protection. This requires that it be proven that an activity will not create unacceptable impacts on existing resources or species. The burden of this proof falls on the proponents of that activity.

Internationally, the precautionary principle has been incorporated in a number of agreements, among them the 1992 Rio Declaration on Environment and Development.[133] Principle 15 of the Rio Declaration states that:

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129. OFFICE OF PROTECTED RES., NOAA, *supra* note 22.

130. NAT'L RESEARCH COUNCIL 2000, *supra* note 17, at 5.

131. For a discussion of the formative stages of regulation of marine pollution, see generally, Gerald Moore, *Legal Aspects of Marine Pollution Control, in* MARINE POLLUTION (1976); INTERNATIONAL LAW AND POLLUTION, (Daniel Barstow Magraw, ed., 1991); BIRNIE, *supra* note 5; Boyle, *supra* note 87.

132. HARALD HOHMANN, PRECAUTIONARY LEGAL DUTIES AND PRINCIPLES OF MODERN INTERNATIONAL ENVIRONMENTAL LAW, (Graham & Trotman, Int'l Envtl. Pol'y Series, 1994); John M. Macdonald, *Appreciating the Precautionary Principle as an Ethical Evolution in Ocean Management*, 26 OCEAN DEV. & INT'L L. 255, 267 (1995); *see also* GARDNER, *supra* note 40 (discussing the application of the precautionary principle to marine acoustic activities and the U.S. Navy's Low-Frequency Active SURTASS Sonar Program).

133. *United Nations Conference on Environment and Development: Rio Declaration on Environment and Development*, 31 I.L.M. 874 (1992).

"[i]n order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[134]

With the advent of the precautionary principle, today's state of environmental law has shifted to a model that emphasizes the custodial relationship of States with the environment.[135] It is no longer appropriate to consider environmental law in terms only of tort or property. "The history of international environmental controls shows [incremental change] away from bilateral diplomatic negotiation [over] damages that have already occurred to a more multinational attempt to prevent harm before it occurs."[136] This appears to be the path that prevention of undersea noise pollution is following. Chapter 17 of the UN's Agenda 21 refers to the need for "new approaches to marine and coastal area management and development, at the national, subregional, regional and global levels, approaches that are integrated in content, and are precautionary and anticipatory in ambit."[137] This approach, which stresses the precautionary principle, should be applied to all types of pollution, including underwater noise pollution.

The precautionary principle raises some difficult questions in regard to interpretation and implementation. There has not been international agreement concerning the potential level of harm that would invoke the precautionary principle.[138] Determining the obligations of the proponents of an activity in addition to deciding acceptable risks can be problematic. Furthermore, many critics claim that the precautionary principle is simply too vague to serve as a regulatory standard.[139] One commentator argues that it is "not very helpful as a prescription for international action, but it nevertheless does indicate an important change in policy and perspective with wider potential implications." [140]

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134. *Id.* at 879.

135. *See* BIRNIE, *supra* note 5, at 85.

136. Wenner, *supra* note 122, at 166.

137. Protection of the Oceans, All Kinds of Seas, Including Enclosed and Semi-Enclosed Seas, and Coastal Areas and the Protection, Rational Use and Development of their Living Resources, Agenda 21, ch. 17, para. 17.1, *available at* http://www.igc.apc.org/habitat/agenda21/ch-17.html.

138. For a discussion concerning levels of harm, *see* John Moffet, *Legislative Options for Implementing the Precautionary Principle*, 7 J. ENVTL. L. & PRAC., 157, 160 (1997).

139. *Id.* at 2.

140. Alan E. Boyle, *Protecting the Marine Environment: Some Problems in Developments of the Law of the Sea*, MARINE POL'Y, Mar. 1992, 79, 85.

D. The Trend Toward a More Holistic Treatment of Ocean Noise

In the past, the focus of most transboundary pollution litigation has been on incidental events such as air pollution and oil or chemical spills that are universally recognized as disasters.[141] Within the ocean however, ambient noise pollution exists at all times. The major source of omnipresent noise in the ocean is shipping. The cumulative and long-term transboundary noise pollution caused by continuous industrial activities such as shipping and construction therefore must be addressed. But they must be addressed within the context of all other ocean noise—both man-made and naturally occurring.

Ocean noise needs to be considered in a new light—that of the ecosystem or habitat. This holistic approach would take into account *all* sources of noise, both incidental and continuous. It should consider not only the direct effects of noise on marine mammal physiology, but also the cumulative, long-term effects on their behavior. Additionally, it should consider effects on other marine life as well as humans.

E. The Value of International Organizations

The global nature of activities that produce underwater noise pollution and the species that are affected by it demand the involvement of international institutions. International organizations play several important roles in the development of policy and regulations that could address an emerging source of pollution. These roles include placing and keeping issues on the international agenda, negotiating and bargaining, and in some cases, acting as an obstacle to change. Additionally, international organizations can provide a source of leadership and can act as architects of institutional agreements that emerge from negotiations between States. Finally, international organizations often keep global environmental issues alive during periods when one or more major States have reasons to de-emphasize them. There is need for international organizations to carry out all these functions in the realm of underwater noise pollution.

In the absence of a comprehensive convention, marine life is currently protected from ocean noise pollution on a piecemeal basis by a series of treaties, protocols, conventions and regional agreements. The response of the international community is usually reactive rather than proactive. Action has been *ad hoc*—generally in response to a series of events that propelled the issue of noise into the public eye briefly, before receding again. Lack of binding international standards and the absence of strong

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141. *See* PLATER ET AL., *supra* note 2, at 998.

international organizations for monitoring and regulating noise in the ocean exacerbate the problem. Nevertheless, strategies are gradually emerging at the international level, where some of the power now held by States is migrating to international institutions. Thus, the establishment of regional agreements that specifically address ocean noise holds promise.

F. What's Next? The Challenges Ahead

There are some who argue that the development of an international instrument is a necessary step in addressing undersea noise pollution.[142] In the 1970s, persistent problems with transboundary air pollution led to the drafting of the "Convention on Long-Range Transboundary Air Pollution.[143] Perhaps a similar instrument is required to address long-range transboundary ocean noise pollution. The Natural Resource Defense Council has recommended that environmental noise standards should be included in multilateral treaties and conventions, each governing a major source of pollution.[144] But what international legal controls can realistically be implemented and enforced? And how can non-signatory nations be prevented from continuing to pollute the world's oceans with noise?

There are several obstacles to the successful creation of an international treaty on undersea noise pollution. In the first instance, many States are presently concerned with other more immediate environmental matters and therefore have not yet acknowledged the issue. The international community must raise public awareness of the problem for it to be formally acknowledged. Acknowledgment of the problem is complicated by the somewhat elusive nature of sound in the sea combined with the significant scientific uncertainty that surrounds its effects on marine life. Secondly, enforcement is compounded by the challenge of monitoring noise emissions globally and continuously. The issue is further complicated by many developed countries' economic dependence on underwater sound. In the controversy over underwater noise pollution, the U.S. and other countries with strong defense and oil industries may attempt to slow the pace of discussions based on grounds of scientific uncertainty or national defense. What of possible ramifications from a strong shipping industry? Environmental groups have proposed techniques to reduce sound emissions from

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142. *See* JASNY *supra* note 1, at 59. *See also* SILENT OCEANS, *supra* note 118 (calling for an "international treaty and convention of undersea acoustic pollution").

143. United Nations: Convention on Long-Range Transboundary Air Pollution, Nov. 13, 1979, 18 I.L.M. 1442. *See also* Armin Rosencranz, *The ECE Convention of 1979 on Long-Range Transboundary Air Pollution,* 75 AM. J. INT'L L. 975 (1981) (discussing the significance and prospective impact of the ECE convention).

144. For recommendations on ship-silencing techniques, see JASNY, *supra* note 1, at 59.

ships but ship-quieting technology is costly and may be difficult to enforce on flags of convenience.[145] Furthermore, some techniques for noise reduction from propellers are proprietary. Added costs from reducing noise emissions would greatly affect flag States with large commercial fleets such as Panama or Liberia. If an international treaty were established, would these countries comply or would they oppose the agreement? The issue has received little attention from the shipping industry thus far. The president of the American Institute of Maritime Shipping has been reported as saying, "What do they want, no ships in the ocean? . . . We have water pollution, air pollution—the latest thing was our ballast water. Noise pollution? That's a whole new one."[146]

It is a transboundary problem with the potential to affect the global commons. The establishment of an international treaty that addresses noise pollution would prove formidable. Ocean noise pollution is a complex problem with significant economic and political ramifications—the road ahead is fraught with controversy.

IX. CONCLUSION

Increasingly, noise is created by activities such as shipping, scientific research, salvage, oil exploration, fishing, and aquaculture. This increase in anthropogenic noise is altering ecosystems and contributing to the destruction of natural habitat. These threats to the marine environment represent a vital and difficult issue regarding the future of our environment and the survival of many species. The development of a proactive position regarding possible restrictions on underwater sound is prudent for all activities that occur in the marine environment. Because militaries rely on sonar for many of their research activities and operational systems, regulation that restricts the use of sonar could have an enormous impact on national security in many States. Unilateral regulations concerning underwater sound could have far-reaching implications that could affect national sovereignty as well as commerce.

The legal framework exists but has not yet specifically been applied to underwater noise pollution. The problems of underwater noise pollution are significant and its international regulation is complicated by the transboundary nature of sound in the ocean. To address these problems effectively necessitates a system of controls on a global scale.

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145. *Id.* at 55.

146. Richard C. Paddock, *Beneath the Not So Silent Sea*, LOS ANGELES TIMES, May 3, 1994, at A1.

International law *can* moderate externalities caused by ocean noise pollution, but only to the extent that environmental protection is favored over the economic benefits from activities that produce ocean noise such as shipping and oil exploration. This would entail limitation on States' sovereignty. Ultimately, mitigation and compromise will be key components of any strategy designed to address noise pollution.

The interests of scientists, non-governmental organizations, and individual States have shaped the controversy over the effects of low-frequency sound. It is an emerging problem with many complex aspects. An international debate over the future of sound in the ocean has resulted. Preliminary attempts at soft law and the establishment of formal agreements indicate that the issue of unregulated noise in the ocean may soon achieve global agenda status. It is a topic ripe for discussion. The implications are enormous. Clearly, as in the case of ATOC, precedence is being set as environmental groups challenge more acoustic research, commercial and military operations. This could contribute to the establishment of customary law and rules and standards to prevent pollution in the ocean.

Although the *Trail Smelter* case dealt with a single source of air pollution with transboundary effects in close proximity, the tribunal's finding was relevant to pollution from underwater sound as well. Developments in the globalization of international law are especially pertinent to the issue of transboundary ocean noise pollution. These developments are indicative of a shift away from concentration on the impacts of pollution on neighboring States to a broader concern for the entire global commoins.[147] Freedom of the seas is a concept referred to in Oppenheim's general principle of international law which prohibits States from exercising their rights under Freedom of the Seas in a fashion that is neglectful of the legitimate rights of other States or general international interest.[148] Freedom to pollute is no longer a right.

Trail Smelter made it clear that States are required to protect the environment—and not just *their* environment. The case laid the foundation for the issue of ocean noise pollution.

It has been sixty years since *Trail Smelter*, but some things have not changed. The concept of transboundary pollution must still be addressed in a global context—and it still promises to bring controversy in its wake.

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147. Alexandre Kiss, *Nouvelles Tendances en Droit International de L'environment*, 32 GERMAN Y.B. OF INT'L L. 241 (1989).

148. OPPENHEIM'S INTERNATIONAL LAW, §§ 281, 285 (9th ed. 1992).