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Marine snow storms: Assessing the environmental risks of ocean fertilization

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Abstract

The threats posed by climate change to the global environment have fostered heightened scientific interest in marine geo-engineering schemes designed to boost the capacity of the oceans to absorb atmospheric carbon dioxide. This is the primary goal of a process known as ocean fertilization which seeks to increase the production of organic material in the surface ocean in order to promote further draw down of photosynthesized carbon to the deep ocean. This article describes the process of ocean fertilization, its objectives and potential impacts on the marine environment and some examples of ocean fertilization experiments. It analyses the applicability of international law principles on marine environmental protection to this process and the regulatory gaps and ambiguities in the existing international law framework for such activities. Finally it examines the emerging regulatory for legitimate scientific experiments involving ocean fertilization being developed by the London Convention and London Protocol Scientific Groups and its potential implications for the proponents of ocean fertilization trials.

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Marine Snow Storms: Assessing the Environmental Risks of Ocean Fertilization

Robin Warner*

The threats posed by climate change to the global environment have fostered heightened scientific and commercial interest in marine geo-engineering schemes designed to boost the capacity of the oceans to absorb atmospheric carbon dioxide. This is the primary goal of a process known as ocean fertilization which seeks to increase the production of organic material in the surface ocean in order to promote further draw down of photosynthesised carbon to the deep ocean. This article describes the process of ocean fertilization, its objectives and potential impacts on the marine environment and some examples of ocean fertilization experiments. It analyses the applicability of international law principles on marine environmental protection to this process and the regulatory gaps and ambiguities in the existing international law framework for such activities. Finally it examines the emerging regulatory framework for legitimate scientific experiments involving ocean fertilization being developed by the London Convention and London Protocol Scientific Groups and its potential implications for the proponents of ocean fertilization trials.

1. Introduction

The adverse impacts of anthropogenically induced climate change on the terrestrial and marine environments have been acknowledged by a succession of expert reports commissioned by global and national bodies.[1] This recognition has prompted a variety of marine geo-engineering schemes to mitigate the detrimental effects of climate change on the environment including enhanced schemes to remove carbon dioxide from the atmosphere using the world's oceans. The ocean is already a major sink for carbon dioxide because of its capacity to readily absorb excess atmospheric carbon and convert it to soluble form. Scientists have estimated that approximately 5.5 billion tonnes (or gigatonnes) of carbon are now released into the atmosphere each year as carbon dioxide from the burning of fossil fuels and that a third of that is taken up by the oceans.[2] Augmenting the rate at which the oceans absorb carbon dioxide is the fundamental objective of a process known as ocean fertilisation or ocean nourishment being proposed for iron and other nutrient deficient areas of the ocean many of which are located beyond national jurisdiction.[3] Ocean fertilization seeks to increase the production of organic material in the surface ocean, with a commensurate rise in "marine snow" or organic detritus falling from the upper layers of the water column to the deep ocean. Carbon transported as marine snow into the deep ocean and finally decomposed to inorganic nutrients and dissolved carbon dioxide can remain out of

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[1] Intergovernmental Panel on Climate Change (IPCC), *Fourth Assessment Report* (2007) ('IPCC Fourth Report') <http:www.ipcc.ch/ipccreports/ar4-syr.htm> accessed 29 May 2008; Nicholas Stern et al, *Stern Review: The Economics of Climate Change* (HM Treasury, London, 2006); BL Preston & RN Jones, *Climate Change Impacts on Australia and the Benefits of Early Action to Reduce Global Greenhouse Gas Emissions. A consultancy report for the Australian Business Roundtable on Climate Change* (CSIRO Canberra, Canberra ACT, 2006).

[2] Tony Koslow, *The Silent Deep* (UNSW Press, University of New South Wales, Sydney, Australia, 2007) at 156.

[3] Karen N Scott, 'The Day After Tomorrow: Ocean CO2 Sequestration and the Future of Climate Change' (2005) 18 *Georgetown International Environmental Law Review* at 57.

contact with the surface ocean and atmosphere for relatively long time scales associated with ocean currents and circulation.[4]

The long term environmental impacts of ocean fertilisation are still uncertain and the regulatory framework for this process is still developing. While climate change mitigation activities such as ocean fertilisation conducted in marine areas within national jurisdiction may be subject to coastal State legislation and policy on environmental impact assessment, strategic environmental assessment and other environmental protection safeguards, the regulatory framework for such activities beyond national jurisdiction is fragmentary and less defined. General obligations to protect the marine environment beyond national jurisdiction are contained in Part XII of the *United Nations Convention on the Law of the Sea* (*'1982 LOSC'*)[5] but these have not been supplemented in the case of marine areas beyond national jurisdiction with international law instruments applying modern environmental protection principles to the conduct of emerging activities such as ocean fertilisation by flag States, their nationals and corporations. In the absence of systems to monitor and mitigate the adverse impacts of such activities in marine areas beyond national jurisdiction, there is a real risk of irreversible damage to the marine environment of these areas and its biodiversity.[6]

This article will begin by describing the process of ocean fertilization, its objectives and potential impacts on the marine environment and some examples of ocean fertilization experiments. It will then analyse the applicability of international law principles on marine environmental protection to this activity. Finally it will discuss the emerging regulatory framework for legitimate scientific experiments involving ocean fertilization being developed by the London Convention and Protocol Scientific Groups and its implications for proponents of ocean fertilisation trials.

2. The Process and Practice of Ocean Fertilization

The process of open ocean fertilisation uses iron and other micro nutrients to increase phytoplankton primary productivity in iron and other nutrient deficient areas of the ocean in order to promote further draw down of photosynthesised carbon into the deep ocean.[7] There are a variety of risks and uncertainties associated with ocean fertilisation which have prompted concern among scientists and environmentalists. The effects of stimulating phytoplankton productivity on other marine organisms and marine ecosystems generally, is poorly understood.[8] Increased productivity of

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[4] John L. Cullen and Philip W. Boyd, "Predicting and verifying the intended and unintended consequences of large-scale ocean iron fertilization" (2008) 364 *Marine Ecology Progress Series* at 296.

[5] *United Nations Convention on the Law of the Sea*, opened for signature on 10 December 1982, 1833 UNTS 3(entered into force 16 November 1994) (*'1982 LOSC'*). The term 'marine areas beyond national jurisdiction' when used in this article refers to all those parts of the sea which are not included in the exclusive economic zone, territorial sea or the internal waters of a State or the archipelagic waters of an archipelagic State and all those parts of the seabed and ocean floor and sub-soil thereof beyond the outer limit of the continental shelf of a State.

[6] Koslow, above n.2 at 159-160; Scott, above n.3 at 58.

[7] Koslow, above n.2 at 157-158; Rosemary Rayfuse, Mark G. Lawrence and Kristina M. Gjerde, "Ocean Fertilisation and Climate Change: The Need to Regulate Emerging High Seas Uses" (2008) 23(2) *The International Journal of Marine and Coastal Law* 1 at 6-7.

[8] Rayfuse et al, above n.7 at 8-9; Koslow, above n.2 at 159; Scott, above n.3 at 87-88.

phytoplankton may boost the production of other greenhouse gases such as nitrous oxide neutralising the positive effects of enhanced carbon dioxide draw down. The sinking of phytoplankton blooms into the deep ocean may also reduce oxygen levels at these depths with adverse consequences for fisheries and other marine organisms.[9] Scientists have examined the relationship between ocean fertilization and ocean acidification concluding from one set of experiments, using a global ocean carbon cycle model and investigating the maximum potential effect of ocean fertilization on ocean carbonate chemistry, that with fixed emissions of CO2 to the atmosphere, ocean fertilization moderately mitigates changes in ocean carbonate chemistry near the ocean surface, but at the expense of further acidifying the deep ocean.[10]

The sustainability of this activity as a climate change mitigation option has also been called into question on the basis of the time frames and quantities of iron or other nutrients required for the process to be effective. Results from several iron fertilisation projects in open ocean areas beyond national jurisdiction, including the Southern Ocean, with high dissolved concentrations of nutrients and low photosynthetic biomass have concluded that there is no evidence of increased carbon dioxide draw down to the deep sea within the time frame of the experiments.[11] In the recent LOHAFEX ocean iron fertilization experiment conducted by the Alfred Wegener Institute for Polar and Marine Research in conjunction the Indian National Oceanographic Institute (NIO) from 7 January to 17 March 2009 in an ocean eddy at 48 degrees South 16 degrees West in the Southern Atlantic Ocean, preliminary conclusions indicated that the CO2 drawdown effect of the ocean iron fertilization was low.[12] One projection quoted in a Greenpeace Technical Report on the Ocean Disposal/Sequestration of Carbon Dioxide estimates that approximately 470,000 tonnes of iron per year, spread over as much as 25 percent of the ocean surface and repeated for an indefinite period would be needed for this method of carbon dioxide sequestration to be effective.[13] Notwithstanding the uncertainties and environmental risks associated with open ocean fertilisation, some commercial ventures have become interested in the process in recent years and have attracted investment for their operations.[14]

In 2007, a proposed ocean fertilization experiment to be launched from the Philippines attracted criticism from local communities and regional and global environmental organizations concerned that adequate assessment of its impacts on the

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[9] Paul Johnston et al, *Ocean Disposal/Sequestration of Carbon Dioxide form Fossil Fuel Production and Use: An Overview of Rationale, Techniques and Implications* (Greenpeace Research Laboratories, Technical Note 01/99, March 4th 1999) at 24-25; Rayfuse et al, above n.7 at 10.

[10] L. Cao and K Caldeira, "Ocean Fertilization and Ocean Acidification", American Geophysical Union, Fall Meeting, 2008, abstract, available at http://adsabs.harvard.edu.abs//2008AGUFM.B22C.06C, accessed 20 October 2009.

[11] Koslow, above n.2 at 159; Tatjana Rosen, 'Open Ocean Fertilisation' in Cutler J. Cleveland (ed.), *Encyclopaedia of Earth* (Environmental Information Coalition, National Council for Science and the Environment, Washington D.C., 2007) http://www.eoearth.org/article/Open_ocean_iron.fertilization accessed 10 June 2008; Rayfuse et al, above n.7 at 9.

[12] Report of the Thirty Second Meeting of the Scientific Group of the London Convention and the Third Meeting of the Scientific Group of the London Protocol, UN Doc LC/SG 32/15, 29 June 2009, paragraph 2.13; more information on the LOHAFEX experiment is available at the Alfred Wegener Institute website http://www.awi.de/en/news/selected_news/2009/lohafex/.

[13] Johnston et al, above n.9 at 23-24.

[14] Koslow, above n.2 at 159; Rayfuse et al, above n.7 at 3.

marine environment and marine biodiversity had not been undertaken.[15] Ocean Nourishment Corporation (ONC), an Australian based company, had developed technology which involved the injection of urea, a nitrogen compound, into areas of the world's oceans considered to be nitrogen deficient.[16] The liquid urea was to be mixed with other nutrients, diluted in sea water and transported via a marine pipeline to deep waters off the continental shelf of the participating State where it would be injected into the sunlit layer of the ocean 50 metres below the ocean's surface.[17] ONC claimed that the nutrient mix would stimulate further growth of existing stocks of phytoplankton through photosynthesis which, after a short life cycle of approximately 5 days, would die, increasing the flux of carbon dioxide locked in the plant tissues of the phytoplankton to the deep ocean floor.[18] ONC asserted that a further benefit of this process would be increased fish stocks as phytoplankton are at the base of the aquatic food chain and in essence, would fertilize the ocean, fuelling the production of more fish.[19] ONC claimed that one of their plants could remove approximately 5 to 8 million tonnes of carbon dioxide from the atmosphere every year and that this was equivalent to off-setting annual emissions from a typical 1200 megawatt coal fired power station or the short term sequestration potential which would be created from one million hectares of new growth forest.[20] It was also stated in their promotional material that their technology was only applicable to deep ocean sites and was not suitable for shallow bays or coastal waters, however, the transport of nutrients to the deep ocean sites would involve the establishment of an ONC plant on shore and the use of a deep ocean pipeline to transport the nutrient mix to deep waters off the continental shelf.[21]

Reports emerged of ONC's first large scale field trial in 2007. This would involve the release of 500 tonnes of urea into the Sulu Sea between the Philippines and Borneo through a pipeline form the Philippines coast.[22] The trial was to be undertaken by ONC in conjunction with two Philippines institutions, the University of the Philippines and the University of San Carlos. The Bureau of Fisheries and Aquatic Resources in the Philippines had issued a permit for the activity to take place without any prior environmental impact assessment or consultation with relevant stakeholders in the local coastal communities, fishing industry or other sectors of civil society.[23] Concerns were raised by local fishing communities, civil society groups in the Philippines and environmental non governmental organizations (NGOs) about the potential threats to the marine environment and its biodiversity posed by the ONC trial.[24] These included the creation of toxic algal blooms and dead zones in the ocean

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[15] ETC Group (Canada)/SEARICE (Philippines)/Third World Network (Malaysia)/Corporate Watch (UK), *Ocean Nourishment Corporation plans imminent urea dumping experiment in Southeast Asian seas. Civil Society groups call on London Convention to halt marine dumping geo-engineering experiments*, 5 November 2007, <http://www.etcgroup.org/en/materials/publications.html?pub_id=660, at 31 August 2008; Rayfuse et al, above n.7 at 3.
[16] Ocean Nourishment Corporation, Technology, http://www.oceannourishment.com/technology.asp at 31 August 2008.
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] ETC Group et al, above n.15 at 1-2.
[23] Ibid, at 2-3.
[24] Ibid, at 1.

from oxygen depletion.[25] The civil society groups noted that the Scientific Groups of the London Convention and London Protocol parties had raised concerns that ocean fertilization would result in adverse impacts to marine ecosystems caused by large scale artificial algal blooms and called on the 29th Consultative Meeting of the London Convention and the second meeting of the Contracting Parties to the London Protocol to consider the threats of large scale nitrogen addition projects such as the ONC proposed trials.[26] As well as the Philippines based trial, it was reported that ONC planned to conduct a trial in 2008 involving the release of 1000 tonnes of dissolved urea off Malaysia under similar conditions to the Philippines trial and it had also approached Chile and Morocco to conduct trials off both these countries.[27] A common feature of these proposals for ocean fertilization trials appeared to be that developing countries or countries in transition with less well established environmental impact assessment policies and processes were being targeted as conduits for the trials.

3. The Applicability of International Law Principles to Ocean Fertilization in Marine Areas beyond National Jurisdiction

The regulatory framework for environmental protection in marine areas beyond national jurisdiction is in the preliminary stages of its development. Environmental regulation in marine areas beyond national jurisdiction is gradually evolving against a background of vast tracts of ocean where the freedoms of the sea have traditionally held sway. This section will explore some of the general international law principles which apply to climate change mitigation activities such as ocean fertilization in marine areas beyond national jurisdiction.

A. 1982 LOSC Provisions

At the zenith of the 1982 LOSC framework for protection and preservation of the marine environment is Article 192 in Part XII which imposes a general obligation on States Parties to protect and preserve the marine environment. The obligation in Article 192 is not limited in geographic scope although in practice its implementation is highly dependent on the regulatory measures in place for different sectors of human activity at sea and the relative strength of enforcement measures within different areas of ocean space.[28] Notwithstanding the unqualified nature of the obligation in Article 192, the debates in the Third Committee of the Third United Nations Conference on the Law of the Sea (UNCLOS III) and other articles in the 1982 LOSC indicate that the general obligation under Article 192 must be interpreted consistently with States Parties rights and obligations under other provisions of the 1982 LOSC and related international conventions.[29] Article 194(1) of the LOSC begins the process of giving

[25] Ibid, at 3.
[26] Ibid, at 1.
[27] Ibid, at 2-3.
[28] Myron Nordquist, Shabtai Rosenne and Alexander Yankov (eds.), *United Nations Convention on the Law of the Sea 1982. A Commentary Vol. IV* (Martinus Nijhoff, Dordrecht, 1991) at 43; Philomene Verlaan, 'Experimental Activities that Intentionally Perturb the Marine Environment: Implications for Marine Environmental Protection and Marine Scientific Research Provisions of the 1982 United Nations Convention on the Law of the Sea' (2007) 31 *Marine Policy* 210 at 210.
[29] Commonwealth of Australia, Report of the Australian Delegation to the Third United Nations; Conference on the Law of the Sea, Second Session, Caracas, Venezuela, Parliamentary Paper 164

content to this general obligation by codifying the duty of States Parties to prevent, reduce and control pollution of the marine environment from any source.[30] The global scope of this responsibility is manifest in Article 194(2) which refers to States Parties' duty to ensure that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights. An indicative list of the sources of marine pollution is contained in Article 194(3) which provides that States Parties shall take measures designed to minimise to the fullest possible extent their effects. The following descriptions of two categories of marine pollution in Article 194(3) could apply to some of the impacts of the climate change mitigation activities such as ocean fertilization on the marine environment:

> "(a) the release of toxic, harmful or noxious substances, especially those which are persistent from land based sources, from or through the atmosphere or by dumping;
>
> (d) pollution from other installations and devices operating in the marine environment…"

In addition to these general duties to take measures to prevent, reduce and control marine pollution, Article 194(5) imposes a positive duty on States to take measures to protect and preserve rare and fragile ecosystems as well as the habitat of depleted, threatened or endangered species from marine pollution representing an early recognition of the need for ecosystem based management of the oceans. The obligation imposed on States Parties in Article 195 not to transfer, directly or indirectly, damage or hazards from one area to another has particular relevance to marine areas beyond national jurisdiction as these areas have often been used as dumping grounds for vessel source and other forms of pollution. The practical issues of environmental impact assessment and monitoring of the risks and effects of marine pollution in all areas of the sea are addressed in Article 204 and 206 which require States Parties to assess, as far as practicable, the potential effects of planned activities under their control which may cause substantial pollution or significant and harmful changes to the marine environment and to communicate reports of the results of such assessments by publishing them or providing them to the competent international organisations.

Rather than being prescriptive in character, Part XII of the LOSC recognises the role of competent international organisations such as the International Maritime Organisation and diplomatic conferences in supplementing the 1982 LOSC framework on marine pollution control with regulatory instruments which address specific forms of marine pollution. Article 197 provides for a duty on the part of States Parties to cooperate on a global and, as appropriate, regional basis in the protection of the marine environment, directly or through competent international

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(AGPS, Canberra, 1974), Item 12 – Preservation of the Marine Environment, para 127: 'The emphasis on the part of the maritime States was to give the greatest protection possible to freedom of navigation.'

[30] Alan Boyle, 'Protecting the Marine Environment: Some Problems and Developments in the Law of the Sea' (1992) 16(2) *Marine Policy* at 80 describes the general obligation of States to protect the marine environment from all sources of marine pollution as a rule of customary international law.

organisations, in formulating and elaborating international rules, standards and recommended practices and procedures for the protection and preservation of the marine environment. States must also cooperate directly or through competent international organisations 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 and to participate actively in programmes to assess the nature of and extent of marine pollution, exposure to it and its pathways, risks and remedies. The extensive regulatory activity undertaken by the International Maritime Organisation (IMO) and its member States on vessel source pollution and dumping at sea is a manifestation of this type of cooperation.

Where climate change mitigation activities are experimental in character, the 1982 LOSC provisions on marine scientific research may apply to their conduct. Article 87 confirms the freedom of scientific research in high seas areas subject to the provisions of Part VI on the continental shelf and Part XIII on Marine Scientific Research. Articles 256 and 257 in Part XIII reinforce this freedom providing that all States and competent international organisations have the right in conformity with the 1982 LOSC to conduct marine scientific research in the Area and the water column beyond the limits of the exclusive economic zone. Marine scientific research activities are, however, expressly subject to the marine environmental protection provisions of the 1982 LOSC under Article 240(d).[31] Where climate change mitigation activities such as are conducted in high seas areas above a continental shelf, States Parties and flag vessels under their jurisdiction or control would also need to have due regard for the sovereign rights of coastal states in relation to the living and non living resources of the shelf. For example, Article 79(2) of the 1982 LOSC provides that although a coastal State may not impede the laying or maintenance of pipelines on the continental shelf beyond its territorial sea, it has the right to take reasonable measures for the prevention, reduction and control of pollution from such pipelines.

While some essential principles of environmental protection in the 1982 LOSC, which may apply to climate change mitigation activities, extend to marine areas beyond national jurisdiction these are largely dependent on flag State responsibility for their implementation. Under Article 217 of the 1982 LOSC, flag States must ensure compliance by vessels flying their flag with applicable international rules and standards established through the competent international organisation and with their own laws and regulations for the prevention, reduction and control of marine pollution from vessels including pollution by dumping.[32] Flag States must provide for the effective enforcement of such rules, standards, laws and regulations, irrespective of where a violation occurs. The system of flag State jurisdiction over all forms of vessel source pollution depends on the commitment and resources of States to monitor the compliance of their own fleets and take enforcement measures against delinquent vessels.

B. Complementary Principles for Regulating the Marine Environment

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[31] Verlaan, above n.28 at 211.

[32] Patricia Birnie & Alan Boyle, *International Law and the Environment* (2nd Ed.) (Oxford University Press, Oxford, 2002) at 370; Erik J. Molenaar, *Coastal State Jurisdiction over Vessel Source Pollution* (Kluwer Law International, The Hague, 1998) at 99.

Since the 1972 Stockholm Declaration on the Human Environment, a body of modern conservation principles has emerged which apply to the protection of the marine environment both within and beyond national jurisdiction.[33] Although these principles have generally been expressed as consistent with the provisions of the 1982 LOSC, they have followed a separate development trajectory from the law of the sea. The predominant policy objective in the more recent instruments and soft law declarations on the environment has been the adoption of a more integrated ecosystem based regime for managing the oceans which promotes sustainable use of marine resources and a precautionary approach to the protection of the marine environment. This objective has usually been qualified with the prescription that marine environmental protection principles and policies must be implemented consistently with the rights and obligations of States under the law of the sea as reflected in the 1982 LOSC. Climate change mitigation activities such as ocean fertilization conducted in marine areas beyond national jurisdiction, are also subject this evolving body of marine environmental protection principles.

(i) United Nations Conference on Environment and Development (UNCED) – Rio Declaration and Agenda 21 Oceans Chapter

The UNCED process had the effect of catalysing the formation of a whole body of emerging international environmental law principles and demonstrating their application to various components of the environment.[34] Although different versions of the precautionary approach had been contained in other regional and global instruments prior to UNCED, its inclusion in Principle 15 of the Rio Declaration[35] was a major step in its global maturation as an emerging principle of customary international law.[36] The Principle 15 version of the precautionary approach contains a familiar formulation of the concept specifying that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation. For marine areas beyond national jurisdiction, the precautionary approach has particular relevance because of the still developing state of scientific knowledge in relation to most aspects of the deep seas environment and the wide array of new and emerging uses of these areas. The embryonic state of knowledge of the marine environment beyond national jurisdiction arguably imposes an even greater responsibility on the international community to adopt preventive strategies to protect this part of the global environment. The more stringent nature of the obligation imposed by the precautionary approach for areas beyond national jurisdiction is borne out in the content of provisions incorporating the precautionary approach in some of the global instruments which apply to areas beyond national jurisdiction. Birnie and Boyle cite examples of instruments where the burden of proof is reversed in these circumstances making it impermissible to carry out an activity in areas beyond national jurisdiction unless it can be shown that it will not cause

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[33] Verlaan, above n.28 at 210-211.
[34] David Freestone, 'The Road from Rio: International Environmental Law After the Earth Summit' (1994) 6 *Journal of Environmental Law* 193 at 216.
[35] UNCED, *Rio Declaration*, UN Doc A/CONF.151/PC/WG.III/L.33/Rev 1.
[36] Birnie & Boyle, above n.32 at 116; Patricia Birnie, 'The Status of Environmental "Soft Law": Trends and Examples with Special Focus on IMO Norms' in Henrik Ringbom, *Competing Norms in the Law of Marine Environmental Protection* (Kluwer Law International, London, 1997) at 51; Stuart B. Kaye, *International Fisheries Management* (Kluwer Law International, The Hague, 2001) at 171-172; Freestone, above n36 at 216.

unacceptable harm to the environment.[37] The use of environmental impact assessment processes for proposed activities that are likely to have a significant adverse impact on the environment is also encouraged in Principle 17 of the Rio Declaration. Many of the principles contained in the Rio Declaration, including the precautionary approach and the recommendation that States conduct environmental impact assessments for proposed activities were applied systematically across all programme areas in the UNCED Action Plan, Agenda 21[38], including the oceans.

The Introduction to the Oceans Chapter of Agenda 21 recognised the underlying unity of the oceans, describing the oceans and all seas and adjacent coastal areas as 'an integrated whole that is an essential component of the global life support system.'[39] The primacy of the 1982 LOSC as the governing framework for the protection and sustainable development of the marine and coastal environment and its resources was also acknowledged in the Introduction to the Oceans Chapter but it also signalled the need for fresh approaches to marine and coastal management at the various levels of oceans governance, specifying that such approaches should be 'integrated in content' and 'precautionary and anticipatory' in ambit.[40] Section B of the Oceans Chapter gave more specific content to the general obligation of States to protect and preserve the marine environment in Article 192 of the 1982 LOSC by specifying a set of objectives to guide States efforts in arresting the degradation of the marine environment. Many of these are derived from the principles contained in the Rio Declaration. They include the application of preventive, precautionary and anticipatory approaches to reduce the risk of long term and irreversible damage to the marine environment, the prior assessment of activities that may have significant adverse impacts on the environment, the integration of marine environmental protection considerations into social and economic development policies, incentives such as the polluter pays principle to encourage the application of clean technologies and other means consistent with the internalisation of environmental costs.[41]

(ii) 1992 Convention on Biological Diversity ('1992 CBD')

The provisions of the *1992 CBD*[42] are closely linked to the vision expounded in the Rio Declaration and Agenda 21 of integrated and ecosystem based management of the environment including marine areas beyond national jurisdiction.[43] Biological diversity is an all encompassing term defined in Article 2 of the 1992 CBD as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part' and including 'diversity within species, between species and ecosystems." In the context of the marine environment, the concept of biodiversity was allied to the notion of large marine ecosystems forming an interconnecting web of marine living

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[37] Birnie & Boyle, above n.32 at 118.
[38] UNCED, UN Doc A/CONF.151/26 (1992) (*Agenda 21*).
[39] Agenda 21, Chapter 17, para 17.1.
[40] Ibid.
[41] Ibid, paragraph 17.22(a-d).
[42] *Convention on Biological Diversity*, opened for signature on 22 May 1992, 31 ILM 822 (entered into force 29 December 1993) (*'1992 CBD'*).
[43] Michael Grubb, Matthias Koch, Koy Thomson, Abby Munson & Francis Sullivan, *The 'Earth Summit' Agreements. A Guide and Assessment* (Earthscan Publications Ltd, London, 1993) at 75-76.

resources and their habitats.[44] The obligation to conserve biodiversity contained in the 1992 CBD requires protection of a range of interlinked components in the marine environment including species, habitats, ecosystems and genetic material and takes into account the social, economic and political factors affecting the various components of marine biodiversity.[45] Under Article 14 of the 1992 CBD Contracting Parties must introduce environmental impact assessment procedures for proposed projects such as ocean fertilization that are likely to have significant adverse effects on biodiversity in order to avoid or minimise such effects. In the case of biological diversity beyond national jurisdiction, Article 5 of the 1992 CBD limits the obligations of Contracting Parties to a duty to cooperate in its conservation and sustainable use directly or through competent international organisations. Arguably, however, the general obligation of States to protect and preserve the marine environment and their more specific obligations to take measures to protect and preserve rare or fragile ecosystems as well as the habitat of depleted threatened or endangered species under Part XII of the LOSC must now be interpreted in the light of the provisions of the 1992 CBD.[46]

3. The Emerging Regulatory Framework for Legitimate Scientific Experiments involving Ocean Fertilization

Where climate change activities involve the deliberate disposal of waste material at sea, they may fall within the regulatory ambit of the 1972 *Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter* (*'1972 London Convention'*) [47] and 1996 *Protocol to the London Convention* (*'1996 London Protocol'*).[48] The 1972 London Convention applies to disposal of waste material in any area of the water column but not to disposal in the seabed.[49] Dumping of 'waste materials generated by industrial or processing operations' into the water column has been prohibited under the 1972 London Convention since 1996, unless the particular materials appear on a reverse list of industrial wastes that can be dumped.[50] The definition of dumping under the 1972 London Convention, however, does not include placement of matter for a purpose other than mere disposal provided that such placement is not contrary to the aims of the Convention.[51] This qualification on the definition of dumping potentially excludes the research and development phase and experimental stages of ocean fertilization from the general prohibition on dumping of industrial wastes however in view of its potentially adverse effects on the marine environment even the experimental phases of such disposal may be regarded as

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[44] Christopher C. Joyner, 'Biodiversity in the Marine Environment: Resource Implications for the Law of the Sea' (1995) 28 *Vanderbilt Journal of Transnational Law* at 637.
[45] Ibid, 644 and 646.
[46] Lee A. Kimball, 'The Biodiversity Convention: How to Make it Work' (1995) 28 *Vanderbilt Journal of Transnational Law* at 769-771; Patricia Birnie, 'Are Twentieth Century Marine Conservation Conventions Adaptable to Twenty First Century Goals and Principles? Part 1' (1997) 12 *The International Journal of Marine and Coastal Law* at 338.
[47] *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, opened for signature 29 December 1972, 11 ILM 1294 (entered into force 30 August 1975) (*'1972 London Convention'*).
[48] *Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, opened for signature 7 November 1996, 36 ILM 1 (entered into force 24 March 2006) (*'1996 London Protocol'*).
[49] 1972 London Convention, Article III(1) and (3).
[50] Ibid, Article IV, Annexes I paragraph 11.
[51] 1972 London Convention, Article III(1)(b)(ii).

contrary to the aims of the 1972 London Convention and contrary to the provisions of Part XII of the 1982 LOSC on prevention, reduction and control of pollution.[52]

The 1996 London Protocol was negotiated to replace the 1972 London Convention and although it has entered into force it has limited participation and the two regimes are still operating in parallel.[53] A fundamental premise of the 1996 London Protocol is that Contracting Parties should avoid using the sea for the dumping of wastes and that any exceptional dumping of wastes at sea should be subject to rigorous risk assessment and control and scientifically based procedures for disposal.[54] Dumping of waste or other matter is prohibited under the 1996 London Protocol except for those materials specifically listed in Annex I.[55] Annex I includes "inert, inorganic geological material" and organic material of natural origin but it is unlikely that iron or the other nutrients used in ocean fertilization would fall into either category.

It is arguable that ocean fertilization falls outside the definition of dumping under the Convention and Protocol as the iron and other nutrients are being placed in the water column for purposes other than mere disposal, however, if adverse impacts to the marine environment ensue as a result of their placement, it can also be argued that these activities are not consistent with the aims of the Convention and Protocol.[56] At their Second Consultative Meeting in November 2007, the 1996 London Protocol Contracting Parties considered a report from their Scientific Groups and other submissions concerning open ocean fertilisation and expressed the view that knowledge about the effectiveness and potential environmental impacts of open ocean fertilisation was currently insufficient to justify large scale projects and that these could have negative impact on the marine environment and human health.[57] They also agreed that this process falls within their regulatory competence and that they would further study this issue from scientific and legal perspectives.[58] In October 2008 the governing bodies of the London Convention and London Protocol adopted resolution LC-LP.1 on the regulation of ocean fertilization which declared that "given the present state of knowledge ocean fertilization activities other than legitimate

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[52] Scott, above n.3, at 80.
[53] The London Protocol has 37 States Parties, http://www.imo.org/dynamic/mainframe.asp?topic_id=1509 accessed 15 November 2009 representing 32.22% of the world's shipping tonnage.
[54] 1996 London Protocol, Article 2.
[55] Ibid, Article 4.
[56] Rayfuse et al, above n.7 at 16-18.
[57] IMO Press Briefing 40, 16 November 2007 http://www.imo.org/includes/blastDataOnly.asp/data_id%3D20395/Pressbriefing16-11-07.doc accessed 10 June 2008.
[58] Scientists meeting under the auspices of the 1972 London Convention and 1996 London Protocol from 19 to 23 May 2008 in Guayaquil Ecuador reviewing the evidence on open ocean fertilisation concluded that 'based on scientific projections, there is the potential for significant risks of harm to the marine environment' even if direct scientific evidence on the environmental impact was still lacking. This decision prompted the Conference of the Parties of the CBD at their 9th meeting from 19 to 30 May 2008 to request Parties and urge other Governments 'in accordance with the precautionary approach to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, including assessing associated risks, and a global transparent and effective control and regulatory mechanism is in place for those activities; with the exception of small scale scientific research within national jurisdiction.', IUCN, *Marine Miracles at Convention on Biological Diversity* http://www.iucn.org.law accessed 10 June 2008. The final decision is available on the CBD COP 9 website http://www.cbd.int/cop9/.

scientific research should not be allowed."[59] They also identified the need for preparatory work in the intersessional period on technical/scientific issues related to ocean fertilization and agreed to further consider a potential legally binding resolution or an amendment to the London Protocol at their fourth consultative meeting in October 2009.[60]

In this context, the Intersessional Technical Working Group on Ocean Fertilization (ITWGOF) was established to develop an assessment framework on ocean fertilization and to prepare, in conjunction with other relevant international organizations and experts, an information document for Contracting Parties summarising the current state of knowledge on ocean fertilization and its impacts on the marine environment.[61] The Ocean Fertilization Working Group (OFWG) drew on the report of the ITWGOF and reports from other delegations to prepare a draft assessment framework which was reviewed at the thirty second meeting of the Scientific Groups of the London Convention and London Protocol. For the purposes of the assessment framework, ocean fertilization is defined as:

:"..any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans."[62]

The Framework provides:

> (a) a tool for assessing scientific research proposals on a case by case basis to determine if a proposed activity is consistent with the aims and objectives of the London Convention or Protocol and meets the requirements of Annex 2 to the Protocol which contains the general waste assessment provisions for dumping at sea; and
>
> (b) guidance to:
>
> (i) determine whether a project is legitimate scientific research, and therefore should be regarded as placement under the London Convention and Protocol rather than dumping;
>
> (ii) characterize risks to the marine environment from ocean fertilization on a project specific basis in order to determine whether the proposed activity is contrary to the aims of the London Convention and Protocol; and
> (iii) obtain the necessary information to develop a risk management strategy.[63]

The Assessment Framework is composed of a number of elements. The initial assessment determines whether a proposal falls within the definition of ocean fertilization specified in resolution LC/LP.1 (2008) and is a scientific project eligible

[59] UN Doc LC/SG 32/15, above n.12, paragraph 2.1
[60] Ibid.
[61] Ibid, paragraph 2.3.
[62] Ibid, Annex 2, paragraph 1.1
[63] Ibid, Annex 2, paragraph 1.2.

to be considered and evaluated in a risk analysis.[64] A number of criteria are considered in determining whether the project has the proper scientific attributes to be evaluated including whether:

> (a) the project is designed to answer questions that will add to the body of scientific knowledge. Proposals must state their rationale, research goals, scientific hypothesis, methods, scale, timings and locations with clear justification for why the expected outcomes cannot reasonably be achieved by other methods;
>
> (b) the proposal is subject to scientific peer review, at appropriate stages in the assessment process. The outcome of the scientific peer review is to be taken into consideration by the [competent body](the identity of which is still under discussion)
>
> (c) the project proponents have made a commitment to publish the results in peer reviewed scientific publications and to include a plan in the proposal to make the data and outcomes publicly available in a specified time frame.[65]

Ocean fertilization proposals must fulfil the criteria specified in the initial assessment before proceeding through the subsequent stages of the risk assessment.[66]

The risk analysis element of the Framework determines whether a project constitutes legitimate scientific research that is not contrary to the aims of the London Convention and Protocol and includes a number of components. The problem formulation component describes the project and sets the bounds for the assessment. The site selection and description concerns the provision of data necessary for describing the physical, chemical and biological conditions at the site. The exposure assessment is concerned with describing the movement and fate of added substances within the marine environment while the effects assessment assembles the information necessary to describe the response of the marine environment resulting from exposure to ocean fertilization. The risk characterization integrates the exposure and effects information to provide an estimate of the likelihood of adverse impacts on the marine environment and the magnitude of those impacts. Finally risk management procedures are required to ensure that a precautionary approach is followed and as far as practicable, environmental risks are minimized and the benefits maximized. Risk management uses the results of the risk characterization together with the other information to enable a decision on whether the project constitutes legitimate scientific research that is not contrary to the aims of the London Convention and Protocol.[67]

The risk analysis element of the Framework also requires that proponents provide a description and summary of the uncertainties associated with the conclusions of the risk analysis including a listing of the significant and consequential assumptions, data gaps and sources of variation in exposure and effects processes. This description is designed to assist decision makers to inform themselves about the implications for

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[64] Ibid, Annex 2, paragraph 1.3.1.
[65] Ibid, Annex 2, paragraph 2.3.
[66] Ibid, Annex 2, paragraph 2.4.
[67] Ibid, Annex 2, paragraph 1.3.

their decision of the identified uncertainties. [68] The Framework specifies that once a determination is made that a proposal falls within the definition of ocean fertilization, the Secretariat of the London Convention and Protocol should be informed, countries should be identified that may be affected and a plan developed to explain the potential impacts, encourage scientific cooperation and provide for ongoing consultation during the assessment process.[69]

The Framework provides that a decision to approve a proposal should only be made if all the earlier steps of the Framework have been satisfactorily completed and the approval should ensure that the scientific objectives of the experiment can be met and that, as far as practicable, environmental disturbance and detriment are minimized and the benefits maximized.[70] Approvals must include the duration and location of the activity, the requirements for monitoring and reporting and any other conditions required by the competent body (the identity of which is still under discussion) and should only be issued for defined periods of time and defined regions.[71] The assessment and approval documentation should be made publicly available at the time the decision is made and the approval should also be communicated to the Secretariat of the London Convention and Protocol and relevant States.[72] Reporting on the conduct of the experiment and compliance with approval conditions and the results of monitoring of the impacts on the marine environment should be submitted to the [competent body], [the Secretariat of the London Convention and Protocol] and [where appropriate, to other Contracting Parties] (all these recipients are still to be finally approved).[73]

At the time the Scientific Groups considered the draft Assessment Framework at their thirty second meeting in June 2009, there were still a number of outstanding issues requiring further discussion including the definition of the "competent body" responsible for execution of the assessment framework (i.e. the relevant decision makers at the Contracting Party level), the definition of impact hypothesis, the establishment of a mechanism for sharing the results of the risk analysis of projects for possible use in future assessment activities, the establishment by national administrators of a consultation or communication process with stakeholders when conducting an assessment.[74] Some Contracting Parties suggested that criteria addressing commercial benefits should also be included in the assessment framework although the Scientific Groups declined to address this issue as it fell outside their area of responsibility and it may therefore be deferred for decision by the governing bodies of the London Convention and Protocol.[75]

4. Conclusion

The urgency and lack of regulation associated with climate change mitigation activities involving the oceans beyond national jurisdiction, poses actual and potential

[68] Ibid, Annex 2, paragraph 1.5.
[69] Ibid, Annex 2, paragraph 1.7.
[70] Ibid, Annex 2, paragraph 9.1.
[71] Ibid, Annex 2, paragraphs 1.8 and 9.2.
[72] Ibid.
[73] Ibid, Annex 2, paragraph 1.8.
[74] Ibid, paragraphs 2.23 and 2.24.
[75] Ibid, paragraph 2.26.

threats to the physical characteristics and biodiversity of the open ocean and deep sea environments. Arbitrary human intrusions into previously undisturbed marine domains have the potential to harm the intricate links between complex marine ecosystems and to erode components of marine biodiversity. Protection of the vast tracts of ocean from the adverse impacts of new and emerging uses such as climate change mitigation activities requires concentrated global, regional and sectoral investment into coordinating and extending environmental protection regimes and developing assessment frameworks. The risk assessment process evolving under the London Convention and Protocol for legitimate scientific experiments involving ocean fertilization provides a model for States Parties to apply modern international environmental law principles to protect the marine environment and conserve biodiversity even particularly where experiments occur beyond national jurisdiction. This model has obvious limitations, however, as it is designed for a specific activity which falls within the regulatory scope of the London Convention and Protocol, only binding on States Parties to the London Convention and Protocol and relies on individual flag State responsibility for implementation of the risk assessment process. Other climate change mitigation activities involving the oceans may be subjected to similar examination in the future by the London Convention and London Protocol scientific groups if they fall within the regulatory ambit of these conventions but the proliferation of such activities suggests the need for a more integrated system of global, sectoral and regional instruments to provide an more comprehensive system of environmental impact assessment. Enhanced environmental protection for marine areas within and beyond national jurisdiction will require concerted action by the international community to put in place best practice guidelines and measures to assess and minimise the adverse impacts of emerging climate change mitigation activities on all areas of the ocean.