

The New Paradox in Marine Scientific Research: Regulating the Potential Environmental Impacts of Conducting Ocean Science

ANNA-MARIA HUBERT

Bremen International Graduate School for Marine Sciences (GLOMAR)
Bremen, Germany

Concerns about the negative effects of marine scientific research are in clear juxtaposition to the beneficial role that scientific knowledge plays in enhancing the understanding of the oceans and protecting the marine environment. This presents a regulatory paradox that is examined in this article in light of the legal framework in the 1982 United Nations Convention on the Law of the Sea. The article traces how these general principles in the Convention are elaborated in soft law instruments for the promotion of environmentally sustainable research practices. It also looks at an example of state practice in this area by examining regulatory measures instituted in the Canadian Endeavour Hydrothermal Vent Marine Protected Area.

Keywords freedom of scientific research, marine environment, marine scientific research

The Environmental Impacts of Marine Scientific Research

The oceans cover approximately 70% of the earth's surface, yet a limited understanding of the marine environment persists as a major knowledge gap confronting science and society. The benefits derived from science and technology in other fields point to the enormous gains that humanity can make by promoting marine scientific research. Basic, curiosity-driven research is rapidly transforming our understanding of the world's oceans, and fundamental discoveries of new ocean phenomena are frequent. Investments in marine research underpin economic growth in marine sectors such as shipping, offshore energy, and security and defense. Applied marine research also holds promise for pioneering new and more sustainable routes for exploitation and technological development. Perhaps more pressing, however, is the need for scientific research on global environmental change. Science continues to demonstrate the gravity of the threat that human activities pose to the marine environment such as climate change, marine pollution, ocean acidification, overfishing, habitat destruction, and loss of marine biodiversity.¹ Scientific advice is a pre-requisite for identifying and assessing marine environmental risks and developing sound

Received 6 May 2011; accepted 20 June 2011.

I would like to acknowledge the advice and support of Prof. Dr. Gerd Winter and Dr. Till Markus during the preparation of this article.

Address correspondence to Anna-Maria Hubert, Bremen International Graduate School for Marine Sciences (GLOMAR), Universität Bremen, MARUM-Building, Leobener Strasse, 28359 Bremen, Germany. E-mail: annamaria.h@gmail.com

conservation and management policies and laws. These factors have contributed to substantial increases in marine research globally.

The compelling need for information about the marine environment supports a robust case for promoting scientific study of the marine realm.² Nevertheless, scientists' use of the oceans is subject to legal restrictions. Legal controls were introduced at the international level as a corollary of coastal states' inherent sovereign rights over offshore natural resources.³ This tension between scientific freedoms and control over marine resources is explicit in the provisions on marine scientific research in Part XIII of the 1982 United Nations Convention on the Law of the Sea (LOSC).⁴ Coastal state consent is required for marine scientific research conducted within areas of national sovereignty, sovereign rights, or jurisdiction. Coastal states, however, do not enjoy an unfettered discretion over marine research projects carried out in the vast areas of the exclusive economic zone (EEZ) and continental shelf. In normal circumstances, consent is to be given by coastal states for marine scientific research conducted exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment.

Recent developments highlight a new ground for limiting the free exercise of ocean research—the concern that, if unregulated, marine scientific research may harm the marine environment.⁵ In general, the environmental threat posed by marine scientific research is estimated to be low relative to other human uses of the oceans.⁶ This is mainly because, compared to industrial-scale activities, scientific research generally involves smaller-scale or novel projects. However, our growing knowledge of the marine environment has delivered an understanding that all human activities can disrupt the balance of marine ecosystems, particularly those most sensitive to anthropogenic interference.⁷ This revelation casts light on the potential adverse effects of marine research and its contribution, however small, to environmental damage.

The term “marine scientific research” is undefined in the LOSC, but it broadly encompasses most forms of scientific investigation directed at understanding the marine environment.⁸ As such, the concept captures disparate strands of scientific activities that vary in their potential for causing environmental harm. Some adverse environmental effects are not specific to marine scientific research and are common to other ocean uses. For example, operating research vessels can have the same environmental impacts as shipping (e.g., accidental oil spills, exhaust and vessel noise emissions, problems associated with hazardous waste and ballast water release).⁹ Other environmental impacts are science-specific and relate to the methods and means used to study the oceans. These can be categorized as physical, acoustical, chemical, or accidental in nature.¹⁰ Physical effects arise from sampling and the use of drilling technologies, explosives, and other specialized scientific equipment (e.g., piloted or remotely operated vehicles) and can harm marine species or habitats and damage structural features of marine ecosystems.¹¹ Other physical impacts include disturbances to marine organisms caused by exposure to heat and light from scientific instruments.¹² In terms of acoustical impacts, marine scientific research sometimes introduces sound into the marine environment, which can detrimentally affect marine life.¹³ Chemical impacts may result from the use of chemical tracers and disposable devices containing hazardous materials.¹⁴ Finally, accidental impacts from marine research operations include biological contamination (e.g., introduction of alien species or pathogens that alter local community structure and potentially cause extinctions of native species).¹⁵

Another way to distinguish the environmental impacts of marine research activities is in terms of research design. Extended scientific and technological capability permits more than mere data collection for describing the oceans; science is now capable of experimentally manipulating marine systems and processes to advance scientific understanding of

such phenomena.¹⁶ Intervention-style research aimed at altering marine systems touches on a more sensitive domain bounded by societal fears of ecological risks and uncertainties of “meddling with nature.”¹⁷ For example, within the fisheries sector, the design of genetically modified organisms for use in aquaculture may threaten marine biodiversity and marine ecosystems.¹⁸ Ocean fertilization experiments directly alter marine ecosystems by introducing nutrients such as iron, phosphorous, and nitrogen to artificially stimulate phytoplankton blooms that are expected to eventually sink, locking fixed atmospheric carbon dioxide in the deep sea for long-time scales.¹⁹ Although these studies may yield important new insights into the structure and functioning of marine ecosystems and potentially offer a method for offsetting rising global carbon dioxide emissions,²⁰ there are widespread concerns about side effects.²¹

Another category of marine scientific research that threatens the marine environment may not constitute bona fide scientific research at all. For example, despite the legal classification as scientific, research programs that rely heavily on the lethal sampling of whales are widely criticized as an abuse of the scientific exception to the ban on commercial whaling in the International Convention for the Regulation of Whaling.²²

The growing list of concerns about the environmental impact of marine scientific research raises questions as to whether further regulation is necessary to ensure that its potential impacts are assessed in advance and that research is conducted in an environmentally responsible way.²³ This presents a regulatory paradox that advances in scientific knowledge necessary for identifying environmental threats and developing effective environmental protection measures may be hindered by regulatory measures that restrict marine research activities to protect the marine environment. Underlying this contradiction are assumptions about the freedom of scientific research as a necessary condition for the generation of scientific knowledge.

This conflict is also mirrored in the provisions of the LOSC, which provides the starting point for examining the international legal implications of scientific activities that potentially damage the marine environment. Article 240(d) of the LOSC serves as a linchpin provision for restricting research activities on ecological grounds, requiring that marine scientific research be “conducted in compliance with all relevant regulations adopted in conformity with the Convention including those for the protection and the preservation of the marine environment.” Also relevant is the general principle in Article 240(b) that marine scientific research uses “appropriate methods and means,” which could be construed as requiring that research be conducted sustainably.²⁴ On the other hand, several provisions in the LOSC, supplemented by other legal norms and principles, uphold the freedom of marine scientific research. These recognize the right of states to conduct marine scientific research and ensure its promotion and codify a key role for research in the development of marine environmental protection laws and policy.

This article analyses the legal issues relating to the regulation of marine scientific research to protect the marine environment. It begins by clarifying the international legal framework by examining the relevant provisions in Part XIII on marine scientific research and in Part XII on the protection and preservation of the marine environment. The guiding principles in the LOSC provide the scaffolding for examining recent efforts to regulate the potential adverse environmental effects of marine research activities. The article also considers ways in which general principles are being elaborated on at the international level through the development of codes of conduct and guidelines designed to ensure that marine scientific research is conducted in an environmentally responsible and sustainable way. The article then goes on to examine measures taken in Canada that regulate scientific activities at the Endeavour Hydrothermal Vent Marine Protected Area (EHV MPA).²⁵ These

measures provide an example of developing state practice regarding the regulation of the environmental impact of marine scientific research in the EEZ and on the continental shelf.

The International Regime on Marine Scientific Research

In the early part of the twentieth century, oceanography was a nascent discipline and marine scientific research remained largely unregulated.²⁶ Rapid innovations in the 1950s and 1960s led to the development of new oceanographic instruments and data collection methods, opening up greater scientific and technical possibilities for investigating the oceans. Ironically, ocean researchers became victims of their own success. States began linking the establishment of marine research programs with the development of offshore natural resources and technological advances relating to military security. This awareness of the potential for applying new scientific discoveries propelled research efforts, but also contributed to the introduction of legal restrictions on the conduct of marine scientific research so that states could fully utilize and exploit ocean resources.²⁷ The 1958 Geneva Convention on the Continental Shelf represented a first attempt at regulating marine scientific research by an international treaty, introducing the requirement of coastal state consent for all research activities conducted on their continental shelf.²⁸ Although consent was not normally to be withheld for “purely scientific research,” coastal states had a wide discretion to prohibit marine scientific research pertaining to the natural resources on their continental shelf.²⁹

The issue of a regime to govern marine scientific research was raised again at the Third United Nations Conference on the Law of the Sea (UNCLOS III), where negotiations addressed the need for a new, more comprehensive convention to govern the oceans. A key matter to be resolved at UNCLOS III was the division of ocean space.³⁰ This opened up debate over what rules would apply to marine scientific research in the newly created maritime zones as well as the degree of oversight that coastal states should have over marine research activities within areas of national jurisdiction.³¹ Developing states favored greater control over research, in accordance with their newly acquired rights over the natural resources in the EEZ and on the continental shelf.³² The international research community, represented by a few states with advanced research capacity, viewed this level of control as a threat to scientific freedoms.³³ The basis for compromise lay in devising a flexible regime that would not unduly restrict marine research activities, but also would give coastal states control over research touching on certain vital interests.

Coastal states' economic interest in maintaining exclusive control over offshore natural resources has remained a central consideration in the regulation of marine research activities to date. However, in response to worldwide concern over the rapidly degraded condition of the oceans, states have enhanced their legal commitments to protect marine environment. This new concern provides an alternate rationale for greater state control over marine research activities.

The LOSC framework concerning the environmentally responsible conduct of marine scientific research is not as explicitly developed in the Convention as that governing marine scientific research and the exploration and exploitation of natural resources. Nevertheless, it supplies important principles and norms for weighing scientific freedoms against the need for legal restrictions on marine research, which are described in further detail below.

Freedom of Marine Scientific Research Under the LOSC

An important pillar of the legal regime on marine scientific research is the overarching right of all states to conduct marine scientific research and the correlative duty to promote the global study of the oceans. Together, these articles come closest to articulating a concept of the freedom of scientific research under the LOSC and provide an important check on the

scope of other provisions in the LOSC that restrict scientific freedoms. Article 238 of the LOSC, the first provision of Part XIII, declares that all states and competent international organizations have the right to conduct marine scientific research. The freedom of scientific research is also recognized as a high seas freedom under Article 87 of the LOSC, ensuring all states the right to conduct marine scientific research in the water column beyond the EEZ.³⁴ The express legal recognition of these rights and freedoms underscores that marine scientific research is a legally legitimate use of the oceans vis-à-vis other uses.³⁵ States also have a duty to promote and facilitate the global study of the oceans under Article 239 of the LOSC. Whether this article creates a specific, binding legal obligation is a contested issue, but it nonetheless expresses an important general principle of the marine scientific research regime.³⁶ Specific formulations of the duty to promote marine scientific research and international cooperation in scientific endeavors are expressed in other articles of the LOSC³⁷ such as the requirement that states share information in order to prevent and control damage to the marine environment.³⁸

The right to conduct marine scientific research is not absolute and is subject to the rules of international law and the rights and duties of other states.³⁹ This limit accords with the general requirement that states give “due regard” to the rights of other states in the EEZ⁴⁰ and on the high seas.⁴¹ Thus, although marine scientific research constitutes a legitimate use of the oceans, the exercise of the right to research must be balanced against competing objectives in the LOSC, including “the conservation of their living resources, and the study, protection and preservation of the marine environment.”⁴²

As a further restriction on the freedom of marine scientific research and consistent with the international legal order, the LOSC does not recognize the freedoms of individual researchers to pursue their own scientific aims and objectives. Rather, the right to conduct marine scientific research is state bound. The LOSC does not confer on individuals any rights or entitlements broadly recognized under modern human rights instruments.⁴³ At the national level, some states do provide constitutional protection for the freedom of scientific research.⁴⁴ For example, Article 5(3) of the German Basic Law (*Grundgesetz*) states that “science, research, and teaching are free.” In other countries, the freedom of scientific research may also be stated as a positive obligation to promote and support research.⁴⁵ Individual scientists from countries that expressly guarantee scientific freedoms have certain legal rights to pursue their science, and the actions of these states in the international sphere could be challenged in national courts as a violation of constitutional rights. These states must take into account the freedom of scientific research when formulating and implementing international norms. However, in those states that do not recognize constitutional protection for scientific freedoms, the position of individual scientists could be legally tenuous.

Legal commentators point out the trend toward increased regulation of marine scientific research at the international and national levels.⁴⁶ However, the regime on marine scientific research in the LOSC also bolsters scientific freedoms by expressly recognizing the right to conduct marine scientific research. This places research on an equal footing with other competing uses. Moreover, the adoption of duty to cooperate to promote marine science, together with practical needs for improved scientific knowledge, coincide with a major escalation in international and national research efforts.⁴⁷ The impact of these and other provisions in international law for the promotion of marine scientific research should be factored in when calculating the net effect of international regulation on scientific freedoms.

Zone-Specific Provisions Regulating Marine Scientific Research Under the LOSC

Part XIII of the LOSC adopts a zonal approach to the regulation of marine scientific research such that the rights of coastal states diminish moving seaward from the baseline.

Nearest to the shore, coastal states, in the exercise of their sovereignty, have the exclusive right to regulate, authorize, and conduct marine scientific research in their territorial sea and archipelagic waters.⁴⁸ Research in these areas may be carried out only with the express consent and subject to the conditions established by the coastal state, including any restrictive measures imposed to protect the marine environment.⁴⁹ By contrast, a freedom regime applies in areas beyond the limits of national jurisdiction. All states and competent international organizations are free to conduct research on the high seas, provided that their actions are consistent with their obligations under the LOSC and other rules of international law.⁵⁰ States and international organizations also have the right to conduct marine scientific research in the Area (i.e., the seabed and ocean floor and subsoil beyond the limits of national jurisdiction) provided it is carried out exclusively for peaceful purposes and for the benefit of mankind as a whole, and in conformity with Parts XIII and XI of the LOSC.⁵¹

The core of Part XIII of the LOSC is the consent regime that applies to the maritime zones straddling areas of national sovereignty and high seas freedoms. Here, the LOSC establishes detailed provisions governing the conduct of marine scientific research in the EEZ and on the continental shelf. The coastal state has the right to regulate, authorize, and conduct marine scientific research in these zones and its consent is required for other states or competent international organizations to conduct research in these areas.⁵² The coastal state's right to authorize research is not absolute. In "normal circumstances," it has a duty to consent to research that is "exclusively for peaceful purposes" and aims to "increase scientific knowledge of the marine environment for the benefit of all mankind."⁵³ The LOSC also seeks to preserve scientific freedoms by ensuring that research planning is not hindered by administrative delays or other omissions or irregularities. Coastal states are required to establish rules and procedures for ensuring that consent will be granted within a reasonable time.⁵⁴ Consent is implied if the coastal state does not respond after 4 months of notification of the proposed project.⁵⁵

Researching states and competent international organizations must also provide specific information to the coastal state to conduct marine scientific research in the EEZ and on the continental shelf. From an environmental management standpoint, the informational requirements and conditions imposed under these provisions can assist the coastal state in identifying, assessing, and controlling the environmental impacts of a marine research project. Such information may also serve to alert national officials to the possibility of duplicated research effort in a specific area. In terms of informational requirements, Article 248 of the LOSC requires that researching states and competent international organizations provide a "full description" of the proposed research project, including the nature and objectives of the scientific study; the method, means, and scientific equipment to be used; and the precise geographical location of the research.⁵⁶ Coastal states may also make reasonable requests for additional information in order to satisfy concerns about the proposed research project.⁵⁷

The researching state or international organization must also comply with certain conditions set out in Article 249 of the LOSC to conduct marine scientific research in the EEZ and on the continental shelf. These conditions include: the right of the coastal state to participate in or to be represented in the research project, without cost; the duty to provide the coastal state with access to data, samples, and results; the obligation to furnish preliminary reports as well as final results and conclusions at the completion of the research project; and the requirement that research results be made internationally available through national or international channels as soon as practicable.⁵⁸

An important question concerns the conditions under which the coastal state can deny its consent to a proposed research project that may have potential adverse environmental

impacts. As an exception to the general rule that coastal state consent should normally be granted, the coastal state enjoys a discretionary power to refuse its consent to research projects that touch on certain recognized state interests. This power is restricted to the four cases specified in Article 246(5) of the LOSC.⁵⁹ Paragraphs (5)(a) and (b) are the most relevant to the issue of marine scientific research with potential environmental impacts.

The exception in Article 246(5)(a) allows the coastal state to refuse to consent to a research project that is of direct significance for the exploration and exploitation of natural resources in the EEZ or on the continental shelf.⁶⁰ A broad construction of the term “living and non-living natural resources” to include ecosystem components without direct commercial value could provide a potential ground for denying consent to research projects that may adversely impact the marine environment.⁶¹ However, the prevailing interpretation is that this exception is restricted to research involving the collection of commercially valuable information about the living and nonliving natural resources in the EEZ and on the continental shelf.⁶²

Article 246(5)(b) provides “the most explicit legal basis” for disallowing marine scientific research projects that perturb the marine environment.⁶³ According to this article, coastal states may withhold their consent to marine scientific research that involves drilling into the continental shelf, the use of explosives, or the introduction of harmful substances into the marine environment.⁶⁴ Although this exception captures several potentially dangerous scientific activities, it does not cover all of the environmental risks associated with conducting marine scientific research. For example, noise and light emissions likely do not fall within definition of “harmful substances” and, thus, are not included in Article 246(5)(b) as environmental impacts based on which a coastal state has an absolute discretion to refuse its consent.

Beyond the four exceptions in Article 246(5), the *Revised Guide to the Implementation of the Relevant Provisions of the United Nations Convention on the Law of the Sea*, published by the UN Division for Ocean Affairs and Law of the Sea Office of Legal Affairs in 2010 (OALOS Revised Guide), alludes to other “exceptional situations” in which the coastal state may refuse its consent to a research project in its EEZ or on its continental shelf.⁶⁵ These situations may include those in which it is clear based on the information required under Article 248 that a research project does not comply with one or more provisions of the Convention pursuant to Article 246(3).⁶⁶ This interpretation is supported by the general principle in Article 240(d) and provides an additional basis for coastal states to deny their consent to research projects that violate one or more of the provisions in Part XII on the protection and preservation of the marine environment.⁶⁷

The regime on marine scientific research aims to balance the freedom of scientific inquiry against other lawful uses and objectives concerning the oceans. Nowhere is this more evident than in the consent regime that applies in the EEZ and on the continental shelf. The consent regime provides the legal means for coastal states to assess and manage the environmental risks of marine research projects conducted within areas of national jurisdiction or sovereign rights. On the other hand, scientific freedoms are safeguarded in the EEZ and on the continental shelf by limits on coastal states’ absolute discretion to refuse their consent to research projects on environmental grounds.

The Application of Marine Environmental Protection Law to Marine Scientific Research

Several norms and principles of environmental law apply to the conduct of marine scientific research. According to the general principle in Article 240(d) of the LOSC, marine

scientific research must be “conducted in compliance with all relevant regulations adopted in conformity with the Convention including those for the protection and the preservation of the marine environment.”⁶⁸ As a consequence, marine scientific research must be carried out in accordance with the provisions of Part XII of the LOSC on the protection and preservation of the marine environment.⁶⁹

Part XII of the LOSC adopts a comprehensive legal framework on the protection and preservation of the marine environment. Several articles of this part may apply to restrict research activities that pose a threat to marine ecosystems. Article 192 establishes the fundamental duty of all states to protect and preserve the marine environment. This obligation is comprehensive, covering areas within and beyond national jurisdiction.⁷⁰ It is further elaborated on in Article 194, which requires that states are to take measures to prevent, reduce, and control marine pollution.⁷¹ This obligation includes the prevention of pollution from installations and devices operating in the marine environment⁷² and from the use of technologies under their jurisdiction or control.⁷³ States are also required to protect rare and fragile ecosystems and the habitats of depleted, threatened, or endangered species.⁷⁴

The wording of Article 240(d) indicates that the scope of the principle is not limited to the provisions in Part XII. Rather, states are to conduct marine scientific research in accordance with all environmental protection regulations adopted in conformity with the LOSC. Thus, Article 240(d) covers relevant regulations established in other international and regional agreements as well as national legislation that conforms with the provisions of the Convention.

The general principle in Article 240(b) of the LOSC also hints at the possibility of science-specific regulations requiring that marine scientific research be carried out in an environmentally responsible manner. The provision states that “marine scientific research shall be conducted with appropriate scientific methods and means compatible with this Convention.” Although the term “appropriate” is undefined in the LOSC, it could be interpreted as requiring that marine research operations meet certain environmental standards.⁷⁵

The LOSC also provides mechanisms for the law to evolve to respond to new and emerging environmental problems.⁷⁶ For example, Article 237 of the LOSC permits states to conclude other agreements in furtherance of the “general principles and objectives” of the LOSC. Indeed, since the adoption of Part XII of the LOSC, there has been a proliferation and deepening of states’ commitments to address specific threats to the marine environment as they become known.⁷⁷ The expansion of the sphere of marine environmental protection laws at all levels increases the potential for legal conflicts with marine scientific research and raises concerns that, in carrying out their ecological mandate, states will overlook the specific needs of international science.

Marine Scientific Research as a Contribution to Marine Environmental Protection

The LOSC recognizes the close nexus between the “the study, protection and preservation of the marine environment.”⁷⁸ For this reason, the LOSC mandates that states actively cooperate “for the purpose of promoting studies, undertaking programmes of scientific research and encouraging the exchange of information and data acquired about pollution of the marine environment.”⁷⁹

Scientific advice is essential to making effective the provisions on marine environmental protection in Part XII the LOSC. Scientists play a critical role in identifying environmental risks and providing the information necessary for environmental assessment

and monitoring as well as for establishing rules, standards, recommended practices, and procedures to address environmental threats. States are also obliged to monitor the risks or effects of marine pollution using “recognized scientific methods.”⁸⁰ Scientific research is also necessary for the rational exploitation of marine resources—a concept that has evolved since the adoption of the LOSC into the contemporary notion of sustainable development.⁸¹ For example, the LOSC requires that marine research provide the basis for making informed decisions for exploring, exploiting, conserving, and managing the oceans’ living and non-living resources.⁸² Scientific expertise provides the foundation for making the necessary assessments and determining the appropriate limits under these provisions. For example, states are required to take into account the “best scientific evidence available” when establishing conservation and management measures.⁸³ These and other provisions in the LOSC illustrate the need to promote scientific research in furtherance of the goal of safeguarding the marine ecosystems.

A role for scientists has also been codified in a significant number of international and regional instruments for the protection and preservation of the marine environment. These agreements stress, among others, the importance of marine research for ensuring the protection and preservation of the marine habitat and biodiversity. Some require that state parties promote marine scientific research by encouraging research that contributes to the purposes of the treaty,⁸⁴ for example, by including provisions that stipulate science-based decision making⁸⁵ or that mandate the establishment of cooperative research programs.⁸⁶ Other agreements contain provisions that create exceptions for research activities from general prohibitions or restrictions on other types of activities (e.g., regulatory measures that apply in protected areas).⁸⁷ On the whole, these provisions emphasize the degree of mutuality in the objectives of the protection of the marine environment and the promotion of marine scientific research and the need to pursue these aims in tandem.

Weighing the Issue of Marine Scientific Research as a Risk to the Marine Environment

According to the general principle in Article 240(d), marine scientific research must be conducted in compliance with all relevant standards and regulations on the protection of the marine environment. Thus, in principle, states can restrict marine research activities that have the potential to damage the marine environment.

On the basis of Article 240(d), it may be argued that the legal regime on marine scientific research is subordinate to the growing body of legal rules and standards on the protection and preservation of the marine environment.⁸⁸ The problem with this hierarchical interpretation is that it does not sufficiently take into account the significant role of marine scientific research in the development of environmental law and policy. From a practical standpoint, a restrictive interpretation of the freedom of marine scientific research may lead to regulatory and jurisdictional barriers to conducting vital science for identifying environmental problems, adopting effective conservation and environmental management measures, and ensuring the sustainable use of marine resources.

A more comprehensive interpretation of Article 240(d) does not regard the requirement that marine scientific research must be conducted in compliance with all relevant environmental protection standards and regulations as unqualified,⁸⁹ nor does it read this principle in isolation from the LOSC as a whole.⁹⁰ In support of this standpoint, it is important to note that the general principle in Article 240(d) is expressly limited by the condition that environmental protection regulations that restrict research must be “adopted in conformity” with the LOSC.⁹¹ A contextual interpretation entails balancing the priority objectives of

marine science and environmental protection and requires that states give due regard for the important role of marine science in conserving marine ecosystems. There are several counterbalancing provisions in the LOSC that temper the general principle that marine scientific research must comply with all relevant environmental protection regulations. These provisions include the express right of all states to conduct marine scientific research and the positive duty to cooperate and promote scientific activities for the benefit of humankind and the protection and preservation of the marine environment. It should also be taken into account that, in some states, the freedom of scientific research is a constitutionally protected right that must be taken into account in the development and domestic implementation of international law. Such guarantees provide an additional legal check on the ability of states to impose restrictions on the conduct of marine scientific research.

Although the LOSC supplies a framework for addressing the environmental impacts of marine scientific research, its guidance remains very general. Further elaboration of these principles must take into account a number of important considerations. As a starting point, marine scientific research for peaceful purposes that increases the knowledge of the marine environment should be privileged. Lawmakers might also take into account the potential benefits of conducting research in relation to the environmental risks as a basis for a legal exception for marine research activities. Where marine research crosses a certain risk threshold and the benefits of scientific activities are duly considered, regulatory measures restricting scientific activities may be required. However, given the diverse range of scientific activities now being conducted in the oceans involving specific localities, time frames, and types of operations and methods, a case-by-case approach is preferable to the creation of general rules that target the broad category of marine scientific research. Regulators should also remain aware of the limitations of relying solely on legal solutions to address the adverse impacts of marine scientific research. These limitations include problems that the law faces in addressing complex and rapidly evolving lines of research, the difficulties associated with enforcing restrictions and prohibitions on scientific activities, and the uncertainty regarding how restrictions will affect development of scientific knowledge and technological progress.⁹² Depending on the circumstances, better outcomes can sometimes be achieved outside of binding hard law instruments, for example, by relying on codes of conduct and voluntary standards.⁹³

The second part of this article addresses these issues by examining examples of how the general framework governing the environmental risks of conducting marine scientific research under the LOSC has been integrated into soft law instruments designed to ensure that research is conducted in an environmentally sustainable manner. It also looks at an example of domestic regulations and management measures designed to ensure the environmentally responsible conduct of marine scientific research.

Legal Instruments Promoting the Environmentally Responsible Conduct of Marine Scientific Research

An array of legally binding and nonbinding instruments have been introduced recently that seek to minimize the potential adverse impacts of marine scientific research. These regulatory and management tools can apply within or beyond the limits of national jurisdiction. The growing body of principles and guidelines, regulations, and management measures provides additional guidance on conducting marine scientific research in an environmentally responsible way. These instruments also give shape to the general framework that applies under the LOSC. In particular, regulatory measures elaborate on the general principle in Article 240(b) that states use appropriate methods and means for conducting marine

scientific research. Finally, the important concept that state-of-the-art scientific knowledge should precede and form the basis of environmental law and policy is expressly recognized in many of these instruments.

The establishment of environmental standards for conducting field research in the marine environment is a relatively novel concept that has only recently received formal attention from policymakers and lawmakers.⁹⁴ There are obvious reasons why scientists might be reluctant to engage this issue.⁹⁵ However, the scientific community was among the first to appreciate the vulnerability of some marine ecosystems to disturbances from research activities. Marine researchers have been proactive in developing codes of conduct, principles, and guidelines for good scientific practice aimed at minimizing the environmental impacts of their work.⁹⁶ Active input from the scientific community lends legitimacy to legal processes and standards that guide environmentally responsible research operations and scientific cooperation.⁹⁷

Examples of nongovernmental initiatives for the environmentally responsible conduct of marine scientific research include: the "InterRidge Statement of Commitment to Responsible Research Practices at Deep-Sea Hydrothermal Vents"⁹⁸ and the "Code of Conduct for Marine Scientific Research Vessels" proposed by the Marine Board of the European Science Foundation and adopted at the International Research Ship Operators' Meeting (ISOM).⁹⁹ At the national level, Germany requires that applications for ship time on large- and medium-sized German research vessels conform to its "Commitment to Responsible Marine Research."¹⁰⁰ The Irish Department of the Environment, Heritage and Local Government adopted a "Code of Practice for Marine Scientific Research at Irish Coral Reef Special Areas of Conservation"¹⁰¹ for four sites containing coldwater coral reefs, set aside under the European Community Habitats Directive.¹⁰² These efforts at defining responsible research practices were recently taken up by the OSPAR Commission,¹⁰³ which has compiled the most comprehensive code of conduct to date. The OSPAR "Code of Conduct for Responsible Marine Research in the Deep Seas and High Seas of the OSPAR Maritime Area"¹⁰⁴ incorporates previous work by InterRidge and Germany and was developed in consultation with deep sea scientists and with the support of European and international research organizations.¹⁰⁵ The significant degree of overlap in the provisions of the various codes not only reflects that recent instruments borrow from previous efforts at defining relevant standards, but also indicates that consensus is building among scientists, advisory organizations, and governments regarding the general standards of conduct that should apply to marine scientific research.

An important feature of the codes of conduct is that they establish professional standards and risk thresholds for conducting scientific operations. The OSPAR Code of Conduct states that when studying marine biota researchers should "avoid, in the course of research, activities which could lead to long-lasting changes in regional populations or substantially reduce the number of individuals present."¹⁰⁶ Scientists have the most latitude when conducting research in habitats not classified as fragile where the threshold is to "avoid, in the course of research, activities which could lead to substantial physical, chemical, biological or geological changes or damage to marine habitats."¹⁰⁷ A more stringent standard applies to research carried out in areas of "particular ecological vulnerability" where "utmost care should be taken not to disturb or damage the features as far as possible."¹⁰⁸ Regarding methods and operating protocols, the OSPAR Code of Conduct calls on scientists to "use the most environmentally-friendly and appropriate study methods which are reasonably available."¹⁰⁹ Although the OSPAR Code does not give significant detail, it provides general advice on sampling protocols, the use of chemical tracers, and the emission of underwater noise. Sampling methodologies are to be designed with the particular

characteristics of the study site in mind; to employ nonintrusive or minimally intrusive instruments and tools; and to avoid nonessential collections and limit the number of samples to the necessary minimum. The use of chemical tracers and expendable devices that contain hazardous materials is “discouraged” and, in the absence of alternatives, these techniques should be used sparingly. Regarding acoustical impacts, the OSPAR Code recommends that underwater noise emissions be “restricted to a minimum required to achieve the desired results and acoustic frequencies should be chosen which minimize impacts on marine life.” It also lists a number of measures that apply in areas where marine mammals are known or suspected to exist such as soft starts, visual surveillance, and acoustic monitoring.¹¹⁰

The various codes of conduct and guidelines stress the need for communication and research planning as vital aspects of environmentally responsible research practices. This is especially important at sites receiving intensive, interdisciplinary study where there is the potential for user conflicts between research groups with interfering experimental objectives. The ISOM Code of Conduct generally recommends that researchers develop a marine environmental management plan as part of their scientific cruise planning. The OSPAR Code of Conduct further specifies that scientists familiarize themselves with the research taking place at the site and communicate their research plans to other scientists via public domain databases and Web sites. It also advises that scientists conduct risk assessments for research carried out in areas containing features on the “OSPAR List of Threatened or Declining Species and Habitats.”¹¹¹ In these more vulnerable areas, operators are encouraged to modify their research plan to reduce risks to an acceptable level and to develop contingency measures to recover lost equipment.¹¹²

The codes of conduct and guidelines also emphasize collaboration and cooperation as an important aspect of environmentally responsible research practices.¹¹³ The OSPAR Code of Conduct seeks to minimize environmental impacts by encouraging “the fullest possible use of all biological, chemical and geological samples through collaborations and cooperation within the global community of scientists.”¹¹⁴ Underutilized or lost data also has the potential to lead to duplicated research effort. Maximizing the use of scientific results and publishing findings promptly may help to avoid unnecessary damage caused by redundant research operations. Guidelines also recommend the use of sample repositories and the sharing of biological and physical data, samples, and results in order to reduce unnecessary sampling.¹¹⁵

Collectively, legal instruments promoting environmentally responsible marine research serve to introduce the concept of the “reasonable and prudent marine researcher” to be held up as an objective standard against which scientific conduct can be evaluated. This general standard can be defined as requiring that, in the conduct of marine scientific research, scientists show reasonable care and forethought depending on the particular circumstances and that they maximize the knowledge and benefits derived from scientific fieldwork.¹¹⁶ However, it does not call for marine researchers to do no harm.¹¹⁷ Rather, the codes and guidelines aim at minimizing environmental disturbances and maximizing research effort, without compromising the scientific integrity of the research. For example, the OSPAR Code of Conduct states:

In the interest of environmental stewardship, it must be the goal of research scientists to minimize disturbances as much as possible, while still gathering the information necessary both to understand the systems and to form a basis for sustainable use strategies. Therefore, marine scientists should always evaluate their research plans from a conservative standpoint, and choose the most environmentally friendly research approach.¹¹⁸

A similar statement in the introduction to the Irish Code of Practice emphasizes that measures were “not designed to prevent or restrict [marine scientific research] from being conducted within the designated areas,” but instead aim to “provide a transparent framework for the adoption of best environmental practices that will ensure the activity is pursued on a sustainable basis and to the highest operating standards.”¹¹⁹ This balanced approach reflects the general framework in the LOSC, as described above, and implicitly recognizes the value of scientific research for environmental protection and conservation and achieving other societal goals.¹²⁰

It is also important to note that the codes of conduct and guidelines have little to say about the lines of inquiry and objectives that marine scientists can pursue.¹²¹ They do not endorse an evaluation of the substance or merits of a proposed research project. Nor do they provide a cost-benefit mechanism for weighing environmental costs against the value of acquiring certain kinds of knowledge. This can be contrasted with the specific regime addressing ocean fertilization experiments under the London Dumping Convention and the London Protocol.¹²² A nonbinding 2008 resolution adopted by the state parties prohibits all ocean fertilization activities “other than legitimate scientific research,”¹²³ which is defined as “those proposals that have been assessed and found acceptable under the assessment framework.”¹²⁴ The recently adopted Assessment Framework¹²⁵ for ocean fertilization research has significant overlaps with the principles in the various codes of conduct and guidelines (e.g., requiring that scientists use the least intrusive means and methods and that they publish their data and findings promptly). However, the Assessment Framework also evaluates the merits of the scientific experiment requiring that the “proposed activity [be] designed to answer questions that will add to the body of scientific knowledge.”¹²⁶ Proposals for conducting ocean fertilization experiments are to be reviewed according to their rationale, research goals, scientific hypotheses and methods, scale, timings, and locations, and scientists are to provide an explanation for why the expected outcomes cannot reasonably be achieved by other methods.¹²⁷ The differences between the regulatory approaches taken in the codes of conduct and for ocean fertilization activities partly lie in the degree of risk to the marine environment and the uncertainty associated with conducting ocean fertilization experiments relative to general scientific activities. Clearly, marine scientific research that is more likely to have a significant effect on the marine environment necessitates a more restrictive regulatory regime and greater oversight of scientific aims and objectives.

Although the development of codes of conduct is an important first step in establishing general standards of professional behavior for the marine scientists, their effectiveness has been questioned in various ways. The standards have been criticized as being too general, providing limited detail, and unduly relying on sound professional judgment to ensure their effective implementation.¹²⁸ For this reason, a recent report of the International Council for the Exploration of the Sea (ICES) has recommended that “general principles are best accompanied by technical annexes describing research activities in relevant detail for the characteristic features of different sensitive habitats.”¹²⁹ However, given the exploratory nature of marine scientific research and the limited knowledge of ocean systems and processes, general benchmarks for evaluating the performance of marine research operations seem like a reasonable starting point since detailed rules may not be germane in all contexts. Codes of conduct can also serve as an intermediate step, supplying general guiding principles that can supplement or be adapted to more specific regulatory contexts.¹³⁰ More fundamentally, scientists’ specialized knowledge and appreciation of the marine environment and their role in voluntarily instituting environmentally responsible research practices suggest that a degree of deference is owed to their professional judgment.¹³¹ On the other hand, researchers working in the field must also recall their ethical duties when studying

nature and their vested interest in maintaining sites of scientific interest in pristine condition for future discovery.¹³²

Another criticism leveled against codes of conduct concerns compliance and enforcement.¹³³ Soft law standards established in self-regulatory instruments play an important gap-filling role in the absence of binding law and management plans.¹³⁴ However, they might not deter misconduct on the part of ocean scientists.¹³⁵ The proper implementation and enforcement of standards seems like a logical next step in ensuring that damage to the marine environment from marine scientific research is avoided. However, the task of monitoring compliance and undertaking enforcement is likely to be complicated and resource intensive.¹³⁶ In light of the relative impact of marine scientific research being low relative to other human activities in the oceans, and given the interest scientists have shown in mitigating potential damage, it is not at all clear that traditional compliance and enforcement mechanisms are necessary or even appropriate. Flexible, science-specific regulatory mechanisms—such as making research grants and ship-time awards conditional on the application of the code of conduct¹³⁷ and enforcing standards through the scientific peer review process¹³⁸—are more likely to be effective and less likely to unduly burden scientific work.

Canadian Endeavour Hydrothermal Vents Marine Protected Area Regulations

Consistent with the obligation in Article 194(5) of the LOSC to take measures necessary to protect and preserve rare or fragile ecosystems, Canada has established a network of marine protected areas (MPAs) under Section 35(1)(c) of its Oceans Act that aims, among others, to conserve and protect unique habitats.¹³⁹ Marine scientific research is subject to an authorization requirement within the entire network of Canada's marine protected areas.¹⁴⁰ However, the Endeavour Hydrothermal Vents (EHVs) MPA is particularly appropriate for studying the legal issues related to the environmental impacts of marine scientific research since regulatory and management measures target marine researchers directly as the main users of the site.¹⁴¹

In 2003, Canada designated its first MPA to protect a seismically active seafloor-spreading zone with deep ocean hydrothermal vent fields.¹⁴² The EHVs are located on Canada's continental shelf, approximately 300 kilometers off the coast of British Columbia. Since the discovery of the vents in 1982, the site has received intense multidisciplinary study. Among other things, scientists from around the globe have come to study the unique and abundant biodiversity, venting processes and chemistry, and seismic and magmatic activity at this area.¹⁴³

Although a 1999 report commissioned by the Canadian Department of Fisheries and Oceans concluded that the overall impact of research on the vent sites was "very low," it nevertheless noted that damage due to scientific activity had already been observed at certain locations.¹⁴⁴ Environmental impacts of scientific activities at hydrothermal vent sites include: energy input (e.g., light and sound); the introduction of foreign materials and species transplantation via scientific equipment; and other damage caused by scientific sampling and the operation of scientific equipment (e.g., the removal or disturbance of living organisms or nonliving ecosystem components and changes in vent fluid flows).¹⁴⁵ Environmental impacts also vary commensurate with site use intensity, the scale of the research operation, the relative sensitivity of species and habitats to disturbance, and the methods and means used.¹⁴⁶ There is also a concern about the compatibility of different

scientific uses of the sites, for example, that more invasive studies involving intensive sampling will interfere with observational studies that require undisturbed conditions.¹⁴⁷ These concerns led to calls for greater cooperation and coordination at these scientific hot spots.¹⁴⁸ After consultations with members of the scientific community, other stakeholders, and government agencies, the Endeavour Hydrothermal Vents Marine Protected Area Regulations¹⁴⁹ were adopted in 2003 to operate in conjunction with an MPA management plan.¹⁵⁰ The aim is to provide a comprehensive system of oversight for all marine scientific research conducted within this MPA.

The Regulations designate the site as a MPA and create a legal framework for its management by establishing its legal boundaries and the requirements for site access. Section 2 contains a general prohibition against the disturbance, damage, destruction, or removal of any part of the seabed or subsoil, or any living marine organism or any part of its habitat within the MPA, or any underwater activity in the area that is likely to result in these effects.¹⁵¹ However, Section 3 provides an exception for “scientific research for the conservation, protection and understanding of the Area.”¹⁵² To fall within the exception, researchers must submit a research plan that conforms to the MPA management requirements at least 90 days before the start of the research project and obtain all the necessary licenses, authorizations, or consents.¹⁵³ Foreign states are exempt from the requirement to submit a separate research plan, if the requisite information has previously been provided in the application for consent to conduct research in Canadian waters.¹⁵⁴ The EHV MPA Management Plan states that research carried out by foreign vessels must be carried out in accordance with all other environmental protection and management requirements contained in the MPA Regulations and that terms and conditions to this effect may be attached to consent for foreign research vessels conducting research in protected areas.¹⁵⁵

The principle tool for managing and monitoring the scientific activities is the review and authorization procedure that applies to all research activities conducted within the boundaries of the MPA. It incorporates several innovative management measures regarding research planning and reporting, site-specific use requirements, and guidelines for best scientific practices.

To prevent user conflicts between scientific groups, the MPA is divided into four management areas corresponding to the four principle vent fields within the MPA. The management of each site varies according to the management objectives for each area. For instance, the relatively pristine Salty Dawg management area has been preserved as an observational research site where only low-impact activities such as water column sampling and acoustic imaging are permitted. More intrusive research activities are permitted at the Main and Mothra vent fields, which in the past have received the most study.¹⁵⁶ A management support system incorporating a spatial database and web mapping system is being developed to track research activity and the operation of equipment within the MPA.¹⁵⁷ It will be used for identifying areas impacted by intensive scientific use, coordinating research projects to avoid duplicated research effort and instrumentation conflicts, and determining which areas are deserving of more or less study. One issue this raises under the qualified consent regime for marine scientific research that applies in the EEZ and on the continental shelf under the LOSC is whether a coastal state can refuse a request by a foreign state to conduct research within a specific area on the ground that the overall volume of scientific activity exceeds conservation needs. Article 246 of the LOSC provides rules only on the duty of the coastal state to provide its consent for individual applications to conduct research in these maritime zones.

Applications to conduct research within the EHV MPA are reviewed by the MPA manager, taking into account a number of criteria. Research activities must be consistent with the

overall MPA management objectives, appropriate for the proposed site, and compatible with other research activities in the area.¹⁵⁸ Chief scientists must integrate appropriate mitigation measures as a part of their cruise planning in accordance with “best practices for research in marine environments.”¹⁵⁹ The “InterRidge Statement of Commitment to Responsible Practices at Deep Sea Hydrothermal Vents”¹⁶⁰ has been endorsed and it is expected that scientists adhere to these guidelines when working within this MPA.¹⁶¹ Such requirements are grounded in the general principle in Article 240(b) of the LOSC that marine scientific research must be conducted using appropriate scientific methods and means.

A primary goal of the EHV MPA management framework is “to encourage research at the EHV MPA while meeting its conservation objective, currently within a limited-data environment.”¹⁶² In response to knowledge gaps about ecosystem functioning, the management framework employs a precautionary and adaptive approach. The precautionary component is based on the idea of “erring on the side of caution” when dealing with potential threats to ecosystems and in accordance with the “best available science.”¹⁶³ The adaptive component requires that management measures that apply to research activities be amended as knowledge of the marine environment improves.¹⁶⁴ This approach recognizes the “dual identity” of research in the management of the MPA.¹⁶⁵ Management measures target marine scientific research as a human use with potential environmental impacts; however, scientific data provides valuable information about the state of the environment and is therefore necessary for the rational and adaptive management of the MPA.¹⁶⁶

The EVH MPA Management Plan states that the grant of a research license may be made conditional on scientists satisfying requests for data, thereby allowing regulators to fill in knowledge gaps and improve monitoring.¹⁶⁷ This approach has the advantage of ensuring that knowledge gained from fieldwork is maximized. However, it raises the issue of whether and the extent to which the coastal state can influence the objectives of a research project carried out by a foreign vessel in its EEZ or on its continental shelf. Article 249(1)(c) of the LOSC grants the coastal state access to data and samples, once collected,¹⁶⁸ but does not expressly recognize the right of the coastal state to have advance input into the kinds of samples and data that will be collected. In addition, Article 249(1)(a) recognizes the coastal state’s right to participate in or be represented in the marine scientific research project. The 2010 OALOS Revised Guide takes a broad view of this condition in recommending that researching states “endeavor to maximize, as far as feasible, the involvement of the coastal State in all stages of the project, that is, the preparatory stage, the actual field work and the evaluation stage at the completion of the field work.”¹⁶⁹ However, an advance request for specific data that materially alters the scientific objectives of the expedition could extend beyond the scope of the coastal state’s right to participation, particularly where the coastal state makes this a condition for granting its consent.¹⁷⁰

The EHV MPA Management Plan also imposes specific reporting requirements on marine scientists. After the completion of a research cruise, foreign and domestic vessels are required to provide preliminary and final cruise reports with data.¹⁷¹ The Management Plan places a high priority on timely reporting by requiring that a member of the scientific staff of the research cruise submit cruise reports within 2 months of completion of the fieldwork.¹⁷² Such requests by the coastal state are permitted under Article 249(1)(d) of the LOSC.¹⁷³ According to this provision, preliminary reports must be furnished “as soon as practicable” and “final results and conclusions” supplied “after the completion of the research.” Since paragraph (1)(d) does not stipulate a fixed time limit for reporting, the OALOS Revised Guide suggests that the coastal state can propose a time frame for submitting preliminary reports when it provides its consent to the proposed research project and that the final results and conclusions should be provided as soon as they become available.¹⁷⁴ However,

any proposed time frame must be reasonable depending on the relevant circumstances.¹⁷⁵ As a result, a blanket deadline for submitting cruise reports may not be appropriate in all cases. Moreover, it is worth noting in this regard that interpretations of reporting and publishing requirements under Article 249 of the LOSC are not trivial since the presence of outstanding obligations from a prior research project is grounds for the coastal state to withhold its consent to future research.¹⁷⁶

On the whole, the existing international rules on marine scientific research allow coastal states sufficient maneuverability for monitoring and managing the environmental impacts of marine research activities conducted within their EEZ or on the continental shelf. In some instances, however, the provisions on coastal state consent in the LOSC do not provide enough detail regarding the requirements for providing consent to research projects that may adversely impact vulnerable ecosystems. It is important that national officials strive to achieve a constructive balance between the twin objectives of the freedom of scientific research and environmental protection so that the benefits accrued from marine research activities are maximized while avoiding environmental damage. Although a more restrictive approach to research activities may help achieve short-term, local environmental objectives, this may ultimately provide a stumbling block to long-term protection of the marine environment by undermining the epistemic basis for marine environmental protection that marine science provides. Domestic regulations and management measures must comply with the LOSC and be implemented in a reasonable way that avoids the creation of extra expense and additional planning time for research. Regulators must also consider that an overly restrictive approach could drive scientists to conduct marine scientific research in ocean areas beyond national jurisdiction.¹⁷⁷ This could have drawbacks in terms of global environmental protection since few binding regulations govern the conduct of researchers on the high seas. Coastal states would also lose out under this scenario given that they also benefit from research conducted within their coastal waters.

It is equally clear that the international research community should not regard restrictions on marine research activities as necessarily detrimental to their work. The regulations and management measures implemented at the EHV MPA clearly aim to preserve these unique areas so that scientific study will continue to yield valuable insights into the marine environment and ocean systems and processes. Thus, in some cases, regulatory oversight can be regarded as a way of promoting scientific research by preserving sites of scientific interest and defining sustainable research practices so that scientific investigation will continue in these areas for many years to come.

Conclusion

The argument in favor of the freedom of marine scientific research as a precondition to scientific and technological advances is as relevant today as it was during the negotiations at UNCLOS III almost 40 years ago. The right to free scientific inquiry is arguably even more important given the significant knowledge gaps regarding global environmental change. Since scientific investigation thrives under conditions of minimal regulatory interference and in the absence of jurisdictional barriers, in principle, the freedom of marine scientific research should be strengthened and upheld.

An increasingly complex and expanding system of environmental protection laws that apply at various levels may impinge on the free conduct of marine scientific research. In addition, a greater understanding of the impact that humans are having on marine ecosystems gives cause to restrict the conduct of marine scientific research directly. Although such measures may reflect good intentions, this presents a conflict since environmental

protection measures should be based on best scientific evidence. On the other hand, the requirement that marine scientific research be conducted according to best operating practices and in an environmentally responsible way seems patently reasonable. To navigate this dilemma, it is necessary to balance the important ideals of marine scientific research and marine environmental protection to achieve the best outcome.

The provisions on marine scientific research and marine environmental protection in the LOSC provide a viable legal framework for addressing the potential environmental impacts of scientific research activities. In cases of significant threats of environmental damage, what is required is a fresh interpretation and elaboration of existing principles and norms to allow scientific investigation and exploration to be conducted freely, yet responsibly. This work has already begun with the development of codes of conduct, guidelines, and management measures that prescribe best practices for marine research operations in accordance with the provisions of the LOSC. Domestic laws can also make use of the conditions for coastal state consent that apply to foreign states wishing to undertake marine scientific research in the EEZ and on the continental shelf as a tool for protecting the marine environment. However, any reinterpretation of the consent provisions in Part XIII of the LOSC that gives coastal states too wide a berth over research conducted in these maritime zones could come at the cost of scientific independence. At a minimum, national legislation on the protection of the marine environment should comply with the provisions of the LOSC and the rules of international law to ensure the continued functioning of the marine scientific research consent regime and to preserve the freedom of marine scientific research.

Notes

1. See GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection and Advisory Committee on Protection of the Sea), *A Sea of Troubles*, Rep. Stud. GESAMP No. 70 (2001), available at unesdoc.unesco.org/images/0012/001229/122986e.pdf.

2. International human rights law expressly recognizes the rights of individuals to partake in the benefits of scientific research. Article 27(1) of the Universal Declaration of Human Rights, December 10, 1948, UNGA Res. 217 A(III), states that “everyone has the right [. . .] to share in scientific advancement and its benefits.” See also International Covenant on Economic, Social and Cultural Rights, Article 15(1)(b), December 16, 1966, 6 *I.L.M.* 368: “The State Parties to the present Covenant recognize the right of everyone: [. . .] (b) To enjoy the benefits of scientific progress and its applications.”

3. Convention on the Continental Shelf, Article 5(8), April 29, 1958, 499 *U.N.T.S.* 311.

4. United Nations Convention on the Law of the Sea (hereafter LOSC), December 10, 1982, 1833 *U.N.T.S.* 397.

5. United Nations General Assembly, *Report of the Secretary General, Oceans and the Law of the Sea, Addendum*, UN Doc. A/60/63/Add.1 (July 15, 2005), paras. 174–175 (hereafter Secretary-General’s Report (2005)); Philomène A. Verlaan, “Experimental Activities that Intentionally Perturb the Marine Environment: Implications for the Marine Environmental Protection and Marine Scientific Research Provisions of the 1982 United Nations Convention on the Law of the Sea,” *Marine Policy* 31 (2007): 210.

6. A. R. Benn, et al., “Human Activities on the Deep Seafloor in the North East Atlantic: An Assessment of Spatial Extent,” *PLoS ONE* 5 (2010): e12730D.

7. Division for Ocean Affairs and the Law of the Sea Office of Legal Affairs, *Law of the Sea: Marine Scientific Research: A Revised Guide to the Implementation of the Relevant Provisions of the United Nations Convention on the Law of the Sea* (New York: United Nations, 2010), 31 (hereafter OALOS Revised Guide); Secretary General’s Report (2005), *supra* note 5, at paras. 174–175.

8. Patricia Birnie, "Law of the Sea and Ocean Resources: Implications for Marine Scientific Research," *International Journal of Marine and Coastal Law* 10 (1995): 229, at 242.
9. J. Breslin, D. Nixon, and G. West, *Code of Conduct for Marine Scientific Research Vessels*, International Ship Operators Meeting (ISOM) (October 17–20, 2007) (hereafter ISOM Code of Conduct), available at www.eurocean.org/np4/file/140/Code_of_Conduct_for_Marine_Scientific_Re.pdf.
10. *Ibid.*
11. David Kenneth Leary, *International Law and the Genetic Resources of the Deep Sea* (Leiden: Martinus Nijhoff, 2006), 189; K. M. Gjerde, et al., *Options for Addressing Regulatory and Governance Gaps in the International Regime for the Conservation and Sustainable Use of Marine Biodiversity in Areas Beyond National Jurisdiction* (Gland, Switzerland: IUCN, 2008), 35, available at data.iucn.org/dbtw-wpd/edocs/EPLP-MS-1.pdf.
12. Secretary-General's Report (2005), *supra* note 5, at para. 174.
13. See Harm M. Dotinga and Alex G. Oude Elferink, "Acoustic Pollution in the Oceans: The Search for Legal Standards," *Ocean Development & International Law*, 31 (2000): 151; M. Simmonds, S. Dolman, and L. Weilgart, eds., *Oceans of Noise: A WDCS Science Report* (Whale and Dolphin Conservation Society, 2004), available at www.wdcs.org/submissions_bin/OceansofNoise.pdf; J. Firestone and C. Jarvis, "Response and Responsibility: Regulating Noise Pollution in the Marine Environment," *Journal of International Wildlife Law and Policy* 10 (2007): 109; and Michel André, et al., "Low-Frequency Sounds Induce Acoustic Trauma in Cephalopods," *Frontiers in Ecology and the Environment* (in press).
14. ISOM Code of Conduct, *supra* note 9.
15. Leary, *supra* note 11, at 189; Gjerde, *supra* note 11, at 35; Secretary-General's Report (2005), *supra* note 5, at para. 174.
16. Verlaan, *supra* note 5. See, generally, Michael Gibbons, et al., *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies* (London: Sage, 2008), 36.
17. V. Smetacek and S. W. A. Naqvi, "The Next Generation of Iron Fertilization Experiments in the Southern Ocean," *Philosophical Transactions of the Royal Society A* 366 (2008): 3947, at 3947.
18. J. A. Beardmore and J. S. Porter, *Genetically Modified Organisms and Aquaculture*, FAO Fisheries Circular No. 989 (2003), 19–21; P. Bateson, et al., *The Use of Genetically Modified Animals* (Royal Society, 2001), 20, available at royalsociety.org/The-use-of-genetically-modified-animals.
19. K. O. Buesseler and P. W. Boyd, "Will Ocean Fertilization Work?" *Science* 300 (2003): 67. See also Secretariat of the Convention on Biological Diversity, *Scientific Synthesis of the Impacts of Ocean Fertilization on Marine Biodiversity*, Technical Series No. 45 (2009), 15–22.
20. Smetacek and Naqvi, *supra* note 17; K. O. Buesseler, et al., "Ocean Iron Fertilization—Moving Forward in a Sea of Uncertainty," *Science* 319 (2008): 162.
21. Secretariat of the Convention on Biological Diversity, *supra* note 19; Rosemary Rayfuse, "Drowning Our Sorrows to Secure a Carbon Free Future? Some International Legal Considerations Relating to Sequestering Carbon by Fertilizing the Oceans," *University of New South Wales Law Journal* 31 (2008): 919; Aaron Strong, et al., "Ocean Fertilization: Time to Move on," *Nature* 461 (2009): 347.
22. International Convention for the Regulation of Whaling, December 2, 1946, 161 *U.N.T.S.* 74. See Peter H. Sand, "Japan's 'Research Whaling' in the Antarctic Southern Ocean and the North Pacific Ocean in the Face of the Endangered Species Convention (CITES)," *Review of European Community and International Environmental Law* 17 (2008): 56; Phillip J. Clapham, et al., "Whaling as Science," *BioScience* 53 (2003): 210; and Peter J. Corkeron, "Reconsidering the Science of Scientific Whaling," *Marine Ecology Progress Series* 375 (2009): 305. See also International Court of Justice, press release 2010/16, "Australia Institutes Proceedings Against Japan for Alleged Breach of International Obligations Concerning Whaling," June 1, 2010.
23. Secretary-General's Report (2005), *supra* note 5, at para. 175.
24. Alfred H. A. Soons, *Marine Scientific Research and the Law of the Sea* (Deventer: Kluwer Law and Taxation, 1982), 136.

25. Canada, Endeavour Hydrothermal Vents Marine Protected Area Regulations, SOR/2003–87, March 4, 2003 (hereafter Endeavour Hydrothermal Vents Regulations), available at the Web site of the Canadian Department of Justice at [http://laws-lois.justice.gc.ca/eng/regulations/SOR-2003–87/page-1.html](http://laws-lois.justice.gc.ca/eng/regulations/SOR-2003-87/page-1.html).

26. John A. Knauss, “The Effects of the Law of the Sea on Future Marine Scientific Research and of Marine Scientific Research on the Law of the Sea,” *Louisiana Law Review* 45 (1984–1985): 1201–1202; Robin R. Churchill and A. V. Lowe, *The Law of the Sea*, 3rd ed. (Manchester: Manchester University Press, 1999), 400.

27. Milner B. Schaefer, “Freedom of Scientific Research and Exploration in the Sea,” *Stanford Journal of International Studies* 4 (1969): 46, at 46, noted that this led to what he referred to as a “paradox” that “scientific progress necessary for a fuller utilization of ocean resources is being retarded by new regimes which were established because of such enhanced utilization.” See also Fletcher A. Blanchard and Robert W. Corell, “Man’s Adaptation to the Sea: A Key to the Ocean’s Resources,” *Stanford Journal of International Studies* 4 (1969): 71; and John A. Knauss, “Development of the Freedom of Scientific Research Issue at the Third Law of the Sea Conference,” *Ocean Development and International Law* 1 (1973): 93.

28. Don Walsh, “Protection and Preservation of the Marine Environment and Marine Scientific Research at the Third United Nations Conference on the Law of the Sea: Comment,” *Law and Contemporary Problems* 46 (1983): 167, at 169; Churchill and Lowe, *supra* note 26, at 401.

29. Geneva Continental Shelf Convention, *supra* note 3, art. 5(8).

30. C. C. Joyner and E. A. Martell, “Looking Back to See Ahead: UNCLOS III and Lessons for Global Commons Law,” *Ocean Development and International Law* 27 (1996): 73.

31. Mark Talwani, “Marine Research and the Law of the Sea,” *Columbia Journal of World Business*, Winter, (1980): 84.

32. John A. Knauss, “Marine Science and the 1974 Law of the Sea Conference,” *Science* 184 (1974): 1335; P. K. Mukherjee, “The Consent Regime of Oceanic Research in the New Law of the Sea,” 5 *Marine Policy* (1981): 98.

33. Deborah Shapley, “Ocean Scientists May Wash Hands of Sea Law Treaty,” *Science* 197 (1977): 645; Desmond P. D. Scott, “Implications of the Third United Nations Conference on the Law of the Sea for Marine Scientific Research,” *Nature* 267 (1977): 762; Ocean Policy Committee of the Commission on International Relations NAS-NRC, “Marine Scientific Research Issue in the Law of the Sea Negotiations,” *Science* 197 (1977): 230; Knauss, *supra* note 32.

34. LOSC, *supra* note 4, art. 87(1)(f).

35. Soons, *supra* note 24, at 129.

36. The legislative history of Article 239 of the LOSC indicates that delegates intended to create a legally binding obligation. See Myron H. Nordquist, et al., *United Nations Convention on the Law of the Sea 1982: A Commentary* (Leiden: Martinus Nijhoff, 1991), 453, noting that earlier drafts of Article 239 did not use obligatory language; rather, they merely required that states and competent international organizations “shall endeavour” or “shall to the extent possible” promote and facilitate research. However, given the general formulation of the provision, the issue has been raised as to whether Article 239 actually gives rise to a hard law obligation. According to Soons, *supra* note 24, at 132, Article 239 “as it stands . . . cannot be considered to be more than a mere exhortation to States and international organizations to act positively towards marine scientific research.” For a contrasting view, see Montserrat Gorina-Ysern, *An International Regime for Marine Scientific Research* (Ardsey: Transnational, 2003), 291–292.

37. LOSC, *supra* note 4, arts. 242–245 and 255.

38. *Ibid.*, art. 242(2).

39. *Ibid.*, arts. 238 and 240(c).

40. *Ibid.*, art. 56(2).

41. *Ibid.*, art. 87(2).

42. *Ibid.*, Preamble.

43. Gerhard Hafner, “Meeresumwelt, Meeresforschung und Technologietransfer,” in *Handbuch des Seerechts*, ed. Wolfgang Graf Vitzthum (Munich: C. H. Beck, 2006), 429–430.

44. Amedeo Santosuosso, et al., "What Constitutional Protection for Freedom of Scientific Research?" *Journal of Medical Ethics* 33 (2007): 342. Regarding the United States, see Robert Post, "Constitutional Restraints on the Regulations of Scientific Speech and Scientific Research: Commentary on 'Democracy, Individual Rights and the Regulation of Science,'" *Science and Engineering Ethics* 15 (2009): 431; and, for Canada, see Barbara Billingsley and Timothy Caulfield, "The Regulation of Science and the Charter of Rights: Would a Ban on Non-reproductive Human Cloning Unjustifiably Violate the Freedom of Expression?" *Queens Law Journal* 29 (2004): 647.

45. See Santosuosso, *supra* note 44, at 342.

46. Tullio Treves, "Marine Scientific Research," in R. Wolfrum (Ed.), *Max Planck Encyclopedia of Public International Law*, Oxford University Press, 2008, online edition, www.mpepil.com, visited on 4 October 2011, para. 7, noted that state practice on marine scientific research "evidence[s] a restrictive trend in the application of the Convention." Furthermore, according to Florian H. Th. Wegelein, *Marine Scientific Research: The Operation and Status of Research Vessels and Other Platforms in International Law* (Leiden: Martinus Nijhoff, 2005), 325, marine scientific research can be regarded as a "receding right."

47. Gunnar Kullenberg, "Ocean Science: An Overview," in *Troubled Waters: Ocean Science and Governance*, eds. Geoff Holland and David Pugh (Cambridge: Cambridge University Press, 2010, at 81).

48. LOSC, *supra* note 4, art. 245. Coastal states also exercise sovereignty over marine scientific research conducted in archipelagic waters. See Treves, *supra* note 46, at para. 8; and Churchill and Lowe, *supra* note 26, at 404.

49. LOSC, *supra* note 4, art. 245. See Gorina-Ysern, *supra* note 36, at 305.

50. LOSC, *supra* note 4, arts. 87, 238, and 257.

51. *Ibid.*, arts. 143(1) and 256.

52. *Ibid.*, art. 246(1) and (2).

53. *Ibid.*, art. 246(3). According to Article 246(4), "normal circumstances" may exist in spite of the absence of diplomatic relations between the coastal state and the researching state. However, the lack of an express definition of "normal circumstances" is a source of ambiguity in the LOSC regime on marine scientific research.

54. *Ibid.*, art. 246(3).

55. *Ibid.*, art. 252.

56. *Ibid.*, art. 248.

57. *Ibid.*, art. 255. Office for Ocean Affairs and the Law of the Sea, *The Law of the Sea: Marine Scientific Research: A Guide to the Implementation of the Relevant Provisions of the United Nations Convention on the Law of the Sea* (New York: United Nations, 1991), 8 (hereafter OALOS Guide).

58. LOSC, *supra* note 4, art. 249.

59. OALOS Revised Guide, *supra* note 7, at 10.

60. LOSC, *supra* note 4, art. 245(5)(a). This provision reflects an important rationale for extending coastal state jurisdiction over marine scientific research; that is, the legal recognition of coastal states' sovereign rights to explore and exploit the natural resources in the exclusive economic zone and on the continental shelf. See also LOSC, art. 56(1)(b)(ii).

61. Marta Chantal Ribeiro, "The 'Rainbow': The First National Marine Protected Area Proposed Under the High Seas," *International Journal of Marine and Coastal Law* 25 (2010): 183, at 203–204.

62. OALOS Revised Guide, *supra* note 7, at 10; Soons, *supra* note 24, at 171.

63. Ribeiro, *supra* note 61, at 204. See also Soons, *supra* note 24, at 172–173.

64. LOSC, *supra* note 4, art. 246(5)(b).

65. OALOS Revised Guide, *supra* note 7, at 42.

66. According to LOSC, *supra* note 4, Article 246(3), marine scientific research must be "carried out in accordance with this Convention, exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind." See OALOS Guide, *supra* note 57, at 11; and Soons, *supra* note 24, at 165–167.

67. However, according to the OALOS Guide, *supra* note 57, the coastal state cannot finally refuse its consent to a research project that is not in accordance with the general requirement in Article 246(3). Rather, the OALOS Guide stipulates that, if the coastal state is of the opinion that the proposed research project is not in compliance with the LOSC, it must inform the researching state or international organization of its view and provide reasons in support of its position. The researching state or international organization should then be given the opportunity to modify its proposed project. It is only after this stage, where the coastal state finds that the modified proposal is still not in compliance with the provisions of the LOSC, that the coastal state can refuse its consent. OALOS Guide, *supra* note 57, at 11; Soons, *supra* note 24, at 165–167.

68. The general principle in LOSC, *supra* note 4, Article 240(d), is also embodied in other parts of the Convention, such as Articles 258–263 governing the deployment and use of scientific installations, and provisions governing the responsibility and liability of states and competent international organizations for damage and pollution caused by conducting marine scientific research. See Gorina-Ysern, *supra* note 36, at 297–298.

69. OALOS Revised Guide, *supra* note 7, at 21.

70. Rüdiger Wolfrum, “International Environmental Law: Purposes, Principles, and Means of Ensuring Compliance,” in *International Regional and National Environmental Law*, eds. Fred L. Morrison and Rüdiger Wolfrum (The Hague: Kluwer Law International, 2000), 48; Patricia Birnie, et al., *International Law and The Environment*, 3rd ed. (Oxford: Oxford University Press, 2009), 387.

71. LOSC, *supra* note 4, art. 194(1). “Pollution of the marine environment” is defined in Article 1(1)(4) of the LOSC as “the introduction by man, directly or indirectly, of substances or energy into the marine environment [. . .], which results or is likely to result in such deleterious effects as harm to living resources and marine life.”

72. *Ibid.*, art. 194(3)(d).

73. *Ibid.*, art. 196(1).

74. *Ibid.*, art. 194(5).

75. According to Soons, *supra* note 24, at 136, “the intention of this paragraph was to prohibit the use of methods and means which are unnecessarily and unreasonably damaging to the marine environment.”

76. Birnie, *supra* note 70, at 382.

77. Gorina-Ysern, *supra* note 36, at 297.

78. LOSC, *supra* note 4, Preamble.

79. *Ibid.*, art. 200. See also *ibid.*, arts. 201 and 242(2).

80. *Ibid.*, art. 204(1).

81. Gunnar Kullenberg, “Reflections on Marine Science Contributions to Sustainable Development,” *Ocean and Coastal Management* 29 (1995): 35; Birnie, *supra* note 8, at 229.

82. For the conservation and management of the living resources within the exclusive economic zone, see LOSC, *supra* note 4, arts. 61–67. For the conservation and management of living resources on the high seas, see LOSC, *supra* note 4, arts. 116–120. See, generally, Birnie, *supra* note 8, at 236–241.

83. LOSC, *supra* note 4, art. 61(2).

84. Convention on Biological Diversity, Articles 12(b) and (c), June 5, 1992, 1760 *U.N.T.S.* 79; Convention on the Conservation of European Wildlife and Natural Habitats, Article 11(1)(b), September 19, 1979, 1284 *U.N.T.S.* 209 (hereafter Bern Convention).

85. Convention on Migratory Species of Wild Animals, Article III(3)(a), June 23, 1979, 1651 *U.N.T.S.* 333 (hereafter Bonn Convention).

86. Convention for the Protection of the Marine Environment of the North-East Atlantic, Article 8(1), September 22, 1992, 2354 *U.N.T.S.* 67 (hereafter OSPAR Convention).

87. Bonn Convention, *supra* note 85, art. III(5)(a); Bern Convention, *supra* note 84, art. 9(1); International Whaling Convention, *supra* note 22, art. VIII.

88. For an argument against a hierarchical interpretation, see Wegelein, *supra* note 46, at 75–77.

89. Despite its unqualified wording, the duty to protect and preserve the marine environment in Article 192 is still subject to other provisions in LOSC. In particular, the binding obligation in

Article 192 must be read in conjunction with Article 193, which recognizes states' sovereign rights to pursue their own economic and environmental policies. See Wolfrum, *supra* note 70, at 48.

90. According to Churchill and Lowe, *supra* note 26, at 411, the general principles in Article 240 must be read within the context of the Convention as a whole.

91. This more stringent requirement can be contrasted with the wording of Article 237 of the LOSC, which does not require that agreements relating to the marine environment conform with Part II, but only that they be "carried out in a manner consistent with the general principles and objectives of [the] Convention." See Alan Boyle and Christine Chinkin, *The Making of International Law* (Oxford: Oxford University Press, 2007), 256.

92. Gary E. Marchant and Lynda L. Pope, "The Problems with Forbidding Science," *Science and Engineering Ethics* 15 (2009): 375, at 375.

93. *Ibid.*, at 375.

94. Helene Marsh and Richard Kenchington, "The Role of Ethics in Experimental Marine Biology and Ecology," *Journal of Experimental Marine Biology and Ecology* 300 (2004): 5.

95. Elizabeth J. Farnsworth and Judy Rosovsky, "The Ethics of Ecological Field Experimentation," *Conservation Biology* 7 (1993): 463.

96. One reason that the international research community has instituted voluntary measures is the inadequacies of the existing international and national legal frameworks for ensuring that marine research is carried out sustainably. See Kim Juniper and Lyle Glowka, "Biology Working Group: A Code of Conduct to Conserve and Sustainably Use Hydrothermal Vent Sites," *InterRidge News* 12 (2003): 8, at 8.

97. It is even argued that broad consensus among scientists on reasonable standards for conducting marine research may transform regulations into something "other than freedom fettering." Regulations could be absorbed into the general body of principles and conventions that define good scientific practice (e.g., methods and procedures for conducting experiments and publishing scientific findings). See Andrew Askland, "Science and Socially Responsible Freedom," *Science and Engineering Ethics* 15 (2009): 343, at 345.

98. InterRidge, "InterRidge Statement of Commitment to Responsible Research Practices at Deep-Sea Hydrothermal Vents" (2006), available at www.interridge.org/IRStatement (hereafter InterRidge Code of Conduct).

99. ISOM Code of Conduct, *supra* note 9.

100. Deutsche Senatskommission für Ozeanographie der DFG and Konsortium Deutsche Meeresforschung (KDM), "Erklärung zu einer verantwortungsvollen Meeresforschung" [Commitment to Responsible German Marine Research], reproduced in English in the International Council for the Exploration of the Sea (ICES), *Report of the ICES NAFO Joint Working Group on Deep Water Ecology (WGDEC)* (March 10–14, 2008), ICES CM 2008/ACOM:45, Annex 13.4, 97, available at www.ices.dk/reports/ACOM/2008/WGDEC/WGDEC_2008.pdf.

101. Irish Department of the Environment, Heritage and Local Government, "Code of Practice of Marine Scientific Research at Irish Coral Reef Special Areas of Conservation" (hereafter Irish Code of Practice) (September 2006), available at www.marine.ie/NR/rdonlyres/8DBA2793-B01E-4576-B2BF-C9403ACD06FA/0/file3654en.pdf.

102. European Community, Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (hereafter Habitats Directive), 92/43/EEC. The Habitats Directive lists "reefs" in Annex 1 as a natural habitat worthy of the designation of a special area of conservation.

103. The OSPAR Commission is established by the OSPAR Convention, *supra* note 86.

104. OSPAR Commission, "OSPAR Code of Conduct for Responsible Marine Research in the Deep Seas and High Seas of the OSPAR Maritime Area" (hereafter OSPAR Code of Conduct), OSPAR 08.24/1, Annex 6 (2008), available at the OSPAR Web site at www.ospar.org.

105. These include the European Centre for Information on Marine Science and Technology (EurOcean) and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

106. OSPAR Code of Conduct, *supra* note 104, para. 12.

107. *Ibid.*, para. 13.

108. *Ibid.*, para. 14. “Areas of particular ecological vulnerability” include features listed in the OSPAR List of Threatened and/or Declining Species and Habitats, available at the OSPAR Web site, *supra* note 104.

109. *Ibid.*, para. 19.

110. *Ibid.*, para. 19(c).

111. See *supra* note 108.

112. OSPAR Code of Conduct, *supra* note 104, paras. 17–18.

113. See *ibid.*, paras. 21–23; and Commitment to Responsible German Marine Research, *supra* note 100, paras. 8–9.

114. OSPAR Code of Conduct, *supra* note 104, para. 22.

115. *Ibid.*, paras. 22–23; Irish Code of Practice, *supra* note 101, para. 12.

116. This concept is embodied in four guiding maxims for designing marine field experiments established by the Australian Science, Technology, and Engineering Council (ASTEC):

Movement of the research, either away from an environmentally sensitive area, or to the use of less invasive techniques such as computer modeling

Minimization of procedures carried out, while ensuring the research has the required statistical power

Modification of experimental activities to reduce impact on the environment or the experimental biota

Maximizing the use and benefits of the research results

ASTEC, “Environmental Research Ethics: National Principles and Guidelines for the Ethical Conduct of Research in Protected and Environmentally Sensitive Areas” (1998), reproduced in Marsh and Kenchington, *supra* note 94, at 10–11.

117. For instance, the OSPAR Code of Conduct, *supra* note 104, para. 8, states that “[m]ost forms of observation and investigation of natural systems involve some disturbance of the systems being studied.”

118. *Ibid.* See also UNEP, “Deep-Sea Biodiversity and Ecosystems: A Scoping Report on Their Socio-economy, Management and Governance” (December 2007), 49, available at www.unep-wcmc.org/biodiversity-series-28_97.html.

119. Irish Code of Practice, *supra* note 101, para. 5.

120. For example, the OSPAR Commission specifically mentions in relation to its own work program on marine protected areas that the management of these areas must be based on the “best available science.” OSPAR Code of Conduct, *supra* note 104, para. 7.

121. An exception is for marine scientific research conducted within areas of national jurisdiction or sovereign rights (i.e., in the EEZ or on the continental shelf, respectively). Under LOSC, *supra* note 4, Article 248(a), the coastal state has a right to be informed about the nature and objectives of the research project as a basis for determining whether it will grant its consent to the proposed research project.

122. London Dumping Convention, December 29, 1972, 1046 *U.N.T.S.* 120; and Protocol to the London Dumping Convention, November 8, 1996, 36 *I.L.M.* 1.

123. The Thirteenth Meeting of the Contracting Parties to the London Convention and the Third Meeting of the Contracting Parties to the London Protocol, “Resolution LC-LP.1(2008) on the Regulation of Ocean Fertilization,” LC 30/16 Annex 6 (adopted October 31, 2008), para. 8.

124. *Ibid.*, para. 7.

125. “Assessment Framework for Scientific Research Involving Ocean Fertilization Resolution LC-LP.2(2010)” (hereafter Assessment Framework) (adopted 14 October 2010). For a discussion of the Assessment Framework for ocean fertilization experiments, see Philomène Verlaan, “Current Legal Developments London Convention and London Protocol,” *International Journal of Marine and Coastal Law* 26 (2010): 185, at 194.

126. Assessment Framework, *supra* note 125, para. 2.2.1.

127. *Ibid.*

128. ICES WGDEC Report, *supra* note 100, at 90–91.

129. *Ibid.*, at 91.

130. Convention on Biological Diversity, Subsidiary Body on Scientific, Technical and Technological Advice, "Options for Preventing and Mitigating the Impact of Some Activities on Selected Seabed Habitats," UNEP/CBD/SBSTTA/13/INF/13 (January 3, 2008), 66; Juniper and Glowka, *supra* note 96, at 8.

131. The introductory part of the OSPAR Code of Conduct, *supra* note 104, para. 5, states: "OSPAR recognizes that marine research scientists appreciate the uniqueness and complexity of the marine environment, and are therefore particularly interested in preserving this scientifically, aesthetically, ecologically, and potentially economically valuable environment." See also Peter J. Auster, et al., "Developing an Ocean Ethic: Science, Utility, Aesthetics, Self-Interest, and Different Ways of Knowing," *Conservation Biology* 23 (2009): 233, at 234, stating that "a deep understanding and appreciation of the natural world motivates conservation scientists."

132. For example, Farnsworth and Rosovsky, *supra* note 95, at 468–469, point out that data interpretation is easier if high methodological standards are used and that scientists also benefit by returning to sites that have been preserved for future use.

133. ICES WGDEC Report, *supra* note 100, at 88.

134. CBD, "Options for Preventing and Mitigating the Impact of Some Activities on Selected Seabed Habitats," *supra* note 130, at 26.

135. *Ibid.*, at 28.

136. Leary, *supra* note 11, at 195.

137. For instance, the EU-funded EUFLEETS project, which aims to coordinate the European research fleet, requires that principle investigators make a declaration that they will "observe and carry out any investigation in accordance with the general principles of the [OSPAR Code of Conduct]." EUFLEETS, *EUFLEETS Ship-Time Application "Ocean" and "Regional 1" Call 2010* (February 28, 2010), available at [www.eurofleets.eu/np4/%7B\\$clientServletPath%7D/?newsId=90&fileName=EUFLEETS_Call_Ship_time_Application.pdf](http://www.eurofleets.eu/np4/%7B$clientServletPath%7D/?newsId=90&fileName=EUFLEETS_Call_Ship_time_Application.pdf). A similar declaration that researchers will comply with the Commitment to Responsible German Marine Research, *supra* note 100, and OSPAR Code of Conduct, *supra* note 104, is required when applying for ship time on German vessels. Deutsche Forschungsgemeinschaft (DFG) und Senatskommission für Ozeanographie, "Leitfaden für die Antragsstellung für Schiffszeit auf dem Forschungsschiffen METEOR, MARIA S. MERIAN, POLARSTERN, SONNE und den mittelgroßen Forschungsschiffen" (November 23, 2010), 14, available at www.dfg-ozean.de/fileadmin/DFG/Leitfaden/Leitfaden_Antragstellung_23112010.pdf.

138. Helene Marsh and Carole M. Eros, "Ethics of Field Research: Do Journals Set the Standard?" *Science and Engineering Ethics* 5 (1999): 375; Marsh and Kenchington, *supra* note 94, at 8–9.

139. Canada, Oceans Act, *Statutes of Canada 1996*, c. 31, as amended.

140. See Canada, Endeavour Hydrothermal Vents Regulation, *supra* note 25; Basin Head Marine Protected Area Regulations, SOR/2005–293, September 26, 2005; Bowie Seamount Marine Protected Area Regulations, SOR/2008–124, April 17, 2008; Eastport Marine Protected Areas Regulations, SOR/2005–294, September 26, 2005; Gilbert Bay Marine Protected Regulations, SOR/2005–295, September 26, 2005; Gully Marine Protected Area Regulations, SOR/2004–112, May 7, 2004; Musquash Estuary Marine Protected Area Regulations, SOR/2006–354, December 14, 2006; and Tarium Niryutait Marine Protected Areas Regulations, SOR/2010–190, August 25, 2010.

141. Canada, "Endeavour Hydrothermal Vents Marine Protected Area Regulatory Impact Analysis Statement," available at www.gazette.gc.ca/archives/p2/2003/2003-03-12/html/sor-dors87-eng.html.

142. Endeavour Hydrothermal Vents Regulations, *supra* note 25.

143. Department of Fisheries and Oceans Canada, "Endeavour Hydrothermal Vents," available at www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/pacific-pacifique/factsheets-feuillets/endeavour-eng.htm.

144. V. Tunnicliffe and R. Thomson, "Oceans Background Report: Endeavour Hot Vents Area: A Pilot Marine Protected Area in Canada's Pacific Ocean," Report for Fisheries and Oceans Canada (January 1999).

145. See Lauren Mullineaux, et al., "Deep-Sea Sanctuaries at Hydrothermal Vents: A Position Paper," *InterRidge News* 7 (1998): 15, at 15; Paul Dando and S. Kim Juniper, eds., *Management and Conservation of Hydrothermal Vent Ecosystems*, Report from an InterRidge Workshop (September 28–30, 2000) at 6–7; and Leary, *supra* note 11, at 189.

146. Gjerde, *supra* note 11, at 35; Mullineaux, *supra* note 145, at 16; Leary, *supra* note 11, at 189.

147. Mullineaux, *supra* note 145, at 15–16; Lyle Glowka, "Putting Marine Scientific Research on a Sustainable Footing at Hydrothermal Vents," *Marine Policy* 27 (2003): 303, at 304.

148. Glowka, *supra* note 147, at 304; Colin W. Devy, et al., "Responsible Science at Hydrothermal Vents," *Oceanography* 20 (2007): 162.

149. Endeavour Hydrothermal Vents Regulations, *supra* note 25.

150. Department of Fisheries and Oceans Canada, "Endeavour Hydrothermal Vents: Marine Protected Area Management Plan 2010–2015" (Endeavour Hydrothermal Vents Management Plan) (2009), available at www.pac.dfo-mpo.gc.ca/oceans/protection/mpa-zpm/endeavour/docs/EHV-CHE-mgmtplan-gestion-eng.pdf.

151. Endeavour Hydrothermal Vents Regulations, *supra* note 25, sec. 2.

152. The term "understanding of the Area" is undefined in the regulations. Although it could be broadly construed to include all manner of basic and applied studies, its meaning is limited by the more specific words in the list that indicate research aimed at understanding and protecting the marine environment. Furthermore, it is arguable that research that undermines the conservation and protection objectives of the MPA should not come within the meaning of scientific research for the understanding of the Area. Thus, applied research aimed at demonstrating, for example, the potential of the site for extractive mining, would not be permitted within the EHV MPA.

153. Endeavour Hydrothermal Vents Regulations, *supra* note 25, sec. 3. Research plans must include particulars on, inter alia, the research vessel, personnel, research itinerary, and a summary of the research to be conducted including: sampling protocols; equipment to be moored; the discharge of substances; and the use of remotely operated vehicles, radioactive labeling, and explosives.

154. *Ibid.*, sec. 3(3). Foreign states and competent international organizations that wish to conduct marine scientific research in Canadian waters are required to submit an "Application for Consent to Conduct Marine Scientific Research in Areas Under National Jurisdiction of Canada" to the Department of Foreign Affairs and International Trade pursuant to the Coasting Trade Act, *Statutes of Canada* 1992, section 3(2)(c).

155. Endeavour Hydrothermal Vents Management Plan, *supra* note 150, at 15.

156. *Ibid.*, at 16–17.

157. *Ibid.*, at 19.

158. *Ibid.*, at 16.

159. *Ibid.*, at 11.

160. InterRidge Statement of Commitment to Responsible Practices, *supra* note 98.

161. Endeavour Hydrothermal Vents Management Plan, *supra* note 150, at 19.

162. *Ibid.*, at 24. The conservation objective is set out at 9 to "[e]nsure that human activities contribute to the conservation, protection and understanding of the natural diversity, productivity and dynamism of the ecosystem and are managed appropriately such that the impacts remain less significant than natural perturbations (e.g., magmatic, volcanic or seismic)."

163. *Ibid.*, at 10 and 15.

164. *Ibid.*, at 5, 10, 15, and 24.

165. *Ibid.*, at 24.

166. *Ibid.*

167. *Ibid.*, at 16.

168. However, the term "undertake to provide" indicates the weak nature of the obligation in LOSC, *supra* note 4, Article 249(1)(c), in acknowledgment of the fact that the coastal state does not

have direct access to the samples that are in the possession of the research institution. Gorina-Ysern, *supra* note 36, at 338; Soons, *supra* note 24, at 190. Irish authorities also capitalize on the right of coastal states in Article 249(1)(e) of the LOSC by requiring that foreign scientists and international organizations make research results internationally available through appropriate channels as soon as practicable. Irish Code of Practice, *supra* note 101, at 7.

169. OALOS Revised Guide, *supra* note 7, at 43.

170. There is an extensive coastal state right to participate in the planning of the research project, as indicated by the use of the term “especially” in LOSC, *supra* note 4, Article 249(1)(a). See OALOS Revised Guide, *supra* note 7, at 43; Soons, *supra* note 24, at 189; and Gorina-Ysern, *supra* note 36, at 335. However, Soons, *supra* note 25, at 189, stresses that “participation in the preparatory stage does not mean that the coastal State gets control over the research project: the coastal State may not fix conditions concerning the content of the research programme to its granting consent, since Article 249(1), does not confer such a right on the coastal State.” Furthermore, the coastal state’s right to full participation in the research project must be exercised reasonably.

171. Endeavour Hydrothermal Vents Management Plan, *supra* note 150, at 18.

172. *Ibid.*

173. According to LOSC, *supra* note 4, Article 249(1)(d), researching states must provide “the coastal State, at its request, with preliminary reports, as soon as practicable, and with the final results and conclusions after the completion of the research.”

174. OALOS Revised Guide, *supra* note 7, at 45.

175. Soons, *supra* note 24, at 190. According to Gorina-Ysern, *supra* note 36, at 335–336, preliminary reports are required within 30 days after the conclusion of the fieldwork (or even before that), and final results and conclusions in 1 to 5 years.

176. LOSC, *supra* note 4, art. 246(d).

177. K. Juniper, “The Scientific Perspective,” paper presented at the Marine Biodiversity Beyond National Jurisdictions Workshop at the Marine and Environmental Law Institute, Dalhousie Law School, January 17, 2006, 9, notes the problems with this approach: “Many scientists go to the deep sea to conduct research partly because there are no regulations there, but controls may be key to providing continued opportunities for research.” Paper available at law.dal.ca/Files/MEL_Institute/Reports/High_Seas_Report_32p_-_OCT06.pdf.