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ARTICLE: From the Harpoon to the Heat: Climate Change and the International Whaling Commission in the 21st Century

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SUMMARY:
... As identified by the IWC's Scientific Committee, the term "environmental change" encompasses the following: climate change, chemical pollution, physical and biological habitat degradation, effects of fisheries, ozone depletion and UV-B radiation, Arctic issues, disease and mortality events, and the impact of noise. ... Part II of this article will discuss the potential ramifications of climate change for cetacean species. ... The Intergovernmental Panel on Climate Change in its most recent regional assessment concluded that projected warming trends in the Arctic over the next century could result in a further fifty percent decline of sea ice. ... CETACEANS AND CLIMATE CHANGE: PROSPECTS IN THE NEXT CENTURY ... It is difficult to be sanguine about the prospects for the IWC to effectively address the threats that cetacean species may face from climate change. ... This could provide additional protection for cetacean species that may be threatened by climate change by precluding direct exploitation. ... Thus, many potential impacts of climate change, including impacts on cetacean species, may be inevitable. Moreover, averting the climate change impacts beyond the middle of the next century will require far more dramatic reductions in greenhouse gas emissions. ... The IWC's recognition of the need to address environmental change issues, including the possible impacts of climate change on cetaceans, is laudable. However, its limited research resources and the speculative future of the UNFCCC likely means that cetaceans will face increasing threats from climate change in the next century. ...

HIGHLIGHT: *While we debate the limits that should be placed on whaling in order to protect the status of the stocks, a silent menace threatens to destroy the populations we strive to protect.*

--D. James Baker n1

TEXT:

[*335] I. INTRODUCTION

The 50th Meeting of the parties to the International Convention for the Regulation of Whaling (ICRW), n2 held in Oman in May 1998, may ultimately be recognized as a watershed in the history of the International Whaling Commission's (IWC) efforts to manage and conserve cetacean species. While the primary focus of most meetings of the IWC during its first half century was on regulating the harvesting of regulated species, IWC50 was dominated by questions of how [*336] to confront perhaps the gravest long-term threat to cetaceans: environmental change. As identified by the IWC's Scientific Committee, the term "environmental change" encompasses the following: climate change, chemical pollution, physical and biological habitat degradation, effects of fisheries, ozone depletion and UV-B radiation, Arctic issues, disease and mortality events, and the impact of noise. n3 The purpose of this article will be to assess the implications of what could prove to be one of the direst of these threats for the viability of cetacean species--climate change--and the role of the IWC in seeking to ameliorate climate change impacts. Part II of this article will discuss the potential ramifications of climate change for cetacean species. Part III will outline the history of the IWC's treatment of climate change issues. Finally, Part IV will assess the viability of the IWC's strategies to protect cetaceans from climate change in the next century and the role of other institutions, including the United Nations Framework Convention for Climate Change and the Convention for the Conservation of Antarctic Marine Living Resources.

II. CLIMATE CHANGE AND CETACEANS

A. CLIMATE CHANGE SCENARIOS

This section will briefly explain the "greenhouse effect" and projected warming trends over the next century, and then seek to assess the possible implications for cetaceans.

The surface of the Earth is heated by solar radiation emanating from the sun at short wavelengths between 0.15 and 5 [mu]m. Approximately one-third of incoming solar radiation is reflected back to space in the form of thermal infrared, or longer-wave radiation, at wavelengths of 3-50 [mu]m with the remainder being absorbed by land, ocean, and ice surfaces. n4

Some of the outgoing infrared radiation is absorbed by naturally occurring atmospheric gases--principally water vapor (H[2]O)--as well as carbon dioxide (CO[2]), ozone (O[3]), methane (CH[4]), nitrous oxide (N[2]O), and clouds. n5 This absorption is termed the "natural greenhouse effect," because these gases, which are termed "greenhouse gases," operate much like a greenhouse--they are "transparent" to incoming short-wave radiation, but "opaque" to outgoing infrared radiation, trapping a substantial portion of such radiation and re-radiating [*337] much of this energy to the earth's surface. n6 This process is critical to the sustenance of life on earth, elevating surface temperatures by about thirty-three degrees Celsius. n7

In the past, the net incoming solar radiation at the top of the atmosphere was balanced by net outgoing infrared radiation, contributing to climatic stability. n8 However, with the advent of fossil fuel burning plants to support industry, automobiles, and the energy demands of modern consumers, "humans began to interfere seriously in the composition of the atmosphere." n9

The burning of fossil fuels, mainly coal, oil, and gas, has soared since the beginning of the Industrial Revolution, producing approximately 5.5 gigatons of carbon annually in recent years, nearly all of which enters the atmosphere as CO[2]. n10 As a consequence, concentrations of carbon dioxide in the atmosphere have increased approximately twenty-five percent since 1850 n11 --from 270-280 parts per million (ppm) by volume in pre-industrial times to over 360 ppm today--with most of the increase occurring in the past fifty years. n12 Anthropogenic activities have also resulted in substantially increased atmospheric concentrations of other greenhouse gases, including methane and nitrous oxides, n13 as well as new sources, including chlorofluorocarbons and halons. n14

[*338] Human-driven buildup of greenhouse gases in the atmosphere results in greater absorption of outgoing infrared radiation, and ultimately an increase in temperature when a portion of this radiation is reflected back to the

Earth's surface. This phenomenon is known as "radiative forcing." n15 Climate researchers have concluded that increased concentrations of greenhouse gases are responsible for the increase in average global temperatures of about 0.6 degrees Celsius in the past century. n16 However, possible climate change in the next hundred years is the cause of researchers' greatest trepidation.

Projected increases in atmospheric greenhouse gases over the next century could elevate temperatures on Earth by three degrees Celsius or more by the year 2100, n17 with the trend accelerating thereafter. n18 While this may seem like a slight shift in temperatures, it would constitute "a change, although gradual, unparalleled [*339] in recent millennia." n19 A comparison to past changes of this magnitude demonstrates the possible implications:

> The last time it was three degrees [Fahrenheit] warmer than now was 100,000 years ago. Then, Central Europe had a climate like Africa's. And just three degrees separate today from the other climatic extreme, the last ice age of 10,000 years ago. Then, half of Europe lay under ice, and the sea level was 390 feet lower than it is today. A bitter north wind nipped at the ears of the polar bears living atop the frozen Baltic . . . Since the end of the last ice age, average global temperatures have never fluctuated by more than one degree. n20

B. CETACEANS AND CLIMATE CHANGE

In assessing the possible impacts of climate change on cetaceans, it must be emphasized at the outset that our ability to assess future impacts at the regional level, which is critical for ascertaining the possible ramifications for many cetacean species, n21 remains limited. n22 Climate model researchers use computer models, derived from weather forecasting, to represent the Earth's energy and water cycles and to predict how enhanced levels of greenhouse gases will affect the Earth's climate. The most sophisticated of these models, general circulation models (GCMs), use a three dimensional grid overlaying the surface of the earth with grid points a few hundred kilometers per side, within which cells are stacked about twenty layers deep. n23

Vertical layers of the model represent levels in the atmosphere and depths in the ocean, dividing the surface of the planet into a series of horizontal boxes separated by lines similar to latitudes and longitudes. n24 Within each grid point, a series of equations are run on a super-computer, producing simulations of key climatic components, including wind, air-pressure, temperature, humidity, ice coverage, and land surface processes. n25 Climate models are usually run for [*340] several simulated decades, with the derived results compared to actual statistics on climatic indicia, such as mean temperatures and precipitation, over this period. Subsequently, the models are run with changes in external forcing, such as projected increases in atmospheric greenhouse gas concentrations over a series of decades or centuries. "The differences between the two climates provide an estimate of the consequent climate change due to changes in that forcing factor." n26

However, as Solman and Nunez recently observed, computer models remain crude instruments for regional climate projections:

> [General circulation models] have difficulty in reproducing regional climate patterns, and large discrepancies are found among models. In many regions of the world, the distribution of significant surface variables, such as temperature and rainfall, are often influenced by the local effects of topography and other thermal contrasts, and the coarse spatial resolution of the GCMs can not resolve these effects. n27

Climate researchers have developed several strategies to conduct regional assessments. Nested models seek to simulate regional climates by the application of limited area models nested in a GCM. n28 In recent years, some of these models have yielded high correlations between regional climate predictions and observed climatic phenomena, including precipitation, thermal inertia of water bodies, and temperature. n29 Downscaling by statistical means, or deriving statistical relationships between observed local climatic variables and large-scale variables, has also proved

successful in linking large-scale spatial averages of precipitation and surface temperature to local precipitation and temperature-time series. n30

With the caveat in mind that regional climate assessments remain speculative, recent research indicates that cetaceans may be seriously threatened by projected warming in the next century. In the Antarctic, where ninety percent of the world's great whales feed, n31 temperatures in some areas have risen more than two degrees [*341] Celsius in the last fifty years, n32 substantially greater than the world average during that period. n33 While the lack of long time-series and natural climatic variability in the region makes it impossible to definitively attribute the region's warming to climate change, n34 recent modeling by the Hadley Centre for Climate Prediction and Research provides some evidence for such a link. n35

Recent research projects that a doubling of greenhouse gases from preindustrial times could reduce sea ice in the Southern Hemisphere by more than forty percent in the next century. n36 This may have several adverse affects on the abundance of the zooplankton species krill (*Euphausiacea*), n37 the primary source [*342] of food for whales in the Southern Hemisphere. n38 First, a diminution in sea ice may lead to a decline in the productivity of algae, the primary source of food for krill during the winter. n39 Second, a reduction in sea ice could deny krill larvae critical protection from predators. Cetacean species that migrate long distances might also have to alter the timing and order of migration to follow the ice front, adversely affecting their energetics, such as feeding and reproductive biology. n40

Finally, sea ice decline could result in the proliferation of the pelagic tunicate *Salpa Thompsoni*, one of the most abundant macrozooplankton species in the ice-free and seasonal pack-ice zone of the Southern Ocean. n41 Salps persist in low numbers under sub-optimal conditions, but can rapidly proliferate when sea ice recedes and phytoplankton becomes more readily available during early spring. n42

This salp proliferation could prove disastrous for krill populations in the region. Salps could act as strong competitors of krill for food prior to the onset of phytoplankton blooms in the spring. This increased competition for food can stunt krill gonadal development, resulting in a reduction in recruitment the following year. n43 Moreover, dense salp blooms can interfere with krill reproduction and kill off their larvae. n44

Warming and possible shifts in wind patterns, could also affect the distribution and characteristics of polynyas in the Antarctic region. n45 Polynyas are areas of open waters in the polar ice pack, formed by a combination of currents, tides, [*343] upwellings, and winds. n46 While snow and ice reflect most of the sun's incident energy, dark polynya water absorbs it, resulting in nutrient upwelling and profusive blooms of phytoplankton. n47 Cetacean species that rely on ice edges for phytoplankton foraging might be adversely affected by reductions in the areal extent and latitudinal shift of ice-edge habitats. n48

The populations of several baleen whale species in the Antarctic, including blue and humpback, were decimated in the past by commercial whaling operations, n49 and blue whales may never recover. n50 Reductions in food supplies as a consequence of warming could further diminish the carrying capacity of whales in the Antarctic and push these species closer to extinction in the next century. n51

Climate change may also have grave implications for cetaceans in the Arctic. Temperatures in the region have increased several times the global rate over the past century, n52 with sea-ice thickness declining more than 40%, from 10.2 feet to 5.9 feet, since 1958, n53 and sea-ice areal extent declining between 3.0 and 4.5% per decade in the past twenty years. n54

It should be emphasized that it is difficult to establish a causal link between melting ice and anthropogenic climate change, because this phenomena could also be attributable to other factors, such as changes in precipitation and snow [*344] cover, or advective processes accompanying the North Atlantic Oscillation in the late 1980s and 1990s. n55 However, a recent study comparing satellite and surface observations with two existing computer models concluded that there was less than a 0.1% chance that ice shrinkage was due to natural cycles. n56

The Intergovernmental Panel on Climate Change in its most recent regional assessment concluded that projected warming trends in the Arctic over the next century could result in a further fifty percent decline of sea ice. n57 Richard Moritz, Director of the Surface Heat Budget for the Arctic Ocean project (SHEBA) goes further in a recent assessment, predicting that the Arctic's year-round icepack could totally disappear in fifty years. n58

Further losses of sea ice over the next century could have adverse impacts on cetaceans in the region. While no single species dominates the Arctic food chain, as does krill in the Antarctic, n59 sea ice decline associated with warming could result in the diminution of phytoplankton populations. n60 This could lead to "knock-on effects" throughout the Arctic food chain, including declines in the stocks of several key prey species of cetaceans, such as copepods and planktonfeeding [*345] fish, including Arctic cod, a key prey species for narwhal and beluga whales. n61 Some cetacean species in the region, such as fin and bowheads, have demonstrated adaptability in feeding behavior and may be able to shift to other prey species. n62 However, other species, or stocks of such species, including narwhals and belugas, might be seriously affected by the loss of ice-dependent prey species. n63

Polynyas are important spring feeding and breeding grounds for marine mammals in the Arctic, as well as overwintering sites for white and possibly bowhead whales. n64 Warming and the attendant ice melt might result in greater stratification of the water column and decreased nutrient supplies, limiting the growth of phytoplankton populations that are a critical link in the cetacean food chain in the region. n65

Projected reductions in sea ice area could also open up the Northwest Passage. This could expose cetaceans to increased ship traffic and dangers associated with mineral exploitation, as well as bycatch threats should new fishing areas appear in the region. n66 Collisions with ships have adversely affected cetacean stocks throughout the world. n67 Vessel noise may also disrupt cetacean migration patterns, n68 increase mortality through stress, n69 result in hearing loss, n70 and interfere with communications, which may result in strandings. n71 Mineral exploitation may also threaten cetaceans through [*346] pollution, n72 noise, n73 and in the case of oil and gas exploration, water dispersal during the drilling phase. n74

In other regions of the world, warming may also alter ocean upwelling patterns, fostering increased blooms of dinoflagellates, many of which produce brevitoxins. n75 Dinoflagellate blooms have been associated with the deaths of marine species throughout the world, including cetaceans in the Mediterranean. n76 The warming of tropical waters may also contribute to epizootics, such as the one that killed thousands of striped dolphins in the Mediterranean in the early 1990s, n77 and augment the spread of marine disease agents and parasites. n78

Warming trends will also likely raise ocean surface water temperatures to above twenty-six degrees Celsius in the next century. n79 This temperature increase could result in a greater exchange of energy and add momentum to the vertical exchange processes critical to the development of tropical typhoons and cyclones. n80 As a consequence, some researchers predict that the occurrence of tropical typhoons and cyclones could increase by as much as fifty to sixty percent, n81 and their intensity by ten to twenty percent. n82 Increased precipitation associated with such storms could result in more pollutants running off from land [*347] into coastal waterways inhabited by whales, n83 as well as the introduction of river-borne contaminants into Arctic waters. n84 Elevated levels of atmospheric carbon dioxide could also increase seawater acidity, potentially raising the concentration of heavy metals in ocean ecosystems, and thus exacerbating the toxic effect of these substances on cetaceans. n85

III. THE IWC AND CLIMATE CHANGE

The ICRW was entered into fifty-four years ago by fifteen nations "in the face of precipitous declines in the stocks of most important whale species" n86 to "establish a system of international regulation for the whale fisheries to ensure proper and effective conservation and development of whale stocks." n87 For the first thirty-five years of its existence, the IWC focused almost exclusively, and for the most part unsuccessfully, n88 on establishing catch quotas for the commercial whaling industry. However, at the IWC's 38th meeting the Commission's Scientific Committee acknowledged the need to assess the impact of human influences other than direct exploitation, including environmental

changes. n89 At the IWC's 44th meeting, the parties decided that the Scientific Committee should establish a regular agenda item to address environmental change issues. n90

In 1996, the Scientific Committee convened a workshop on climate change and cetaceans. n91 While observing that assessment of the possible impacts of climate change on cetaceans was "severely limited" by the limitations of climate models, [*348] the workshop concluded that "concerns about the ability of at least some cetacean populations to adapt to future conditions are justified." n92 It called on the IWC to encourage its members to join international efforts to reduce greenhouse gas emissions. n93 Additionally, the Scientific Committee invited scientists with expertise in the field to attend future Committee meetings and recommended that a future workshop be convened to review progress. n94

In the same year, the IWC endorsed the Scientific Committee's establishment of a Standing Working Group on Environmental Concerns (SWGEC) to assess the effects of environmental change on cetaceans and the Committee's proposal for increased cooperation with other organizations working on environmental change issues. n95 At the 49th meeting, the IWC endorsed the recommendations of the climate change workshop, as well as those from a meeting on pollution issues, and called on the Scientific Committee to produce detailed scientific proposals for future work on environmental concerns. It also encouraged party states to carry out relevant non-lethal research and called upon members to provide additional funds to support the work of the Scientific Committee and SWGEC. n96

At the 50th meeting, the IWC commended the body's Scientific Committee for its two ongoing initiatives on the impacts of pollutants and chemical contaminants and baleen whale habitat and prey studies related to climate change and identification of physical and biological habitat degradation and Arctic issues. n97 It also directed the Scientific Committee to accord high priority to implementing the research initiatives of the SWGEC and to produce costed proposals for non-lethal research. n98 Furthermore, the IWC addressed the critical issue of funding for such initiatives, allocating approximately US $ 170,000 from the Commission's reserves to fund environmental research in the eight priority areas [*349] identified by the Scientific Committee. n99 Additionally, the parties agreed to consider at the 51st meeting the establishment of a dedicated Environmental Research Fund and the attendance of invited participants with relevant expertise at future meetings of the Scientific Committee. n100 Finally, the parties agreed to establish a regular Commission agenda item for environmental concerns to facilitate reporting by the Scientific Committee on its progress in this context and reporting to the parties on national and regional initiatives. n101

At the 51st meeting, the IWC noted that the SWGEC had agreed to focus on one or two priority topics at each meeting to maximize its effectiveness. n102 The Scientific Committee endorsed SWGEC's decision to prioritize two programs in 2000: the Southern Ocean Whale and Ecosystem Research Programme (SOWER 2000) and POLLUTION 2000+. n103

The IWC decided to provide approximately US $ 214,000 for core funding of environmental research programs in 1999/2000. n104 However, it noted that the SOWER 2000 and POLLUTION 2000+ programs would cost more than US $ 510,000 in the first year alone, n105 and called upon parties to the IWC, other governments, international organizations, and other bodies to provide supplemental funding for the programs. n106 At the 52nd Meeting of the parties earlier this year, the IWC observed once again that the Scientific Committee's available funding for environmental initiatives was insufficient to facilitate implementation or development of these programs. n107

The SOWER 2000 research program should yield data relevant to the possible impacts of climate change on cetaceans. In cooperation with the Commission for the Conservation of Antarctic Marine Living Resources, n108 and the Southern [*350] Ocean Global Ocean Ecosystems Dynamics (GLOBEC) program, n109 the SWGEC will conduct an international survey program with two major components: abundance estimates of minke whales and other baleen whales, and an assessment of the status of Southern Hemisphere blue whales. n110 The IWC hopes that this research will facilitate mapping of cetacean distribution and abundance in [*351] relation to krill distribution in the Antarctic and possible changes in cetacean foraging behavior in response to changes in krill abundance and distribution. n111

IV. CETACEANS AND CLIMATE CHANGE: PROSPECTS IN THE NEXT CENTURY

A. THE INSTITUTIONAL ROLE OF THE IWC IN PROTECTING CETACEANS FROM CLIMATE CHANGE

It is difficult to be sanguine about the prospects for the IWC to effectively address the threats that cetacean species may face from climate change. First, it is doubtful whether the IWC possesses, or will be able to cobble together, the financial resources necessary to conduct meaningful climate research. Cetacean research is extremely expensive because many species are highly migratory and rarely come near land. n112 As a consequence of the cost-prohibitive nature of such research, "there are few cases where whale or dolphin populations have been studied for long enough to determine their overall status, let alone identify the key environmental factors which control populations." n113 Cetacean research in the context of climate change will be particularly costly. Climate modeling is a very expensive proposition and research in the context of cetaceans will necessitate extensive modeling. For example, in the Arctic, modeling will be required to ascertain an imposing suite of relevant indicia, including regional ice dynamics, winds, mesoscale features, and mechanisms of nutrient resupply. n114

Yet, the parties to the IWC allocated less than US $ 200,000 at the 50th meeting to address the impact of *eight* major environmental threats to cetaceans. n115 As indicated above, the parties at the 51st meeting did provide additional funding for the 1999/2000 research program, which includes a climate change component, but they acknowledged a US $ 300,000 shortfall for the first year of the program alone.

It is unlikely that the parties will be forthcoming with substantial additional funding for environmental research. As Burke observed, the "IWC is . . . given little or no capacity of its own to increase knowledge and understanding of whales . . . It must rely on member states and on private groups, neither of which [*352] can be presumed to do objective science or to interpret conditions without bias." n116 Given the incredible rancor that characterizes IWC deliberations in this era, primarily over whether the commercial moratorium on whaling imposed in the 1980s should be lifted, n117 it is difficult to believe that the parties will bolster the Secretariat's autonomy by providing it a substantial new source of funding. n118

Even assuming, *arguendo*, that the IWC will be able to conduct adequate research on its own or in cooperation with other agencies, its ability to protect cetaceans from climate change may be extremely limited. Should the moratorium on commercial whaling be lifted in the future, quotas will be the Revised Management Scheme (RMS). The RMS is a mechanism for estimating the abundance of discrete species and sustainable catch limits, as well as to establish methods to ensure such limits are adhered to. It consists of the Revised Management Procedure, "a framework to assess the viability of exploiting discrete stocks of cetaceans to facilitate the establishment . . . of sustainable harvesting quotas for said stocks," and several other components, including an [*353] inspection and observation scheme to deter cheating. n119 The IWC should be encouraged to incorporate possible climate change impacts into the RMS framework. Unfortunately, this will do little to protect cetaceans most vulnerable to climate change because the depleted status of most species would preclude the setting of catch quotas for more than one or two species in the near future. n120 Thus, if the IWC is going to protect vulnerable species from climate change, this protection will have to occur outside the IWC's framework for the establishment of harvesting quotas.

The parties could also vote to expand the boundaries of existing sanctuaries established by the IWC in the Pacific sector of the Southern Ocean, the Southern Hemisphere, and the Indian Ocean, n121 or to create new sanctuaries. This could provide additional protection for cetacean species that may be threatened by climate change by precluding direct exploitation. However, because only a few [*354] species are likely to be subject to commercial whaling in the future, the lifting of the moratorium would not benefit the majority of the species most threatened by climate change.

The IWC may ultimately find that its most effective tool for protecting cetaceans from climate change lies in advocacy of their interests in other forums that may have far more influence on their fate. For example, as outlined above, in the Antarctic, warming may result in diminution of krill stocks, seriously threatening cetaceans in the region. n122 Thus, it may be incumbent upon the IWC to lobby the Convention on the Conservation of Antarctic Marine Living

Resources, the primary body that manages marine resources in the region, n123 to limit commercial harvesting of krill in the future. n124 Similarly, the IWC should press the Intergovernmental Panel on Climate Change (IPCC), the primary scientific research body to inform the decision-making of the United Nations Framework Convention on Climate Change (UNFCCC), n125 to incorporate cetacean data in its assessment reports. The IPCC assessments to date have not addressed this specific issue. However, as discussed in the next section of this article, this input will only make a difference if the UNFCCC has the institutional will to meaningfully address climate change during this century.

B. THE INSTITUTIONAL ROLE OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Even if the research initiatives of the IWC and other organizations improve our understanding of the impact of climate change on cetacean species, this impact can be averted only if nations demonstrate the resolve to substantially reduce greenhouse gas emissions. The primary international instrument to achieve this objective is the United Nations Framework Convention on Climate Change (UNFCCC), n126 which entered into force in 1994 and has been ratified by 180 countries. n127 The overarching objective of UNFCCC is to "achieve . . . stabilization [*355] of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." n128

Reflecting the Convention's emphasis on common but differentiated responsibility, n129 the Convention requires developed country parties to "take the lead in combating climate change and the adverse effects thereof." n130 Article 4(2) requires developed country parties and other parties included in Annex I n131 to "adopt national policies and take corresponding measures on the mitigation of climate change, by limiting [their] anthropogenic emissions of greenhouse gases and protecting and enhancing [their] greenhouse gas sinks and reservoirs." n132

Unfortunately, the record of the UNFCCC's Annex I parties has been disheartening. Initially, the major greenhouse gas emitting states agreed to "aim" to reduce their greenhouse gas emissions to 1990 levels by 2000. n133 Yet, all industrialized nations flouted this pledge, leading the Organization for Economic Cooperation and Development to conclude that emissions from industrialized nations could rise between eleven to twenty-four percent in the next fifteen years. n134

At the First Conference of the Parties to the UNFCCC, held in Berlin in 1995, n135 the parties concluded that their existing commitments were inadequate on three grounds. First, most Annex I nations were not on track to meet their initial aim by 2000. Second, the UNFCCC contained no provision for controlling greenhouse emissions beyond 2000. Third, the parties acknowledged that stabilization of emissions at 1990 levels would be insufficient to stabilize atmospheric [*356] greenhouse gas concentrations. Consequently, in a decision referred to as the "Berlin Mandate," the parties established a process to strengthen UNFCCC commitments through adoption of a protocol or other legal instrument, with the goal of establishing quantified emissions limitation and reduction objectives for the period past 2000. n136

At the Third Conference of the Parties of the UNFCCC, held in Kyoto, Japan, in 1997, the parties adopted the Kyoto Protocol, n137 under which industrialized nations agree to reduce their collective emissions of six greenhouse gases n138 by at least five percent below 1990 levels by 2008 to 2012. n139 However, hostility to the Protocol by powerful sectors in the U.S., including organized labor, fossil fuel producers, and influential members of the Senate, n140 may thwart U.S. ratification. This would severely undercut the treaty's effectiveness, as the U.S. is responsible for approximately one-quarter of greenhouse gas emissions. n141 Also, industrialized [*357] nations continue to demonstrate very little commitment to reducing emissions. A recent report concluded that if present trends continue, emissions in the developed world could increase forty percent over 1990 levels by 2010. n142

Moreover, because many greenhouse gases persist in the atmosphere for decades, "their radiative forcing--their tendency to warm Earth--persists for periods that are long compared with human life spans." n143 Consequently, and from the exclusion of developing countries from reduction commitments, n144 full implementation of the Kyoto

Protocol will only reduce 2050 warming by one-twentieth of one degree n145 and delay doubling of atmospheric concentrations of carbon dioxide from pre-industrial levels by less than a decade. n146 Thus, many potential impacts of climate change, including impacts on cetacean species, may be inevitable. Moreover, averting the climate change impacts beyond the middle of the next century will require far more dramatic reductions in greenhouse gas emissions. The IPCC has estimated that it would be necessary to reduce greenhouse emissions by more than sixty percent to stabilize atmospheric concentrations at 1990 levels. n147 Given how difficult it was to secure agreement to the much more modest reductions contemplated under the Kyoto Protocol, one must be skeptical about the prospects for nations agreeing to such dramatic cutbacks in the future. Recent research indicates that a commitment to increased energy efficiency, energy conservation, and renewable energy sources could reduce emissions by Annex I states to 1990 levels over the next few decades. n148 However, major greenhouse emitters, most notably the U.S., appear to lack the resolve to commit the necessary financial resources to develop such technologies.

[*358] Finally, as indicated earlier, the UNFCCC currently only binds developed countries and economies in transition to the reduction of greenhouse gas emissions. n149 However, given the tremendous projected increases in greenhouse gas emissions in developing countries over the next century, n150 the future effectiveness of the UNFCCC is contingent on engaging these nations in the regime's mission. n151 It is far from certain that developing nations will commit themselves to substantial emission reductions. There is great trepidation among developing countries about possible economic impacts and a sense of unfairness, given the tremendous disparity in per capita emissions between industrialized and developing nations. n152

V. CONCLUSION

The IWC's recognition of the need to address environmental change issues, including the possible impacts of climate change on cetaceans, is laudable. However, its limited research resources and the speculative future of the UNFCCC likely means that cetaceans will face increasing threats from climate change in the next century. It remains to be seen whether many species of [*359] cetaceans that were driven to the brink of extinction by harvesting can now survive the onslaught of environmental change, including the specter of global warming. If the IWC is to make a serious commitment to addressing the possible impacts of environmental change on species under its regulation, the parties to the agreement must substantially increase funding for research and use their influence in other forums to effectuate policies that will protect the interests of cetaceans. If the parties fail to do so, the IWC's ultimate legacy may be that it saved whales from extinction by commercial harvesting but failed them in their time of greatest need.

Legal Topics:

For related research and practice materials, see the following legal topics:
Environmental LawNatural Resources & Public LandsFish & Wildlife ProtectionGovernmentsAgriculture & FoodProcessing, Storage & DistributionInternational Trade LawTrade AgreementsEnvironmental ProvisionsFish

FOOTNOTES:

n1 U.S. Commissioner to the International Whaling Commission.

n2 *See* International Convention for the Regulation of Whaling, Sept. 24, 1931, 161 U.N.T.S. 72 [hereinafter Whaling Convention].

n3 50th Meeting of the International Whaling Commission, *Resolution on Environmental Change and Cetaceans*, IWC Resolution 1998-6 (1998) [hereinafter IWC Resolution]. Resolutions from the 50th Meeting are available on the American Society of International Law--Wildlife Interest Group website, *at*

http://www.eelink.net/asilwildlife.

n4 GRAEME APLIN ET AL., GLOBAL ENVIRONMENTAL CRIES 218-19 (2d ed. 1999); INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), RADIATIVE FORCING OF CLIMATE CHANGE 7 (1994) [hereinafter IPCC].

n5 MELVIN A. BENARDE, GLOBAL WARMING . . . GLOBAL WARNING 45 (1992).

n6 Envtl. & Geographical Sci. Dep't, U. Capetown, *Climate Change--Some Basics*, at pt. 5 (1999), *at* http://www.egs.uct.ac.za/csag/faq/climate-change/faq.html (last visited Nov. 10, 2000).

n7 *Id.* at pt. 3. The "greenhouse effect" phenomenon was first described by the French scientist Fourier in 1827. *See* Spencer Weart, *From The Nuclear Frying Pan Into The Global Fire*, BULL. ATOMIC SCI., June 1992, at 18, 19.

n8 *Scientists Remain Unanimously Concerned Over Climate Change*, 23 ECO-LOG WK., July 14, 1995, *available at 1995 WL 2406417*. "For the past 8,000 years, the world's climate has been very stable, varying only within a range of + or - 1 degrees C." *Id.*

n9 Fred Pearce, *World Lays Odds On Global Catastrophe*, NEW SCIENTIST, Apr. 8, 1995, at 4.

n10 HADLEY CENTRE, THE GREENHOUSE EFFECT AND CLIMATE CHANGE 5 (1999). An additional 1.5 gigatons is released into the atmosphere from land-use changes, such as deforestation. Cement production contributes a small additional amount. *Id.*

n11 Kevin Jardine, *Finger On The Carbon Pulse*, ECOLOGIST, Nov./Dec. 1994, at 220.

n12 TOM M.L. WIGLEY, THE SCIENCE OF CLIMATE CHANGE: REPORT OF THE PEW CENTER ON CLIMATE CHANGE 5 (1999); Christopher Flavin & Odil Tunali, *Getting Warmer*, WORLD WATCH, Mar./Apr. 1995, at 13. Atmospheric concentrations of CO[2] have reached their highest levels in 160,000 years. United Nations Environment Programme (UNEP), GEO-2000, *The State of the Environment--Global Issues* (1999), *at* http://www.unep.org/geo2000/english/0034.htm.

n13 "Methane and nitrous oxide concentrations have increased by 145 and 15 percent respectively [since 1750]." Colin Warbrick & Dominic McGoldrick, *Global Warming and the Kyoto Protocol, 47 INT'L & COMP. L.Q. 446, 447 (1998).* "The primary natural source of [methane] is microbial decay of organic matter under anoxic conditions in wetlands. Anthropogenic sources, which in sum may be twice as great as natural sources, include rice cultivation, domestic ruminants, bacterial decay in landfills and sewage, leakage during the mining of fossil fuels, leakage from natural gas pipelines, and biomass burning." JAMES HANSEN ET AL., NASA GODDARD INSTITUTE FOR SPACE STUDIES, GLOBAL WARMING IN THE 21ST CENTURY: AN ALTERNATIVE SCENARIO 4 (2000), *available at* http://www.giss.nasa.gov/gpol/cites/2000.html (last visited Nov. 10, 2000). Significant sources of nitrous oxide include nitrogen-based fertilizers, the clearing of land, biomass burning, and fossil fuel combustion. UNEP, *supra* note 12.

n14 Guy Brasseur, *Global Warming and Ozone Depletion: Certainties and Uncertainties*, in GLOBAL WARMING AND THE CHALLENGE OF INTERNATIONAL COOPERATION: AN INTERDISCIPLINARY ASSESSMENT 29-30 (Gary C. Bryner ed., 1994). Overall, CO[2] accounts for sixty-five percent of the total radiative forcing resulting from anthropogenically released greenhouse gases, methane contributes an additional nineteen percent, chlorofluorocarbons, ten percent, and nitrous oxide about six percent. APLIN, *supra* note 4, at 222.

n15 IPCC, *supra* note 4, at 8.

n16 UNITED KINGDOM DEP'T OF THE ENV'T, TRANSPORT AND THE REGIONS, CLIMATE CHANGE AND ITS IMPACTS 9 (1999). "20th Century global mean temperature is at least as warm as any other century since at least 1400AD." IPCC, *Contribution of Working Group I to the IPCC Second Assessment Report*, IPCC-XI/Doc. 3 (1995), at SPM.2. Warming has accelerated in the last twenty-five years, more than doubling that of the 20th century average. William K. Stevens, *1999 Continues Warming Trend Around Globe*, N.Y. TIMES, Dec. 19, 1999, at 1.

n17 The IPCC, comprised of 2500 climate scientists from throughout the world, was established by the United Nations in 1988 to gather information and coordinate research related to climate change, to evaluate proposals for reducing greenhouse gas emissions, and to assess the viability of response mechanisms. G.A. Res. 43/53, U.N. GAOR, 2d Comm., 43rd Sess., Supp. No. 49, at 133, U.N. Doc. A/43/49 (1989); David Lewis Feldman, *Iterative Functionalism and Climate Management Organizations: From Intergovernmental Panel on Climate Change to Intergovernmental Negotiating Committee, in* INTERNATIONAL ORGANIZATIONS & ENVIRONMENTAL POLICY 1195-96 (Robert V. Bartlett et al. eds., 1995).

The current "best estimate" by the IPCC is a three degrees Celsius increase in average global temperature by 2100. Hadley Centre for Climate Prediction and Research, *Climate Change & Its Impacts* (1999), *at* http://www.met-office.gov.uk/sec5/CR_div/pubs/brochures/B1998/science.html; Global Network of Environment & Technology News, *Global Warming Forecast Raised One Degree* (Dec. 29, 1998), *at* http://earthvision.net/coldfusion/News_Page2.cfm?NewsID=5981.

However, based on reduced projections of SO[2] emissions over the next century (a gas that ameliorates the greenhouse effect when oxidized) in the IPCC's upcoming Special Report on Emissions Scenarios, Wigley has recently ratcheted the IPCC's upward projections in its Second Assessment, from 0.8-3.5 degrees Celsius to 1.3-4.0 degrees Celsius. Wigley, *supra* note 12, at 21. Moreover, a new study by the Hadley Centre indicates that the carbon absorption capabilities of vegetation and soil, which are now responsible for sopping up fifty percent of carbon emissions, may start to decline with rising temperatures. As a consequence, the Centre now projects that concentrations of carbon dioxide could rise to 1000 ppm, resulting in temperature increases of eight degrees Celsius by the end of the century. Peter M. Cox, et al., *Acceleration of Global Warming Due to Carbon-Cyle Feedbacks in a Coupled Climate Model*, 408 NATURE 184, 186 (2000). Moreover, the upcoming third assessment of the IPCC will project temperature increases of 1.5 [degrees]-6.0 [degrees] C by 2100, almost double the 1995 predictions. International Institute for Sustainable Development, *Summary of the Sixth Conference of the Parties to the Framework Convention on Climate Change: 13-25 November 2000*, 12 (163) EARTH NEGOTIATIONS BULL. 3 (2000), *available at* http://www.iisd.ca/climate/cop6/.

n18 IPCC, THE IPCC ASSESSMENT OF KNOWLEDGE RELEVANT TO ARTICLE 2 OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE: A SYNTHESIS REPORT § 3.2 (1995) (draft).

n19 *The Calamitous Cost of a Hotter World*, WORLD PRESS REV., July 1995, at 9 (reprinted from DER SPIEGEL). Such a change could be ten to fifty times as fast as the natural average rate of temperature change since the last glaciation. *Id.*; MARGRET M.I. VAN VUUREN & MAARTEN KAPPELLE, DUTCH NATIONAL RESEARCH PROGRAMME ON GLOBAL AIR POLLUTION AND CLIMATE CHANGE, BIODIVERSITY AND GLOBAL CHANGE 14 (1998).

n20 *The Calamitous Cost of a Hotter World*, *supra* note 19.

n21 INTERNATIONAL WHALING COMMISSION, REPORT OF THE IWC WORKSHOP ON CLIMATE CHANGE AND CETACEANS 2 (1996) [hereinafter IWC REPORT].

n22 William C.G. Burns, *The Impact of Climate Change on Pacific Island Developing Countries in the 21st Century*, *in* CLIMATE CHANGE IN THE SOUTH PACIFIC: IMPACTS AND RESPONSE IN AUSTRALIA, NEW ZEALAND, AND SMALL ISLAND STATES 234 (Alexander Gillespie & William C.G. Burns eds., 2000).

n23 Hadley Center for Climate Prediction and Research, *Regional Climate*, *at* http://www.meto.gov.uk/sec5CR_div.bak/Brochure/regn_pre.html. *See also* IPCC, AN INTRODUCTION TO SIMPLE CLIMATE MODELS USED IN THE IPCC SECOND ASSESSMENT REPORT 10 (1997).

n24 Kevin J. Hennessy, *CSIRO Climate Change Output*, *at* http://www.dar.csiro.au/res/cm/data.htm (last visited Dec. 19, 2000).

n25 Eric J. Barron, *Climate Models: How Reliable Are Their Predictions?*, CONSEQUENCES 17, 18 (Aug. 1995).

n26 M.E. Schlesinger, *Model Projections of CO[2]-Induced Equilibrium Climate Change*, *in* CLIMATE CHANGE AND SEA LEVEL CHANGE 171 (R.A. Warrick et al. eds., 1993).

n27 Silvina A. Solman & Mario N. Nunez, *Local Estimates of Global Climate Change: A Statistical Downscaling Approach*, 19 INT'L J. CLIMATOLOGY 835, 835-36 (1999). *See also* HADLEY CENTRE, *supra* note 10, at 14.

n28 K. YA. KONDRATYEV & A.P. CRACKNELL, OBSERVING GLOBAL CLIMATE CHANGE 381 (1998); HADLEY CENTRE, *supra* note 10, at 14.

n29 KONDRATYEV & CRACKNELL, *supra* note 28, at 383-84. *See also* Norman Miller, *Climatically Sensitive California: Past, Present, and Future Climate*, *in* POTENTIAL IMPACTS OF CLIMATE CHANGE AND VARIABILITY FOR THE CALIFORNIA REGION, REPORT TO THE UNITED STATES GLOBAL CHANGE RESEARCH PROGRAM NATIONAL ASSESSMENT 25-26 (1998).

n30 Solman & Nunez, *supra* note 27, at 836. *See also* Hartmut Grassl, *Status and Improvements of Coupled General Circulation Models*, 288 SCIENCE 1991, 1994 (2000) (statistical downscaling used to effectively

simulate meteorological variables in Scandinavian mountain area).

n31 *See* Gerard Baker, *Japan Threatens to Quit Whaling Commission*, FIN. TIMES, May 28, 1994, at 4. Three species of whales reside year-round in the ice pack: bottlenose, minke, and killer whales, while sperm, humpback, blue, fin, sei, and some minke stocks migrate to the Southern Ocean during the Antarctic winter. *See also* Paul Lincoln Stoller, *Protecting the White Continent: Is the Antarctic Protocol Mere Words or Real Action?*, 12 ARIZ. J. INT'L & COMP. L. 335, 336 & n.5 (1995).

n32 British Antarctic Survey, *Antarctica: Climate Change and Sea Level* (1999), *at* http://www.nerc-bas.ac.uk/public/info/antwarm.html. *See also* Raymond C. Smith, *Marine Ecosystem Sensitivity to Climate Change*, 49 BIOSCIENCE 393, 395 (1999). Mid-winter surface air temperatures in the western Antarctic have risen 5.5 [degrees] C over the 1941-1991 period. R.C. Smith et al., *Surface Air Temperature Variations in the Western Antarctic Peninsula Region, in* 70 FOUNDATIONS FOR ECOLOGICAL RESEARCH WEST OF THE ANTARCTIC PENINSULA 20 (R.M. Ross et al. eds., 1996).

n33 IPCC, CONTRIBUTION OF WORKING GROUP I TO THE IPCC SECOND ASSESSMENT REPORT, IPCC-XI/Doc. 3 (1995), at SPM.20. *See also* Grover Foley, *The Threat of Rising Seas*, 29 ECOLOGIST 76, 78 (1999) ("Antarctica appears to be warming faster than anywhere else on the planet . . . .").

n34 SCAR Global Change Programme, *A Summary of Change in the Antarctic, at* http://www.antcrc.utas.edu.au/scar/newsletter2/2summary.html (last modified Sept. 20, 2000). *See also* Andrew Clark & Eugene Murphy, *A Long-Term Fast Ice Record from the South Orkney Islands*, 1 GLOBAL CHANGE RES. 1 (1996); Sean Ryan, *Global Warming*, SUNDAY TIMES, Mar. 26, 1995.

n35 British Antarctic Survey, *supra* note 32 ("Measurements made over the Antarctic Peninsula and the Falkland Islands show that the level of peak electron concentration in the ionosphere F-region (at about 300 km altitude) has fallen by about 8km over 38 years . . . . While the lower atmosphere warms in response to increasing concentrations of greenhouse gasses, the upper atmosphere cools. Theoretical studies indicate that the observed fall in the height of the F-region is compatible with expected temperature changes in the thermosphere"). However, annual mean temperature increases of two degrees Celsius over the past fifty years on the Antarctic Peninsula are not consistent with predictions of climate models. *Id.*

n36 IWC REPORT, *supra* note 21, at 3. However, some researchers argue that warming either may have very little effect on ice sheets in the Antarctic, or may even portend an increase in volume, at least for the next century or two, due to an increase in snowfall caused by higher evaporation. University of Tasmania, Antarctic Cooperative Research Centre, *Polar Ice Sheets, Climate and Sea-Level Rise*, Feb. 10, 2000, *at* http://www.antcrc.utas.edu.au/antcrc/about/Position_Statement_2.html (last visited Nov. 26, 2000). *See also* British Antarctic Survey, *supra* note 13; David Schneider, *The Rising Seas*, Mar. 19, 1997, SCI. AM. 96, 114; C.L. Hulbe, *Recent Changes to Antarctic Peninsula Ice Shelves: What Lessons Have Been Learned,?* 1 NATURAL SCI. (Apr. 11, 1997), *available at* http://naturalscience.com/ns/articles/01-06/ns_clh.html.

However, recent research suggests that models of the draining of discharge from the Antarctic Ice Sheet as a consequence of warming may have underestimated ice stream flow rates, "implying that parts of the interior of Antarctica and probably former ice sheets can respond more rapidly to climate forcing than model simulations might suggest." Jonathan L. Bamber et al., *Widespread Complex Flow in the Interior of the Antarctic Ice Sheet*, 287 SCIENCE 1249 (2000).

n37 "Krill" is a general term that encompasses about eighty-five species of ocean crustaceans in the group called *euphausiids*. Five species of krill are found in the Antarctic, the most abundant being *Euphausia superba*, which grow up to about six centimeters and live between five to ten years. Australian Antarctic Division, *Krill: Magicians of the Southern Ocean*, http://www.antdiv.gov.au/resources/more_res/krill.html (last visited Nov. 26, 2000).

n38 O. BALASHOV. & B. HARE, POLAR MELTDOWN: THE CHANGING CLIMATE IN ANTARCTICA: A REPORT FOR GREENPEACE INTERNATIONAL (1997); David Helvarg, *On Thin Ice*, SIERRA, Nov./Dec. 1999, at 40. Blue whales may consume as much as four tons of krill per day. Hulbe, *supra* note 36. Krill are the major biomass component of the epipelagic marine ecosystem in the Seasonal Pack-ice Zone and parts of the Ice-free and the high-Antarctic Zone, comprising approximately 500 million tons of biomass. Charles Arthur, *Global Warming Poses New Threat to Whales' Survival*, INDEPENDENT, June 26, 1997, at 3. Krill support an array of species in the region, including penguins, fur seals, and seabirds, such as the albatross. Debora MacKenzie, *In for the Krill*, NEW SCIENTIST, June 5, 1999, at 26. *See also* Andrew Brierley, *Kingdom of the Krill*, NEW SCIENTIST, Apr. 17, 1999, at 36, 39-40.

n39 World Wide Fund for Nature, *Climate Change: Parks at Risk, at* http://www.panda.org/climate/parks/dr_I_park9.htm (last visited Nov. 26, 2000). Brine channels on the underside of sea ice connect to underlying water and nutrients that are important for the growth of algal species. Alfred Wegener Institute for Polar & Marine Research, *Microstructure*, http://www.awi-bremerhaven.de/Eistour/mikrostruktur-e.html (last visited Nov. 26, 2000).

n40 Thomas Karl, *The Arctic and the Antarctic, in* IPCC, THE REGIONAL IMPACTS OF CLIMATE CHANGE: AN ASSESSMENT OF VULNERABILITY (Robert T. Watson et al. eds., 1997), at 98.

n41 Arthur, *supra* note 38, at 3.

n42 *See* K.H. KOCK & V. SIEGEL, INTERNATIONAL WHALING COMMISSION, TEMPORAL VARIATIONS IN SEA-ICE DYNAMICS AND KRILL ABUNDANCE IN THE ANTARCTIC PENINSULA REGION--IMPLICATIONS FOR THE KRILL-DOMINATED FOOD WEB 3 (1996); V. Siegel & V. Loeb, *Recruitment of Antarctic Krill 'Euphausia superba' and Possible Causes for its Variability*, 123 MAR. ECO. PROGRESS. SER. 45, 54 (1995).

n43 Siegel & Loeb, *supra* note 42, at 54.

n44 Arthur, *supra* note 38, at 3. Krill also face other serious threats, including loss of prey species and direct damage from ozone depletion. Colin Woodard, *Food-Chain Alarm from a Low-Ozone Zone*, CHRISTIAN SCI. MONITOR, Dec. 11, 1998, at 8. Perhaps in the future, Krill will face overexploitation by commercial fishing concerns. *See infra* note 119.

n45 IWC REPORT, *supra* note 21, at 10.

n46 *See Anomalous Sea Ice Conditions in the Cosmonaut Sea During 1999*, http://www.atmosp.physics.utoronto.ca/ANTARCTIC/cosmo_1999.html (last visited Sept. 24, 2000); Fred

Breummer, *Northern Oases*, 114 CANADIAN GEO. 1, 54 (1994).

n47 Laura Cheshire, *Phytoplankton and Polynas, at* http.nasadaacs.eos.nasa.gov/yearbooks/95/polynya.html (last modified Sept. 15, 2000).

n48 IWC REPORT, *supra* note 21, at 10.

n49 By the early 1960s, aided by new technology, including explosive harpoons and stronger vessels, whalers drove blue and humpback whales to the point of commercial extinction. JAMES C.F. WANG, HANDBOOK ON OCEAN POLITICS & LAW 152 (1992). Blue whale populations have plummeted from a pre-exploitation level of 200,000 to as few as 500 in the Southern Hemisphere, and humpbacks have declined from 120,000 to approximately 10,000. WORLD WIDE FUND FOR NATURE, WANTED ALIVE! 1 (1998); John Carey, *Embattled Behemoths; Whales*, 25 INT'L WILDLIFE 4 (1995).

n50 *See Whaling 1989/1990*, 23 ORYX 184 (1989).

n51 World Wide Fund for Nature, *Protected Areas at Risk* (1997), http://www.panda.org/climate/pubs/parks/dr_i_park9.htm. A portent of the danger to whale populations of declining krill biomass may be the substantial drop in Adelie penguin populations in recent years, which some researchers attribute in part to declines in krill populations. KOCK & SIEGEL, *supra* note 42, at 1; Greenpeace, *Antarctic Warming--Early Signs of Global Climate Change* (1995), http://www.greenpeace.org/search/shtml.

n52 *See* Greenpeace, *The Threat of Climate Change to Arctic Wildlife* (1997), http://www.greenpeace.org/comms/97/arctic/library/biodiversity/wildlife.html. "The polar amplification of warming in the Arctic is attributed to the positive albedo feedback of snow and sea-ice." IWC REPORT, *supra* note 21, at 13. *See also* MICHAEL E. MASS & RAYMOND S. BRADLEY, AMERICAN GEOPHYSICAL UNION, NORTHERN HEMISPHERE TEMPERATURES DURING THE PAST MILLENNIUM: INFERENCES, UNCERTAINTIES, AND LIMITATIONS (1999).

n53 *Research Predicts Summer Doom for Northern Icecap*, N.Y. TIMES, July 11, 2000, at D2; D.A. Rothrock et al., *Thinning of the Arctic Sea-Ice Cover*, 26 GEOPHYSICAL RES. LETTERS 3469, 3471 (1999).

n54 *See* Ola M. Johannessen et al., *Satellite Evidence for an Arctic Sea Ice Cover in Transformation*, 286 SCIENCE 1937, Oct. 1, 1999; Kenneth Blackman, *Global Warming Worries Indigenous People*, INTER PRESS SERVICE, Aug. 13, 1998, *available at* LEXIS, World Library.

n55 Rothrock, *supra* note 53, at 3471. *See also* M.C. Serreze et al., *Observational Evidence of Recent Change in the Northern High-Latitude Environment*, 46 CLIMATIC CHANGE 159, 170 (2000):

> Conclusions that greenhouse-gas forcing has been a significant player in recent Arctic warming must be viewed cautiously. There is general agreement between climate model predictions and observations in terms of annual mean warming over the past several decades and for maximum warming in northern continental regions. However, discrepancy arises in the seasonality of change. In general, models project the largest warming during late autumn and winter . . . . By

> comparison, the observations show maximum winter and spring warming for land, and winter through summer warming over the Arctic Ocean.

n56 Konstantin Y. Vinnikov et al., *Global Warming and Northern Hemisphere Sea Ice Extent*, 286 SCIENCE 1936 (1999). *See also* D.K. Perovich et al., *Year on Ice Gives Climate Insights*, EOS, TRANSACTIONS AMERICAN GEOPHYSICAL UNIT, Oct. 12, 1999, at 481.

n57 Karl, *supra* note 40, at 93. However, the IPCC cautioned that the inadequacy of regional polar models render such projections highly speculative. Indeed, some researchers argue that sea ice levels would not be substantially changed under doubled CO[2] conditions. *Id.*

n58 Mariana Gosnell, *Meltdown? Sea Ice May Be Thawing, Which Could Mean Disruption of Life at Earth's Polar Ends*, INT'L WILDLIFE, July-Aug. 1998, at 12. *See* Lars H. Smedsrud & Tore Furevik, *Towards an Ice-Free Arctic?*, 2 CICERONE (Feb. 2000), *available at* http://www.cicero.uio.no/cicerone/00/2/en/smedsrud.pdf. The Arctic Ocean could be ice-free during summer months by the end of this century.

n59 IWC REPORT, *supra* note 21, at 14.

n60 ENVIRONMENTAL INVESTIGATION AGENCY, WHALES IN A CHANGING OCEAN 6 (1994).

> The freshening of high latitude seas from freshwater inputs and melt water could be expected to increase the period of halothermal stratification, increase the depth of the halocline and exacerbate the saline concentration gradient. The longer period of stratification is predicted to disadvantage larger phytoplankton such as diatoms and increase the number of smaller species. This will lengthen the food chain between primary producers and larger consumer species, effectively reducing the biomass of the latter . . . The greater depth of the halocline means that all phytoplankton will spend a greater amount of time in sub-optimal illumination, while the strengthened concentration gradient will make it more difficult for nutrients to enter the surface layer from below. Both of these factors are expected to reduce overall productivity. *Id.*

n61 *Id. See also* IWC REPORT, *supra* note 21, at 14; Cynthia T. Tynan & Douglas P. DeMaster, *Observations and Predictions of Arctic Climatic Change: Potential Effects on Marine Mammals*, ARCTIC, Dec. 1997, *available at* LEXIS, World Library.

n62 IWC REPORT, *supra* note 21, at 14.

n63 *Id.* Changes in thermohaline circulation and the intensification of coastal upwelling as a consequence of warming may also adversely affect the abundance of cephlapod species. *Id.* at 13.

n64 M. Holst & I. Stirling, *A Note on Sightings of Bowhead Whales in the North Water Polynya, North Baffin Bay, May-June 1998*, 1 J. CETACEAN RES. MGT. 153, 153 (1999).

n65 Tynan & DeMaster, *supra* note 61.

n66 IWC REPORT, *supra* note 21, at 13; Smedsrud & Furevik, *supra* note 58; *Research Predicts Summer Doom for Northern Icecap*, *supra* note 53.

n67 RANDALL R. REEVES & STEPHEN LEATHERWOOD, DOLPHINS, PORPOISES, AND WHALES 19 (1994); WORLD WIDE FUND FOR NATURE, *supra* note 49, at 1 (1998); Michael Lipske, *A Whale of a Story*, NAT'L WILDLIFE, Feb./Mar. 1993, at 6.

n68 Kim E.W. Shelden & David J. Rugh, *Bowhead Status Report*, National Marine Mammal Laboratory 17 (1998), *at* http://nmm101.afsc.noaa.gov/CetaceanAssessment/bowhead/bmsos.htm; Alexander Gillespie, *Whale-Watching and the Precautionary Principle: The Difficulties of the New Zealand Domestic Response*, 17 N.Z. U. L. REV. 254, 261-62 (1997); James E. Scarff, *The International Management of Whales, Dolphins, and Porpoises: An Interdisciplinary Assessment*, 6 ENVTL. L.Q. 326, 416 (1977).

n69 David Harrison, *Noise Drives Whales Crazy*, OBSERVER, May 31, 1998 *available at* LEXIS, World Library.

n70 *See* Natural Resources Defense Council, *Sounding the Depths*, http://www.nrdc.org/wildlife/sound/sdinx.asp (last visited Sept. 24, 2000).

n71 *Id. See also* Judith D. Hutchinson, *Fisheries Interactions: The Harbour Porpoise--a Review*, *in* THE CONSERVATION OF WHALES AND DOLPHINS 154-55 (Mark P. Simmons & Judith D. Hutchinson, eds., 1996).

n72 Bernd Wursig, *Cetaceans and Oil: Ecologic Perspectives*, *in* SEA MAMMALS AND OIL: CONFRONTING THE RISK 129-65 (Joseph R. Geraci & David J. St. Aubin eds., 1990); Thomas Land, *Co-Ordinated Action is Key to Black Sea Pollution Strategy*, LLOYDS LIST, Jan. 2, 1998 *available at* LEXIS, World Library.

n73 *See* SWISS COALITION FOR THE PROTECTION OF WHALES, POLAR EXPOSURE: ENVIRONMENTAL THREATS TO ARCTIC MARINE LIFE AND COMMUNITIES 13 (1997).

n74 *See id.*

n75 ENVIRONMENTAL INVESTIGATION AGENCY, *supra* note 60, at 26.

n76 William C.G. Burns, *The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS): A Regional Response to the Threats Facing Cetaceans*, 1 J. INT'L WILDLIFE L. & POL'Y 113, 116 (1998); Fred Pearce, *Dead in the Water: Attempts to Save the Grossly Polluted Mediterranean Seen as Doomed as the Sea Itself*, NEW SCIENTIST, Feb. 4, 1998; Joby Warrick, *Dead Dolphins and Toxin Fish: Scientists Hunt Down Seaborne Saboteurs*, INT'L HERALD TRIB. (Neuilly-sur-Seine, France), Sept. 24, 1997, at 6.

n77 Burns, *supra* note 76, at 115; Seamus Kennedy, *Infectious Disease of Cetacean Populations*, *in* THE CONSERVATION OF WHALES & DOLPHINS, *supra* note 71, at 344-45; Environmental News Network, *Global Warming Poses Threat to Whale Conservation*, *at* http://www.enn.com/specialreports/climate/news/03whal26.txt (last modified Sept. 20, 2000).

n78 IWC REPORT, *supra* note 21, at 16.

n79 NASA Goddard Institute for Space Studies, *How Will the Frequency of Hurricanes Be Affected by Climate Change?*, (1999), *at* http://www.giss.nasa.gov/research/intro/druyan.02/; Thomas R. Karl et al., *The Coming Climate*, SCI. AM. (1997), *available at* http://www.sciam.com/0597/issue/0597karl.html.

n80 *See* Leonard Doyle, *Insurers Refuse to Cover Global Warming Risks*, INDEPENDENT, May 8, 1992, at 11.

n81 NASA, *supra* note 79; R.J. Haarsman, *Tropical Disturbances in a GCM*, *8* CLIMATE DYNAMICS 247 (1993).

n82 Thomas R. Knutson, Robert E. Tuleya & Yoshio Kurihara, *Simulated Increase of Hurricane Intensities in a CO[2]-Warmed Climate*, 279 SCIENCE 1018, 1018 (1998). Not all climatologists agree that warming will result in increases in the incidence or intensity of storms. *See* Bette Hileman, *Climate Observations Substantiate Global Warming Models*, CHEM. & ENG. NEWS, Nov. 27, 1995, *available at* http://pubs.acs.org/hotartcl/cenear/951127/pgl.html; G.J. Holland, *The Maximum Intensity of Tropical Cyclones*, 54 J. ATMOSPHERIC SCI. 2519 (1995).

n83 Arthur, *supra* note 38.

n84 Tynan & DeMaster, *supra* note 61. As the International Whaling Commission has noted, pollution is one of the gravest threats facing cetaceans. IWC RESOLUTION, *supra* note 3. *See also* Letizia Marsili & Silvano Focardi, *Organochlorine Levels in Subcutaneous Blubber Biopsies of Fin Whales (Balaenoptera physalus) and Striped Dolphins (Stenella coeruleoalba) from the Mediterranean Sea*, 92 ENVTL. POLLUTION 1 (1995); ALLISON MOTLUK, *Deadlier than the Harpoon*, NEW SCIENTIST, July 1, 1995; William C.G. Burns, *The International Whaling Commission and the Regulations of the Consumptive and Non-Consumptive Uses of Small Cetaceans: The Critical Agenda for the 1990s, 13 WIS. INT'L L.J. 105, 119 (1994).*

n85 *See* Catherine Dold, *Toxic Agents Found to Be Killing Off Whales*, N.Y. TIMES, June 16, 1992. For an analysis of land-based toxic contaminants that threaten species in the Arctic, see Arctic Council, *Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-Based Activities*, http://arctic-council.usgs.gov/99-0376-eng.pdf (last visited Sept. 23, 2000).

n86 William C.G. Burns, *The International Whaling Commission and the Future of Cetaceans: Problems and Prospects*, 8 COLO. J. INT'L ENVTL. L. & POL'Y 31, 33 (1997).

n87 Whaling Convention, *supra* note 2, pmbl.

n88 "The first few decades of whale management under the IWC can be described as an 'era of "quota whaling,'" . . . during which the recommendations of the Commission's Scientific Committee were often ignored by pro-whaling nations eager to hunt as many whales as possible." (citations omitted). Sarah Suhre, *Misguided Morality: The Repercussions of the International Whaling Commission's Shift from a Policy of Regulation to One of Preservation, 12 GEO. INT'L ENVTL. L. REV. 305, 309 (1999);* Burns, *supra* note 86, at 35.

n89 INTERNATIONAL WHALING COMMISSION, THIRTY-SEVENTH REPORT OF THE INTERNATIONAL WHALING COMMISSION 151 (1986).

n90 *Resolution on the Need for Research on the Environmental and Whale Stocks in the Antarctic Region*, 43 REP. INT'L WHALING COMMISSION 39-40 (1992).

n91 IWC REPORT, *supra* note 21.

n92 *Id.* at 22.

n93 *Id.*

n94 *Id.*

n95 48th Meeting of the International Whaling Commission, *Resolution on Environmental Change and Cetaceans*, IWC/48/44 (1996), at 1. In the context of climate change issues, these other organizations include Global Ocean Ecosystem Dynamics (GLOBEC), a program adopted by UNESCO's International Geosphere-Biosphere Program to "advance our understanding of the structure and function of the global ocean ecosystem." *See* GLOBEC International, http://www.ibss.iuf.net/links/globec/globec1.html (last visited Nov. 26, 2000); The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), *19 I.L.M. 841 (1980);* the Scientific Committee on Antarctic Research/Antarctic Pack Ice Seals; the South Channel Ocean Productivity Experiment; and the Palmer Long Term Ecological Program of the National Science Foundation's Office of Polar Programs. IWC REPORT, *supra* note 21, at 3-4, 23; 50th Meeting of the International Whaling Commission, *Report of the Standing Working Group on Environmental Concerns*, IWC 50/4, Annex H (1998), at 3. The IWC at its 50th meeting also encouraged Japan to coordinate its Whale Research Programme under a Special Permit in the Antarctic with the SWGEC. 50th Meeting of the International Whaling Commission, *Resolution on Coordinating and Planning for Environmental Research in the Antarctic*, IWC Resolution 1998-7 (1998).

n96 *See* ANNUAL REPORT OF THE INTERNATIONAL WHALING COMMISSION, RESOLUTION ON ENVIRONMENTAL CHANGE AND CETACEANS, IWC Resolution 1998-5, Appendix 6, 44 (1999).

n97 IWC RESOLUTION, *supra* note 3.

n98 *Id.*

n99 50th Meeting of the International Whaling Commission, *Resolution for the Funding of Work on*

Environmental Concerns, IWC Resolution 1998-6. For a list of the eight priorities cited by the Scientific Committee, see *supra* note 3 and accompanying text.

n100 *Resolution for the Funding of Work on Environmental Concerns*, *supra* note 99.

n101 *Id.*

n102 51st Meeting of the International Whaling Commission, *Resolution for the Funding of High Priority Scientific Research*, IWC Resolution 1999-5 (1999).

n103 *Id.* The IWC also agreed to a feasibility study on fin and minke whales off West Greenland, and to accord priority to research in this context in 2000/2001 and subsequent years. *Id.*

n104 *Id.*

n105 *See Final Press Release, 1999 Annual Meeting, St. George's, Grenada, at* http://ourworld.compuserve.com/homepages/iwcoffice/Press99.htm (last visited Sept. 25, 2000).

n106 *Resolution for the Funding of High Priority Scientific Research*, *supra* note 102.

n107 International Whaling Commission, Resolution 2000-7 (2000).

n108 Convention on the Conservation of Antarctic Marine Living Resources, May 20, 1980, *33 U.S.T. 3476*, 1329 U.N.T.S. 48, *available at* http://www.eelink.net/asilwildlife/aa.html (The full text of the CCAMLR, and other Antarctic agreements, is available on the American Society of International Law - Wildlife Interest Group's website) [hereinafter CCAMLR]. CCAMLR applies to the Antarctic marine living resources of the area south of sixty degrees south latitude and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence which form part of the Antarctic marine ecosystem. *Id.* art. I(1). Antarctic marine resources are populations of fin fish, mollusks, crustaceans and all other species of living organisms, including birds, found south of the Antarctic convergence. *Id.* art. I(2). The Convention seeks to prevent the decrease of any harvested population to levels below those which ensure its stable recruitment. *Id.* art. II(3)(a). Parties to the Convention pledge to not engage in activities that will contravene the purposes of the agreement. *Id.* art. III. The Commission was established under the Convention to ensure achievement of the Convention's objectives by, *inter alia*, facilitating research and studies of Antarctic marine living resources; identifying conservation needs; and formulating and adopting conservation measures. *Id.* art. IX. The Commission and the Convention's Scientific Committee are required under the Convention to develop co-operative working relationships, as appropriate, with inter-governmental and non-governmental organizations which could contribute to their work including the International Whaling Commission. *Id.* art. XXIII(3).

IWC observers are also onboard research vessels participating in the CCAMLR's 2000 Krill Synoptic Survey, which seeks to improve estimates of the pre-exploitation biomass of krill, a critical parameter for establishing the sustainable yield of the Southern Ocean krill fishery. CCAMLR, *2000 Krill Synoptic Survey of Area 48*, http:www.ccamlr.org/English/e_scientific_committee/e_sc_krill_surv.html (last modified Aug. 11, 1999). The IWC observers will also conduct observations of whale abundance and distribution. Personal correspondence from Eugene Sabourenkov, Science Officer, CCAMLR Secretariat.

For additional information on the Commission, see the IWC website, http://www.ccamlr.org/. *See also* Stuart Kaye, *Legal Approaches to Polar Fisheries Regimes: A Comparative Analysis of the Convention for the Conservation of Antarctic Marine Living Resources and the Bering Sea Doughnut Hole Convention*, *26 CAL. W. INT'L L.J. 75 (1995).*

n109 The Global Ocean Ecosystems Dynamics (GLOBEC) was adopted by the International Geosphere-Biosphere Programme, to "advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the response of the marine ecosystem to global change." GLOBEC is co-sponsored by the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission of UNESCO. Intergovernmental Oceanographic Commission, *GLOBEC Open Science Meeting*, http://ioc.unesco.org/iyo/activities/conferences/globec.htm (last visited Nov. 12, 2000). Southern Ocean GLOBEC is one of GLOBEC's major research programs. Its major research activities will begin over the next two years and will focus on the impact of physical forces on population dynamics and predator-prey interactions between key species in the region, with special emphasis on the overwintering strategies of zooplankton and top predators. Researchers hope this research will advance the understanding of Southern ocean ecosystems and enhance the ability to monitor and predict climate change impacts. U.S. GLOBEC, http://www.pml.ac.uk/globec (last updated Oct. 29, 2000). *See also* IWC REPORT, *supra* note 21, at 4.

n110 International Whaling Commission, *Report of the Scientific Committee*, Annex Z, *Report of the ad hoc Working Group on Future SOWER Planning, reprinted in* 1 J. CETACEAN RES. & MGT. 263-66 (Supp. 1999).

The overall long-term objective of the SOWER programme is to:

> Define how spatial and temporal variability in the physical (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and biological (e.g. prey availability) environment influence cetacean species in order to determine those processes in the marine ecosystem which best predict long-term changes in cetacean distribution, abundance, stock structure, extent and timing of migrations and fitness.

Scientific Committee, International Whaling Commission, Annex H, *Report of the Standing Working Group on Environmental Concerns, reprinted in* 2 J. CETACEAN RES. & MGT. 217 (2000). "A specific objective of the programme is to 'relate distribution, abundance and biomass of baleen whale species to the same for krill in a large area in a single season.'" International Whaling Commission, Scientific Committee, *Report of the SOWER 2000 Workshop*, Annex E (2000), at 32.

n111 International Whaling Commission, *Report of the Scientific Committee*, Annex H, Appendix 3, *Observer's Report of the Meeting of the Southern Ocean GLOBEC Planning Group*, (1999), *reprinted in* 1 J. CETACEAN RES. & MGT. 204 (Suppl. 1999).

n112 *See* Joseph P. Rosati, *Enforcement Questions of the International Whaling Commission: Are Exclusive Economic Zones the Solution?, 14 CAL. W. INT'L L.J. 114, 124 n.101 (1984);* Scarff, *supra* note 68, at 333.

n113 Paul Thompson & Sue Mayer, *Defining Future Research Needs for Cetacean Conservation, in* THE CONSERVATION OF WHALES & DOLPHINS, *supra* note 71, at 412. *See also* Koen van Waerebeek et al., *Spatial and Temporal Distribution of the Minke Whale, Balaenoptera acutorostrata (Lacepede, 1804, in the*

Southern Northeast Atlantic Ocean and the Mediterranean Sea, with Reference to Stock Identity), 1 J. CETACEAN RES. & MGT. 223 (1999); Animal Welfare Institute, *Debunking the RMP: The Case for Practical Reality over Abstract Theory* 14-17 (1993).

n114 Tynan & DeMaster, *supra* note 61, at 20.

n115 *See supra* note 99 and accompanying text.

n116 WILLIAM T. BURKE, THE NEW INTERNATIONAL LAW OF FISHERIES 292 (1994). *See also* Steinar Andresen, *The Whaling Regime, in* SCIENCE AND POLITICS IN INTERNATIONAL ENVIRONMENTAL REGIMES 52 (Steiner Andresen et al., 2000).

n117 Japan, Norway, and their allies in the IWC contend that the moratorium on commercial whaling should be lifted on the grounds that sustainable harvesting of at least one species, minke whales, is now tenable. Parties that oppose lifting the moratorium base their position on ethical or moral grounds or question the sustainability of the harvest. *See* William C.G. Burns, *The Forty-Ninth Meeting of the International Whaling Commission: Charting the Future of Cetaceans in the Twenty-First Century*, 8 COLO. J. INT'L ENVTL. L. & POL'Y 64, 67 (1997); Kristen Fletcher, *The 49th Annual Meeting of the International Whaling Commission: Prelude to the Next Fifty Years*, 1 J. INT'L WILDLIFE L. & POL'Y 134, 134 (1998). As Michael Canny, the Chairman of the International Whaling Commission, recently concluded, there is increasing concern "that the inability of the IWC to reach a consensus on fundamental questions . . . will lead to a breakup of the IWC with detrimental effects on the conservation of whales." Michael Canny, *Opening Statement of the Government of Ireland*, IWC/49/OS/Ireland (1997). *See also* William Aron et al., *The Whaling Issue*, 24 MARINE POL'Y 179, 179 (2000) (IWC "verges on extinction").

n118 Indeed, Norway has expressly declared its misgivings about IWC efforts to assess environmental impact on cetaceans, with the exception of the impact of pollution. At the 51st Meeting, Norway's delegate argued that the IWC should concentrate its limited resources on monitoring of and research related to abundance and distribution of cetaceans, changes in biological parameters and the effects of pollution. The Norwegian delegate also issued the veiled threat that if the Scientific Committee were to accord less priority to advice on whaling issues, Norway might be compelled to seek advice on its whaling activities from another international body, such as the North Atlantic Marine Mammal Commission (NAMMCO), an intergovernmental organization established under the Agreement on Cooperation in Research, Conservation and Management of Marine Mammals in the North Atlantic, http://www.eelink.net/asilwildlife/nam.html, by the Faroe Islands, Greenland, Iceland and Norway in 1992 to conduct scientific study, conservation and management of marine mammals in the North Atlantic region. *See* Professor Lars Wall [empty set] e, *IWC should focus on central issues, not on general environmental topics*, http://www.highnorth.no/Library/Policies/National/lw-IWC-99.htm (last visited Sept. 25, 2000). For an overview of NAMMCO, see David D. Caron, *The International Whaling Commission and the Atlantic Marine Mammal Commission: the Institutional Risks of Coercion in Consensual Structures*, *89 AM. J. INT'L L. 154, 164-65 (1995).* Some fear that NAMMCO will ultimately become "an option for those in the North Atlantic region that decide to withdraw from the IWC or, more likely, to opt out of particular obligations." *Id. at 165.*

n119 William C.G. Burns, *The International Whaling Commission and the Future of Cetaceans: Problems and Prospects*, 8 COLO. J. INT'L ENVTL. L. & POL'Y 33, 54-56 (1997); *Resolution of Provisions for Completing the Revised Management Scheme Proposed by U.S., UK, Netherlands, Denmark, Norway,*

IWC/48/42, Agenda Item 11.4.2 (1996). Under the RMS, catches are not to be permitted on stocks that are below fifty-four percent of the estimated carrying capacity. International Whaling Commission, *Whale Population Estimates*, http://ourworld.compuserve.com/homepages/iwcoffice/Estimate.htm (last visited Nov. 26, 2000). Current scientific research on the RMP centers largely on simulation testing of possible application to specific species and ocean areas. Testing began with North Atlantic and Southern Hemisphere minke whales and has now moved on to North Pacific minke and Bryde's whales. International Whaling Commission, *Report of the Scientific Committee, Annex D. Report of the Sub-Committee on the Revised Management Procedure*, 1 J. CETACEAN RES. & MGMT. (Supp.) 263-66 (1999).

The IWC has accepted and endorsed the Revised Management Procedure; however, several outstanding issues remain before the IWC will consider lifting the commercial moratorium, including the specification of the inspection and observer system and "arrangements to ensure that total catches over time are within limits set under the RMS." International Whaling Commission, *Final Press Release*, 1998 Annual Meeting, May 20, 1998.

At its 50th Meeting, the parties to the IWC passed a resolution agreeing that any catch limits established under the RMS "shall be calculated by deducting all human-induced mortalities that are known or can be reasonably estimated, other than commercial catches, from the total allowable removal." International Whaling Commission, *Resolution on Total Catches Over Time*, IWC Resolution 1998-2.

n120 The IWC is currently conducting simulation trials for only two species of whales for the purposes of establishing quotas under the RMP, minke and Bryde's whales. International Whaling Commission--Scientific Committee, *Report of the Sub-Committee on the Revised Management Procedure*, Annex D, 2 (Suppl.) J. CETACEAN RES. & MGMT. 79, 85-91 (2000).

n121 Article V(1)(c) of the Whaling Convention, *supra* note 3, permits the parties to establish "open and closed waters, including the designation of sanctuary areas." The IWC designated most of the Pacific sector of the Southern Ocean as a sanctuary at the outset of the ICRW, banning the catching of baleen whales. In 1979, it established the Indian Ocean Sanctuary, prohibiting commercial whaling in "the waters of the Northern Hemisphere from the coast of Africa to 100 [degrees] E, including the Red and Arabian Seas and the Gulf of Oman; and the waters of the Southern Hemisphere in the sector from 20 [degrees] E to 130 [degrees] E, with the Southern boundary set at 55 [degrees] S." Whaling Convention, Schedule, sec. III(7)(a), as amended at the 51st Annual Meeting (1999), http://ourworld.compuserve.com/homepages/iwcoffice/Schedule.htm. Ninety percent of the world's whales feed in the Southern Ocean Sanctuary. Gerard Baker, *Japan Threatens to Quit Whaling Commission*, FIN. TIMES, May 28, 1994, at 4. For a history of the establishment of IWC sanctuaries, see Cassandra Phillips, *Conservation in Practice: Agreements, Regulations, Sanctuaries and Action Plans*, *in* THE CONSERVATION OF WHALES & DOLPHINS 460-463 (Mark P. Simmonds & Judith D. Hutchinson eds., 1996).

n122 *See supra* notes 37-43 and accompanying text.

n123 *See supra* note 108 and accompanying text.

n124 Up to this point, efforts to commercially exploit krill in the Antarctic have been minimal, with only approximately 80,000 tons being harvested annually, primarily by the Japanese. However, an American agri-business concern is gearing up for a much larger harvest to supply the aquaculture industry and as a protein supplement for human food. Moreover, it is anticipated that fishers from Britain, several Eastern European nations, China, Canada and perhaps Chile will soon join the hunt. Don Woolford, *Ozone and Overfishing*

Threaten UV-sensitive Krill, AAP NEWSFEED, Feb. 8, 1999 *at* LEXIS, World Library; *Ozone Hole Killing Antarctic Krill Stocks, Scientists Warn*, DEUTSCHE PRESS-AGENTUR, Feb. 8, 1999 *at* LEXIS, World Library. "Krill may take over as the major issue facing CCAMLR . . ."

n125 *See supra* note 17. *See also* Wayne A. Morrissey, *Global Climate Change: Adequacy of Commitments Under the U.N. Framework Convention and Berlin Mandate*, Congressional Research Service Report for Congress (Oct. 25, 1996), http://www.cnie.org/nle/clim-14.html (last visited Nov. 12, 2000).

n126 United Nations Conference on Environment and Development: Framework Convention on Climate Change, May 9, 1992, *31 I.L.M. 849* [hereinafter UNFCC].

n127 International Institute for Sustainable Development, *Summary of the Fifth Conference of the Parties to the Framework Convention on Climate Change*, 12 EARTH NEGOTIATIONS BULL. 2 (1999). For the negotiating history leading up to the UNFCCC, see Elizabeth P. Barratt-Brown et al., *A Forum for Action on Global Warming: The U.N. Framework Convention on Climate Change*, 4 COLO. J. INT'L ENVTL. L. & POL'Y 103, 106-09 (1993).

n128 UNFCCC, *supra* note 126, art. 2.

n129 UNFCCC, *supra* note 126, arts. 3(1) & 4(1); Paul G. Harris, *Common But Differentiated Responsibility: The Kyoto Protocol and United States Policy*, *7 N.Y.U. ENVTL. L.J. 27, 27 (1999).* The principle of common but differentiated responsibility was also adopted in Principle 7 of the Rio Declaration on Environment and Development, requiring nations to share responsibility for confronting environmental problems, but taking into account nations' different contributions to these problems and capacity to confront them. *See* Rio Convention on Environment and Development, Principle 7, U.N. Doc. A/CONF.151/5/Rev. 1, *31 I.L.M. 874 (1992)*

n130 UNFCCC, *supra* note 126, art. 3(1).

n131 Annex I of the UNFCCC is comprised of country parties that were members of the Organization for Economic Cooperation and Development at the time of adoption of the treaty, some Eastern European nations, and some nations that were part of the former Soviet Union.

n132 UNFCCC, *supra* note 126, art. 4(2)(a).

n133 *Id.* art. 4(2).

n134 Bas Arts, *New Arrangements in Climate Policy*, 52 CHANGE 1, 2 (2000) ("The industrialized nations have increased emissions by an average of about 10% above 1990 levels"). *See also EU Moves on Emissions, Warms CO[2] Pollution Rising*, Reuters News Service, (Mar. 9, 2000), http://www.planetark.org/dailynewsstory.cfm?newsid=5917; *Cabinet Okays Plan to Fight Global Warming* (1999), http://www.theglobeandmail.com/gam/Environment/19991215/UWARMN.html.

n135 Under the UNFCCC, the parties established a Conference of the Parties to regularly review and promote implementation of the treaty. UNFCCC, *supra* note 126, art. 7(1)(2). The Conference of the Parties is to be held annually unless otherwise decided by the parties. *Id.* art. 7(4).

n136 UNFCCC, Conference of the Parties, 1st Sess., UN Doc. FCCC/CP/1999/7/Add.1, Decision 1/CP.1, at 4-6 (June 6, 1999). The Conference of the Parties agreed to establish an "Ad Hoc Group on the Berlin Mandate" (AGBM) to, *inter alia*, "set quantified limitation and reduction, objectives within specified time-frames, such as 2005, 2010 and 2020, for [Annex I parties] anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol . . . ." *Id.*

n137 Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, FCCC/CP/1997/L.7/Add. 1, *37 I.L.M. 22.*

n138 The six greenhouse gases regulated under the Kyoto Protocol are: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. *Id.* at Annex A.

n139 *Id.* art. 3 (1). "Individual States' commitments to reductions are differentiated with a view to meeting the 5 percent overall target; the European Community and all its member States are committed to 8 percent reductions, the United States to 7 percent and Japan and Canada to 6 percent. New Zealand, the Russian Federation and Ukraine will stabilise emissions at 1990 levels, whilst some States negotiated an actual increase in emissions." Peter G.G. Davies, *Global Warming and the Kyoto Protocol, 47 INT'L & COMP. L.Q. 446, 453 (1998).*

n140 Andrew C. Revkin, *Senators Doubt Progress on Global Warming Plan*, N.Y. TIMES, Sept. 29, 2000, *available at* http://www.nytimes.com/2000/09/29/science/29CLIM.html; Gretchen Vogel & Andrew Lawler, *Hot Year, But Cool Response in Congress*, 280 SCIENCE 1684, 1684 (1998). Opponents to the Protocol argue that it will have serious adverse impacts on the economies of developed nations, including substantial reductions in economic growth and increased unemployment. *See* Gregg VanHelmond, *Squandering the Surplus: $ 11 Billion on the Unratified Kyoto Protocol*, HERITAGE FOUNDATION BACKGROUNDER, No. 132 (Sept. 17, 1999), *available at* http://www.heritage.org/library/backgrounder/bg1322.html; Margo Thorning, *The Impact of the Kyoto Protocol on U.S. Economic Growth and Projected Budget Surpluses*, American Council for Capital Formation (Mar. 25, 1999), *available at* http://www.accf.org/Mar99test.htm; Consumer Alert, *'Cooler Heads' Members Say Kyoto Protocol Will Have Devastating Effects on Consumers, Seniors, the Poor, Small Business* (Mar. 16, 1998), http://www.consumeralert.org/issues/enviro/MarchPR.htm. Moreover, opponents to the Kyoto Protocol contend that it places developed nations at an economic disadvantage vis-a-vis developing nations who are not required to make emissions reductions commitments under the treaty. *See* U.S. Senate Resolution 2019, 105th Congress, 1st Sess. (1997).

n141 Bharat H. Desai, *Institutionalizing the Kyoto Climate Accord*, 29 ENVTL. POL'Y & L. 159, 161 (1999). *See also* Alex Barnum, *Can World Unite, Halt Climate Threat?*, S.F. CHRON., Nov. 28, 1997, at A21. U.S. refusal to adopt the Protocol might result in European nations balking also. This could doom the agreement because it requires ratification by Annex I nations producing at least fifty-five percent of greenhouse gas emissions. *Risky Business*, GLOBAL CHANGE, Oct. 1998, at 2. Up to this point, the Protocol has been adopted by only twenty-three nations, none of which are significant greenhouse gas emitters. Vanessa Houlder, *Vital Talks Loom at The Hague: The Kyoto Protocol*, FIN. TIMES, Sept. 29, 2000, *available at* http://search.ft.com/search/multi/globalarchive.jsp?docId=000929000414&query.

n142 Breffni O'Rourke, *Europe: Meeting Kyoto Pollution Cuts Will Be Difficult*, Radio Free Europe/Radio Liberty (2000), http://www.rferl.org/nca/features/2000/10/05102000185206.asp. *See also* Colin Macilwain, *Emissions Targets 'Unrealistic' Says U.S. Climate Change Body*, 406 NATURE 333 (2000); *U.S. 'Unlikely to Meet its Targets,'* BBC News (Sept. 21, 2000), http://news.bbc.co.uk/hi/english/sci/tech/newsid_934000/934194.stm.

n143 Bette Hileman, *Climate Observations Substantiate Global Warming Models*, CHEMICAL & ENGINEERING NEWS (Nov. 27, 1995), http://pubs.acs.org/hotartcl/cenear/951127/pgl.html. *See also* Thomas R. Karl et al., *The Coming Climate*, May 1, 1997, SCI. AM. 78, 80 ("as much as 40 percent of [carbon dioxide] tends to remain in the atmosphere for centuries"); Silvia Kusidio, *Climatic Changes Are No Longer Preventable, Warn Experts*, DEUTSCHE PRESSE-AGENTUR, Mar. 22, 1995 *available at* LEXIS, News file ("Even a worldwide stabilization of the emissions would not prevent a rise in the greenhouse gases . . . for the next 200 years . . .").

n144 *See supra* notes 134-37 and accompanying text.

n145 Martin Parry et al., *Buenos Aires and Kyoto Targets Do Little to Reduce Climate Change Impacts*, 8 GLOBAL ENVTL. CHANGE 285, 285 (1998).

n146 Roger Jones, *Climate Change in the South Pacific*, 35 TIEMPO 17, 20 (2000).

n147 *See* World Meteorological Organization/United Nations Environment Programme Intergovernmental Panel on Climate Change, *Climate Change: The IPCC Scientific Assessment*, at xxxvi (J.T. Houghton et al. eds., 1990).

n148 Committee for the National Institute for the Environment, *Energy Efficiency: Budget, Climate Change, and Electricity Restructuring Issues II*, *at* http://cnie.org/nle/eng-48a.html (last visited Dec. 19, 2000); Steven Bernow et al., *America's Global Warming Solutions*, A Study for the World Wildlife Fund and the Energy Foundation (Oct. 6, 1999), http://www.tellus.org/energy/publications/solution.pdf; William K. Stevens, *Price of Global Warming?*, N.Y. TIMES, Oct. 10, 1995, at B6.

n149 U.N. Framework Convention on Climate Change, *supra* note 126, art. 4(2) & Annex I; Kyoto Protocol, *supra* note 137, art. 3. Article 10 of the Kyoto Protocol did affirm the existing commitments imposed on all parties under Article 4(1) of the UNFCCC. These commitments include national emissions reporting to the Conference of the Parties and formulation and implementation of programs containing measures to mitigate climate change.

n150 China's carbon dioxide emissions alone will probably exceed that of the entire OECD by the middle of this century. *See* Francis Cairncross, *Global Warming Won't Cost the Earth*, INDEPENDENT, Mar. 28, 1995, at 13; *see also* Kim Ji-Soo, *Seoul Resists Pressure to Commit to Reducing CO[2] Emissions*, KOREA HERALD, Dec. 8, 1999 at 3. South Korea, with the eleventh highest emissions of greenhouse gases in the world, projected that its emissions will rise seventy-six percent from its 1998 levels by 2020). "By 2100, carbon-dioxide emissions from developing countries will probably be more than the rich world's output." *Global Warming and Cooling Enthusiasm*, ECONOMIST, Apr. 1, 1995, at 33.

n151 Clare Breidenich et al., *The Kyoto Protocol to the United Nations Framework Convention on Climate Change, 92 AM. J. INT'L L. 315, 331 (1998); Kyoto Protocol: The Unfinished Agenda*, 39 CLIMATIC CHANGE (1998) at 9.

n152 Anita Margrethe Halvorssen, *Climate Change Treaties--New Developments at the Buenos Aires Convention*, 1998 COLO. J. INT'L ENVTL. L & POL'Y 1, 1 (1998); Davies, *supra* note 139, at 457. "20 percent of the world's population is responsible for 63 percent of carbon dioxide emissions, while another 20 percent is responsible for only 2 percent of these emissions." Robert Engelman, *Population, Consumption and Equity*, TIEMPO, Dec. 1998, at 5.

Developing countries repulsed an effort at the Third Conference of the Parties in Kyoto to establish emission limitation objectives for wealthier developing states. *Id.* At the Fourth Meeting of the Conference of the Parties, in Buenos Aires, Argentina became the first developing country to commit itself to take on an emissions reduction target for the initial commitment period under Kyoto of 2008 to 2012. *Address by the President of the Republic of Argentina*, Report of the Conference of the Parties on Its Fourth Session, United Nations Framework Convention on Climate Change, Conference of the Parties, 4th Sess., U.N. Doc.FCCC/CP/1998/16, Annex I, at 35 (1999). However, it is unclear how substantive this commitment will be, or if other developing nations will follow suit. Susan Fletcher, *Global Climate Change Treaty: The Kyoto Protocol*, Congressional Research Report for Congress, 98-2, *available at* http://www.cnie.org/nle/clim-3.html (last updated Mar. 6, 2000).