Introductory overview

Protecting the polar marine environment: interplay of regulatory frameworks

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Recent years have witnessed important developments that affect the polar regions of our globe, as well as their marine environments. In 1998, the Protocol on Environmental Protection to the Antarctic Treaty came into force, and entered the phase of implementation.[1] As to the Arctic, the post-Cold War decade of regional collaboration has resulted in various outcomes as well: in particular the 1997–8 publication by the Arctic Monitoring and Assessment Programme (AMAP) of the two *Arctic Pollution Issues* reports,[2] and the current development of an Arctic Council Action Plan to Eliminate Pollution of the Arctic – though with some still-pending options for a follow-up on the level of regional policy. At the global level, vital developments have been the entry into force of the United Nations Convention on the Law of the Sea, with increasingly universal participation of states,[3] as well as the emergence of other global instruments and arrangements relevant to the polar marine environment.

This book has been prompted largely by those developments. We wish to examine various approaches to protecting the polar marine environment – at the global, regional, sub-regional and domestic levels – and their actual application in selected issue-areas of marine pollution in polar oceans. Let us begin by posing some basic questions.

1. In respect of the various global instruments of environmental protection: to what extent are they *applicable* to the Arctic Ocean and the Southern Ocean?
2. In respect of the more specific arrangements worked out at the regional, sub-regional or national level: are they *sufficient*?

[1] The Protocol was signed in Madrid, on 4 October 1991, and entered into force on 14 January 1998. Text reprinted ILM, Vol. 30, 1991, pp. 1,416ff. On issues involved in implementation of the Protocol see D. Vidas (ed.), *Implementing the Environmental Protection Regime for the Antarctic* (Dordrecht: Kluwer Academic Publishers, 2000).

[2] *AMAP Assessment Report: Arctic Pollution Issues* (Oslo: Arctic Monitoring and Assessment Programme, 1998); and *Arctic Pollution Issues: A State of the Arctic Environment Report* (Oslo: Arctic Monitoring and Assessment Programme, 1997).

[3] UN doc. A/CONF.62/122, 10 December 1982; text reprinted in ILM, Vol. 21, 1982, pp. 1,261ff. As at 8 June 1999, there were 130 parties to the Convention.

Why focus specifically on the polar regions? And why approach protection of their marine environments in a comparative fashion? As to the latter question, despite the abundance of studies on marine environmental protection, comparative studies of different regional marine environment protection regimes are still rare.[4] As we leave the 1990s, it is timely to assess marine environmental protection regimes applicable to the two polar regions which have witnessed such vital developments in the course of the decade. Moreover, the realities of the Arctic and Antarctic pose additional, unique challenges. Both polar oceans have distinctive features that render them special 'polar cases' in many respects, where solutions agreed for warmer seas may not be sufficient nor readily applicable. On the other hand, there is also the mutual polarisation of the Arctic and Antarctic, due to differences in their socio-economic and political settings.

AREAS DEALT WITH IN THIS BOOK

In the context of the law and policy of marine environmental protection, and pollution prevention in particular, we will be interested in *extremes* in global proportions. Our focus will be on a very special part of the global environment – the vast polar ocean areas, largely frozen on the surface but teeming with life beneath their cold covers. The Arctic Ocean and the Southern Ocean are special in the geographical and geophysical sense – situated at the 'ends of the earth', with their extreme conditions, in contrast to all the other, more temperate seas of our world. And they are special in the political and legal sense, not least since the problems of the polar oceans often seem to remain equally remote in the context of global instruments for marine environmental protection – which in turn may diminish any truly global application of their provisions.

Disregarding for a moment both their unique features and the impact of the Arctic and Southern Oceans on the global environment, their sheer size deserves closer notice. The combined surface of the two polar oceans would cover an area approximately five times the size of Europe. *Approximately*, since it is difficult to reach consensus on how to define the Arctic or the Antarctic regions, and, accordingly, to delimit precisely their maritime area; estimates vary by millions of square kilometres, with the criteria depending on the specific context.[5]

[4] See E. Franckx and M. Pallemaerts, 'Conference on "Toxic Reductions Programmes in the North Sea and Baltic Sea: A Comparative Perspective" – Introduction', *International Journal of Marine and Coastal Law*, Vol. 13, 1998, pp. 300–1, and the literature referred to therein.

[5] For example, while an area of approximately 14 million km^2 is most often referred to as the size of the Arctic Ocean, there are considerable variations. The esteemed *Encyclopaedia Britannica*, for instance, varies by almost 2 million km^2: compare 'The Arctic', in *The New Encyclopaedia Britannica, Macropaedia*, Vol. 14, 15th edn (Chicago: Encyclopaedia Britannica, 1986), p. 6, where the surface of the Arctic Ocean is estimated at 12,257 million km^2, with 'Oceans' in *ibid.*, Vol. 25, p. 125, which sets it at 14,090 million km^2. Another assessment adds a further 1 million km^2 to the latter figure, thus yielding a total figure of about 15 million km^2; see Working Group on the Protection of the Arctic Marine Environment, *Report to the Third Ministerial Conference on the Protection of the Arctic Environment, 20–21 March 1996, Inuvik, Canada* (Oslo: Norwegian Ministry of the Environment, 1996), p. 21. For AMAP, marine areas assessed cover approximately 20 million km^2; see *A State of the Arctic Environment Report*, p. 10.

As to the Arctic, that criterion may be based on, *inter alia*, climatic (10°C July isotherm), biological (the tree-line) or geographical (the Arctic Circle, i.e. 66°32′ North latitude) circumstances – to mention only those most often put forward. Thus, the geographer will disagree with the biologist, and both will disagree with the physicist; and this difficulty is further multiplied if we seek a definition of the Arctic relevant for *all* areas of science, including social science and international law. Moreover, policy-makers will often disagree with everyone else, as well as among themselves. Consequently, each of the eight Arctic countries – Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States – has adopted its own definition of the 'Arctic'.[6]

As to the extent of the Antarctic region, the question is complex as well, although made somewhat easier by the isolation of the continent of Antarctica from other landmasses. Moreover, there is the phenomenon of the Antarctic Convergence, which is significant as both the oceanographic and ecosystemic boundary.[7] However, the political and legal context of the Antarctic does not always permit its spatial extension to this Convergence.[8]

This all means that we will have to supplement any exclusively *spatial* determination of either the Arctic or the Southern Ocean with a *functional* criterion, concentrating on the patterns of use, as well as a *political* criterion, based on actual cooperation between states in respect of a certain area thus agreed as referring to a 'region'.[9] Here we must bear in mind the close natural interaction between the marine and terrestrial areas within the polar regions, all the while seeing the two polar oceans as integral parts of the Arctic and Antarctic regions in terms of their socio-economic and political settings.

It may make sense to use the notion of 'polar oceans' as a generic term when contrasting them to other, warmer oceans, but one question demands clarification at the outset: to what extent are the two polar regions comparable at all? And is there any benefit to be gained from treating them jointly? Let us begin by reviewing the basic differences and similarities of the two polar regions.

THE ARCTIC AND ANTARCTIC REGIONS: SIMILARITIES AND CONTRASTS

Do the polar conditions of both the Arctic and Antarctic make these two regions not only *special* but also *similar* cases, in terms of the international

[6] In calling those *eight* countries the 'Arctic countries', the criterion used by the Arctic Environmental Protection Strategy and the Arctic Council, respectively, has been followed.

[7] On the Southern Ocean in general, see Sir George Deacon, *The Antarctic Circumpolar Ocean* (Cambridge University Press, 1984). On the phenomenon of the Antarctic Convergence in particular, see *ibid.*, pp. 114–19; and on its significance as the natural boundary of the Antarctic ecosystems see M. W. Holdgate, 'The Use and Abuse of Polar Environmental Resources', *Polar Record*, Vol. 22, 1984, p. 28.

[8] See the discussion by Vidas, Chapter 4 in this book. See also Boyle, Chapter 1 in this book.

[9] For further discussion on understanding the scope of a 'region' as applied to the polar regions and their maritime space, see especially Boyle, Chapter 1 in this book. See also Vukas, Chapter 2; and Stokke, Chapter 6 in this book.

regulation needed for their environmental protection – from which some appropriate 'polar approaches' should be required? Or do their many different socio-economic and political features make the two regions as diametrically opposed as they are in terms of their geographical location and the resulting semantics behind their names: Arctic and *Anti*-Arctic?

Contrasting features

Chiefly as a consequence of major differences in the social, strategic and economic conditions of the two polar regions, they do differ considerably in legal and political terms. When the 1996 Antarctic Treaty Consultative Meeting reviewed the possible mutual relevance of developments in the Arctic and the Antarctic, the emphasis was on:

> the need to bear in mind that, as far as co-ordination was concerned, the political and legal context governing activities in the Arctic and the Antarctic differ considerably.[10]

Indeed, the Arctic still lacks any counterpart to the Antarctic Treaty System, governing the whole spectrum of human activities in the Antarctic with an increasing reliance on 'hard' law.[11] Cooperation among the Arctic Eight has emerged only since the late 1980s, and formally since 1991 within the framework of the Arctic Environmental Protection Strategy.[12] This has been a process based on declarations, i.e. on 'soft' law. Even the Arctic Council has been established, not by an international treaty, but by a declaration.[13] Clearly, these cooperative fora are placed in contrasting social, strategic and economic settings, and here several important differences between the two polar regions emerge.

First, there are *indigenous peoples* inhabiting the Arctic coasts, whereas Antarctica has no native human inhabitants.[14] This very absence of a native population in the Antarctic was, at the time when the Antarctic Treaty was being negotiated,[15] seen as a major factor favouring the founding of what later became the Antarctic Treaty System. A passage from the 1960 US Senate hearings on the ratification of the Antarctic Treaty may serve to illustrate this point:

[10] See paras. 33–7 of the *Final Report of the Twentieth Antarctic Treaty Consultative Meeting, Utrecht, the Netherlands, 29 April–10 May 1996* (The Hague: Netherlands Ministry of Foreign Affairs, 1997).

[11] For a comprehensive review see O. S. Stokke and D. Vidas (eds.), *Governing the Antarctic: The Effectiveness and Legitimacy of the Antarctic Treaty System* (Cambridge University Press, 1996).

[12] Arctic Environmental Protection Strategy, with the Action Plan, was adopted at the First Ministerial Conference on the Protection of the Arctic Environment, at Rovaniemi, Finland, on 14 June 1991. Text reprinted in ILM, Vol. 30, 1991, pp. 1,624ff.

[13] The Arctic Council was established as a 'high level forum' by the Declaration on the Establishment of the Arctic Council, signed by the Arctic Eight in Ottawa, Canada, on 19 September 1996; text reprinted in ILM, Vol. 35, 1996, pp. 1,387ff.

[14] Compare 'Peoples of the North', in *A State of the Arctic Environment Report*, pp. 51–69, with J. C. M. Beltramino, *The Structure and Dynamics of Antarctic Population* (New York: Vantage Press, 1993). Actually, there is some 'native population' even in Antarctica – a dozen or so babies born in Argentine and Chilean scientific bases there.

[15] The Antarctic Treaty was signed in Washington, DC, on 1 December 1959, and entered into force on 23 June 1961; published in UNTS, Vol. 402, pp. 71ff.

SENATOR LAUSCHE: Do you visualize this as an area which, under present conditions, lends itself most favorably to international administration?

MR JESSUP: It clearly is my opinion, Senator, that it has that quality more than any other place on earth, partly because one does not need to deal here with an indigenous population.[16]

In the Arctic context, on the contrary, the presence and demands of the indigenous population may be seen as a factor which prompted the establishment of the Arctic Council, not least linked with domestic policy concerns, especially in Canada and Denmark/Greenland. Nevertheless, while the Antarctic Treaty System is a true form of international administration, the Arctic Council is still largely confined to international consultation.

Secondly, the *strategic importance* of the Arctic, although in military terms significantly diminished in the post-Cold War period,[17] is still far greater than that of the Antarctic. True, this aspect now represents a considerably less striking difference between the two polar regions than only a decade or so earlier. For instance, in 1994 the US administration made an inter-agency review of its Arctic policy, listing environmental protection at the top and thus (at least nominally) 'downgrading' national security and defence considerations.[18] On the other hand, freedom of navigation has traditionally been the strategic military interest of the US Navy, globally as well as Arctic-regionally; and in the latter context particularly when it comes to submarine operations.[19] These concerns are largely distinct from environmental considerations.

This difference is clearly reflected in the constitutive documents of the two regional cooperative processes. While demilitarisation of the Antarctic figures among the basic principles of the Antarctic Treaty, which prohibits any measure of a military nature in the Antarctic,[20] the Arctic Council Declaration expressly states that the Council is *not* to deal with matters related to military security.[21] Instead, environmental protection related to military activity in the Arctic is, on the international level, relegated to separate arrangements among individual states, such as the trilateral Declaration on Arctic Military Environmental Cooperation signed between Russia, the United States and Norway in September 1996.[22]

[16] *Hearings Before the Committee on Foreign Relations, United States Senate, 86th Cong., 2nd Sess., 14 June 1960* (Washington, DC: US Government Printing Office, 1960), p. 55.

[17] See W. Østreng, 'The Post-Cold War Arctic: Challenges and Transitions During the 1990s', in D. Vidas (ed.), *Arctic Development and Environmental Challenges* (Copenhagen: Scandinavian Seminar College, 1997), pp. 33–49.

[18] See 'United States Announces New Policy for the Arctic Region', Press Release of the US Department of State, 29 September 1994. See comments by D. Scrivener, 'Environmental Cooperation in the Arctic: From Strategy to Council', *Security Policy Library*, No. 1 (Oslo: Norwegian Atlantic Committee, 1996), p. 22; and F. Griffiths, 'Environment in the US Discourse on Security: The Case of the Missing Arctic Waters', in W. Østreng (ed.), *National Security and International Environmental Cooperation in the Arctic – The Case of the Northern Sea Route* (Dordrecht: Kluwer Academic Publishers, 1999), pp. 179–203.

[19] See Griffiths, 'Missing Arctic Waters', pp. 197–8. See also Brubaker, Chapter 10 in this book.

[20] Preamble to and Art. I(1) of the Antarctic Treaty.

[21] See explanatory note to para. 1(a) of the Arctic Council Declaration.

[22] Text available at www.denix.osd.mil/denix/Public/Intl/AMEC/declar.html.

Thirdly, various *economic uses*, some of them quite extensive, are present in the Arctic, including the Arctic Ocean. A direct consequence of the differing nature and scope of economic uses of the two polar regions and their oceans – a difference highly relevant to the themes of this book – concerns the type and scale of *sources* of marine pollution situated *within* the polar regions. Of prime importance in this respect, the presence and intensity of land-based sources (by far the largest single source of marine pollution in global terms) in the two polar regions are quite different. Large urban settlements, ports and harbours and other coastal developments, and not least centres of heavy industry – all present in parts of the Arctic, the Russian Arctic in particular – are either absent or negligible in the Antarctic.[23] While some 3.8 million people live in the Arctic region (as assessed by AMAP[24]) approximately 15,000 tourists visit Antarctica annually for shorter periods, and few scientists and station personnel, barely exceeding 1,000 in total, stay year-round.[25] The largest – indeed the only – Antarctic 'town', Villa las Estrellas on King George Island off the Antarctic Peninsula, numbers 50 inhabitants; there can of course be no comparison with Arctic centres such as Murmansk, with its population of close to half a million (and over 1 million in Murmansk *Oblast*). The industrial complexes in the Norilsk area and on the Kola Peninsula, comprising the world's largest nickel-copper smelter, Severonickel, as well as Pechenganickel, are of quite a different order from even the most densely concentrated Antarctic land-based sources of marine pollution: less than two dozen scientific stations and bases, with their related facilities, scattered on King George Island and on the tip of the Antarctic Peninsula.

In contrast to the Arctic, which according to some estimates 'may contain some of the world's largest petroleum reserves . . . located both on land and on the continental shelves',[26] the Antarctic coastal areas have yielded only some indications of mineral resources but no real discoveries. A study made by the US Congress Office of Technology Assessment confirmed that, in the Antarctic, 'there are no known mineral deposits of commercial interest'; it concluded that it 'does not expect that either an oil deposit or metal mine would be developed in Antarctica sooner than about three decades, if ever'.[27] For this reason and others, to be discussed in greater detail in Chapter 4 of this book, all mining in the Antarctic has been prohibited.[28]

There is one other prohibition in force in the Antarctic – that related to the disposal of radioactive waste material.[29] The Arctic, by contrast, is characterised by

[23] See VanderZwaag, Chapter 8 in this book.
[24] *AMAP Assessment Report*, p. 142; on the AMAP area see *ibid.*, pp. 9–10.
[25] See Beltramino, *The Structure and Dynamics of Antarctic Population*. For up-to-date Antarctic tourism statistics, see the website of the International Association of Antarctica Tour Operators, www.iaato.org.
[26] *A State of the Arctic Environment Report*, p. 146.
[27] US Congress, Office of Technology Assessment, *Polar Prospects: A Minerals Treaty for Antarctica* (Washington DC: US Government Printing Office, 1989), pp. 3 and 17.
[28] For the law of the sea implications of this prohibition see D. Vidas, 'Southern Ocean Seabed: Arena for Conflicting Regimes?', in D. Vidas and W. Østreng (eds.), *Order for the Oceans at the Turn of the Century* (The Hague: Kluwer Law International, 1999), pp. 291–314.
[29] See Art. V(1) of the Antarctic Treaty.

the high density of nuclear sources. Questions concerning the storage of spent nuclear fuel, nuclear reactors on land as well as on submarines and icebreakers, and the special issue of decommissioned nuclear submarines – all these represent problems for the Arctic environment, and that of the Russian Arctic especially. The problem of disposal of radioactive waste, and its dumping in the Arctic Ocean in particular, has attracted considerable attention in recent years.[30]

On the other hand, some uses of the two polar oceans are similar in nature, shipping being the most important among these; ice conditions prevail in both the Arctic and the Southern Oceans.[31] However, as a consequence of different geography and human activities, shipping patterns differ considerably. Shipping routes in the Arctic are long circular ones, often passing close to coastlines and through waters under the sovereignty of Arctic coastal states, where different domestic legislation on various ice navigation regimes applies.[32] By contrast, in approaching the Antarctic, shipping has a north–south orientation, traffic volumes are considerably smaller, and there are no domestic navigation regimes in force.

Also several other uses of the polar oceans may be similar in nature, for instance harvesting of marine living resources, scientific research, and tourism. As is the case with shipping, they too will often differ considerably in intensity and patterns.

It should be borne in mind that the sources of pollution affecting the polar oceans do not originate solely within the respective polar regions. *Extra-regional* sources of pollution, often remote from the polar areas themselves, may exert a significant impact on the polar marine environment. Indeed, sources situated at one pole may affect the environment of the other pole. Camplin and Hill have described a typical journey for a nuclide dumped in the cold Arctic water, travelling through the Atlantic, finally reaching the bottom waters of the Southern Ocean, and surfacing in Antarctica, in waters mixed vertically by surface cooling.[33] Recent reports indicate the presence of persistent organic pollutants of extra-regional origin in both polar regions,[34] although it is in the Arctic that this type of environmental contamination may exert significant effects on the indigenous population, for whom local foods remain important dietary and cultural resources.[35]

[30] See Stokke, Chapter 9 in this book. See also S. G. Sawhill, 'Cleaning-Up the Arctic's Cold War Legacy: Nuclear Waste and Arctic Military Environmental Cooperation', *Cooperation and Conflict*, Vol. 35, 2000, pp. 5–36. For an overview of radioactivity in the Arctic, see especially P. Strand, 'Radioactivity', in *AMAP Assessment Report*, pp. 525–620.

[31] On these features, and on the background for the development of an International Code of Safety for Ships in Polar Waters (Polar Code), see Brigham, Chapter 11 in this book.

[32] For Russian regulation of navigation in the Northern Sea Route see Brubaker, Chapter 10 in this book.

[33] W. C. Camplin and M. D. Hill, 'Sea Dumping of Solid Radioactive Waste: A New Assessment', *Radioactive Waste Management and the Nuclear Fuel Cycle*, Vol. 7, 1986, p. 242.

[34] See *Global Environment Outlook 2000: UNEP's Millennium Report on the Environment* (London: Earthscan Publications, 1999), pp. 177–96; and 'Persistent Organic Pollutants', in *AMAP Assessment Report*, pp. 183–371.

[35] See 'Peoples of the Arctic: Characteristics of Human Populations Relevant to Pollution Issues', in *AMAP Assessment Report*, pp. 141–82.

And, finally, although there are *sovereignty disputes* in both polar oceans, they too differ in nature. In the Antarctic such disputes relate to the uncertain status of sovereignty claims; in the Arctic they concern maritime delimitation. In the first half of the twentieth century, seven states – Argentina, Australia, Chile, France, New Zealand, Norway and the United Kingdom – put forward territorial claims to parts of the Antarctic. None of these claims has been expressly recognised by any other country apart from fellow claimants,[36] and even then only partially. Eventually, the seven claimant countries and other parties to the 1959 Antarctic Treaty agreed to put aside their competing positions on territorial claims in the Treaty area, and achieved an 'agreement to disagree' on the sovereignty issue (Article IV), for the sake of establishing a unique form of international governance for the Antarctic.[37] By contrast, in the Arctic there are several generally recognised sovereign coastal states, but several maritime boundaries and jurisdictional zones are disputed among them.

Sharing polar conditions

Notwithstanding all their differences, the Arctic Ocean and the Southern Ocean are both unquestionably characterised by polar conditions. Conventional wisdom tends to see this as the major feature that makes the two similar and thereby different from the rest of the world's oceans. The two polar oceans do share several important characteristics – despite their sharply different placement within the respective polar regions.[38]

Their *oceanographic boundaries* are specific to the polar oceans. The Southern Ocean, while not encircled by any landmass, is bound entirely by the Antarctic Convergence. This is a zone situated mainly between the 50° and 60°S (though extending towards 45°S in the meeting area with the Western Indian Ocean), which separates the cold, ascending and extremely productive waters of the Antarctic from the warmer, biologically less significant waters of the Pacific, Atlantic and Indian Oceans.[39] As to the Arctic, it too has a convergence as a marine boundary, in the zone where cold and diluted water meets warmer and saltier water from the south.[40] The Arctic Ocean is, in addition, almost completely encircled by the landmasses of North America, Eurasia and Greenland. Of the four openings, only one of these is a deep channel that connects the Arctic Ocean to the world

[36] The single possible exception being South Africa's implicit recognition of the Norwegian claim in 1959, in relation to use of an old Norwegian base in Queen Maud Land; see W. M. Bush, *Antarctica and International Law: A Collection of Inter-State and National Documents*, Vol. III (London: Oceana Publications, 1988), pp. 171 and 195.

[37] See an overview in D. Vidas, 'The Antarctic Treaty System in the International Community: An Overview', in Stokke and Vidas (eds.), *Governing the Antarctic*, pp. 35–60.

[38] While the Southern Ocean entirely surrounds the isolated continent of Antarctica, the Arctic Ocean is – quite the contrary – placed in the centre of the Arctic region, surrounded by continental landmasses.

[39] See *The Times Atlas of the Oceans* (London: Times Books, 1983), p. 51.

[40] On this phenomenon, and the coordinates of this convergence in the Arctic, see *A State of the Arctic Environment Report*, p. 7.

ocean space: this is the passage between the islands of Svalbard and Greenland (the Fram Strait), through which the major circulation of waters into and from the Arctic Basin occurs.[41]

Ecosystems found within these oceanographic and biological boundaries possess specific characteristics. While the living resources of the Arctic Ocean and those of the Southern Ocean differ greatly in various respects, they nevertheless share some important features, as a consequence of polar conditions.[42] First, the food chains of species inhabiting polar waters are characteristically short and simple, with a low number of species but large populations.[43] Secondly, their polar setting means short, site-specific breeding seasons. This in turn makes these living resources more exposed to environmental risks, an easy prey to any degradation of the polar environment. Those two specific polar features make the marine living resources of the polar oceans, while otherwise not necessarily fragile, extremely vulnerable to impacts of human activities. At the same time, the polar marine ecosystems are among the most productive in the world, as cold water is rich in the nutrients essential to marine life.

The presence of *ice*, and sea ice in particular, is one other notable feature common to both polar oceans. Most of the Arctic Ocean surface is covered by sea ice: while the perennial pack ice covers about 8 million km^2, the extent of sea ice is almost double between March and May, when it can cover as much as 15 million km^2.[44] Also, much of the Southern Ocean is covered with ice, though with considerably greater seasonal fluctuation than in the Arctic Ocean.[45] Ice formations do, it is true, differ considerably in the Arctic and the Antarctic. Basically, however, the presence of large areas of ice-infested waters, with the concomitant significantly higher exposure to environmental risks when compared with most areas of the warmer seas, makes the Arctic and the Southern Oceans similar as well as unique in global terms. The persistence of oil as a pollutant in ice-covered sea areas, in combination with the harsh climatic conditions which diminish the efficacy of available oil-slick clean-up methods and equipment, especially makes both polar oceans equally in need of special rules for safety of navigation. Oil spilled on or under ice cannot be cleaned by technologies used in warmer waters, and response capability is very limited. In such special conditions, the emphasis will have to be on the prevention of pollution, instead of remedial measures.

[41] *Ibid.*, pp. 10–11 and 31–2. See also *The Times Atlas of the Oceans*, pp. 24, 50–2 and 62–3; and 'The Arctic', in *Encyclopaedia Britannica*, pp. 6–7.

[42] See K. Sherman, 'Large Marine Ecosystems', in *Encyclopedia of Earth System Science*, Vol. 2 (New York: Academic Press, 1992), pp. 653–7, 661–2.

[43] For the European Arctic see J. R. Hansen, R. Hansson and N. Norris (eds.), *The State of the European Arctic Environment* (Copenhagen: European Environment Agency, 1996), p. 33; for the Antarctic see G. A. Knox, 'The Living Resources of the Southern Ocean: A Scientific Overview', in F. Orrego Vicuña (ed.), *Antarctic Resources Policy: Scientific, Legal and Political Issues* (Cambridge University Press, 1983), pp. 21–60.

[44] *A State of the Arctic Environment Report*, p. 12. See also Brigham, Chapter 11 and Figure 11.1, in this book.

[45] See Deacon, *The Antarctic Circumpolar Ocean*, p. 121; and Brigham, Chapter 11 and Figure 11.1, in this book.