PROTECTING THE ANTARCTIC COMMONS

Problems of Economic Efficiency

Bernard P. Herber

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Introduction

A *ventifact*, wind-eroded rock, found in the McMurdo Dry Valleys; photograph by Kristan Hutchison

Introduction

The unique natural resources of Antarctica, including the crucial planetary-wide atmospheric and oceanic effects they help generate, are of great importance to all world nations and their citizens. This monograph assesses—using the benchmark of "economic efficiency" and an analysis of the concepts of public goods, private goods, externalities, and natural resource commons—the degree to which present economic uses of Antarctica are rational and sustainable.

The economic activities of Antarctic science, fishing, and tourism, examined herein, give rise to a number of specific problems that demonstrate the need for policy attention if the Antarctic natural resource "engines" for the global atmospheric and oceanic commons, along with other Antarctic commons features, are to be preserved for future generations.

The central feature of these economic-efficiency problems derives from the difficulty markets encounter in pricing the benefits and costs of (a) public goods, such as science in Antarctica, (b) the Antarctic natural resource commons, and (c) the significant externalities that accompany the allocation of the Antarctic private goods, fishing and tourism.

This monograph analyzes the adequacy of the Antarctic Treaty System—a non-sovereign, international governance body that grew out of the Antarctic Treaty of 1959—to direct an important policy role in the face of such obstacles. The primary goal of a successful policy is the long-term sustainability of the globally strategic Antarctic commons and natural resources. Alternative strategies to attain this desired policy outcome are discussed in light of the emerging trends of economic globalization, on the one hand, and the retrenchment of political multilateralism, on the other.

With this policy goal in mind, the Antarctic Treaty System, the primary governing body of the Antarctic region, is seen as the preferred means to lead the way in managing Antarctic resources with the coordination of the wider international governance community.

Antarctica: A Continent Apart

A research vessel docked at Palmer Station on Anvers Island;
photograph by Zee Evans

Antarctica: A Continent Apart

The continent of Antarctica (Figure 1) represents 10 percent of the Earth's land area, containing more territory than either Europe or Australia, and possesses a number of characteristics unique among the seven continents (Table 1). Antarctica has no indigenous population, no sovereign nations, no heavy manufacturing industry, no arable land, no permanent crops[1]—and it has never experienced war. Ninety-eight percent of Antarctica is covered by ice, with the remaining two percent only seasonally ice free. Antarctica contains more than 90 percent of the world's ice (i.e., glaciers and permanent ice caps), which constitutes nearly 70 percent of the planet's freshwater (U.S. Department of Energy, 2006).

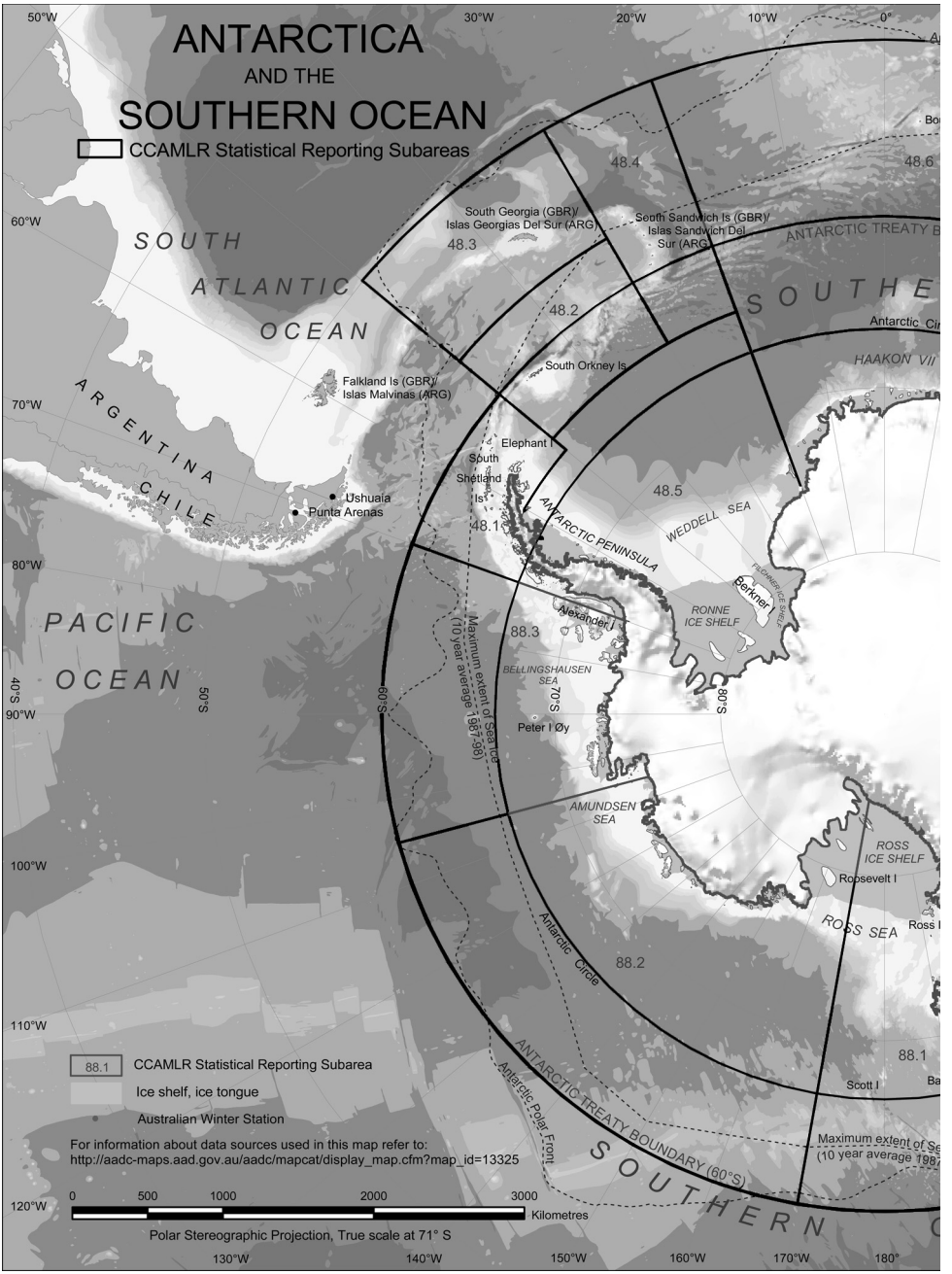
Table 1: Continental Comparisons

Continent	Land Area (million sq. miles)	Population (million persons)*	Sovereign Nations
Antarctica	13.2	0	0
Africa	30.1	878	53
Asia	44.6	3,879	44
Australia/ Oceania	7.7	32	14
Europe	9.9	727	46
North America	24.3	501	23
South America	17.8	379	12

* 2005 estimates
Source: World Atlas, 2006

Meanwhile, Antarctica's harsh climate, difficult terrain, and geographic isolation contribute to its distinction among the

1. World Factbook. 2006. "Antarctica," <www.cia.gov/cia/publications/factbook/geos/ay.html>, last visited December 1, 2006.


ANTARCTICA
AND THE
SOUTHERN OCEAN
CCAMLR Statistical Reporting Subareas
SOUTH
ATLANTIC
OCEAN
PACIFIC
OCEAN
ARGENTINA
CHILE
Falkland Is (GBR)/
Islas Malvinas (ARG)
Ushuaia
Punta Arenas
South Georgia (GBR)/
Islas Georgias Del Sur (ARG)
South Sandwich Is (GBR)/
Islas Sandwich Del
Sur (ARG)
South Orkney Is
Elephant I
South
Shetland
Is
ANTARCTIC PENINSULA
WEDDELL SEA
RONNE
ICE SHELF
Filchner Ice Shelf
Berkner I
Alexander I
BELLINGSHAUSEN
SEA
Peter I Øy
AMUNDSEN
SEA
ROSS
ICE SHELF
Roosevelt I
ROSS SEA
Ross I
Scott I
HAAKON VII
ANTARCTIC TREATY B
SOUTHE
Antarctic Ci
48.1
48.2
48.3
48.4
48.5
48.6
88.1
88.2
88.3
Maximum extent of Sea Ice
(10 year average 1987-98)
Antarctic Circle
Antarctic Polar Front
ANTARCTIC TREATY BOUNDARY (60°S)
SOUTHERN
Maximum extent of Se
(10 year average 198
88.1 CCAMLR Statistical Reporting Subarea
Ice shelf, ice tongue
Australian Winter Station
For information about data sources used in this map refer to:
http://aadc-maps.aad.gov.au/aadc/mapcat/display_map.cfm?map_id=13325
0 500 1000 2000 3000
Kilometres
Polar Stereographic Projection, True scale at 71° S
50°W
30°W
20°W
10°W
0°
60°W
70°W
80°W
90°W
100°W
110°W
120°W
130°W
140°W
150°W
160°W
170°W
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40°S
50°S
60°S
70°S
80°S

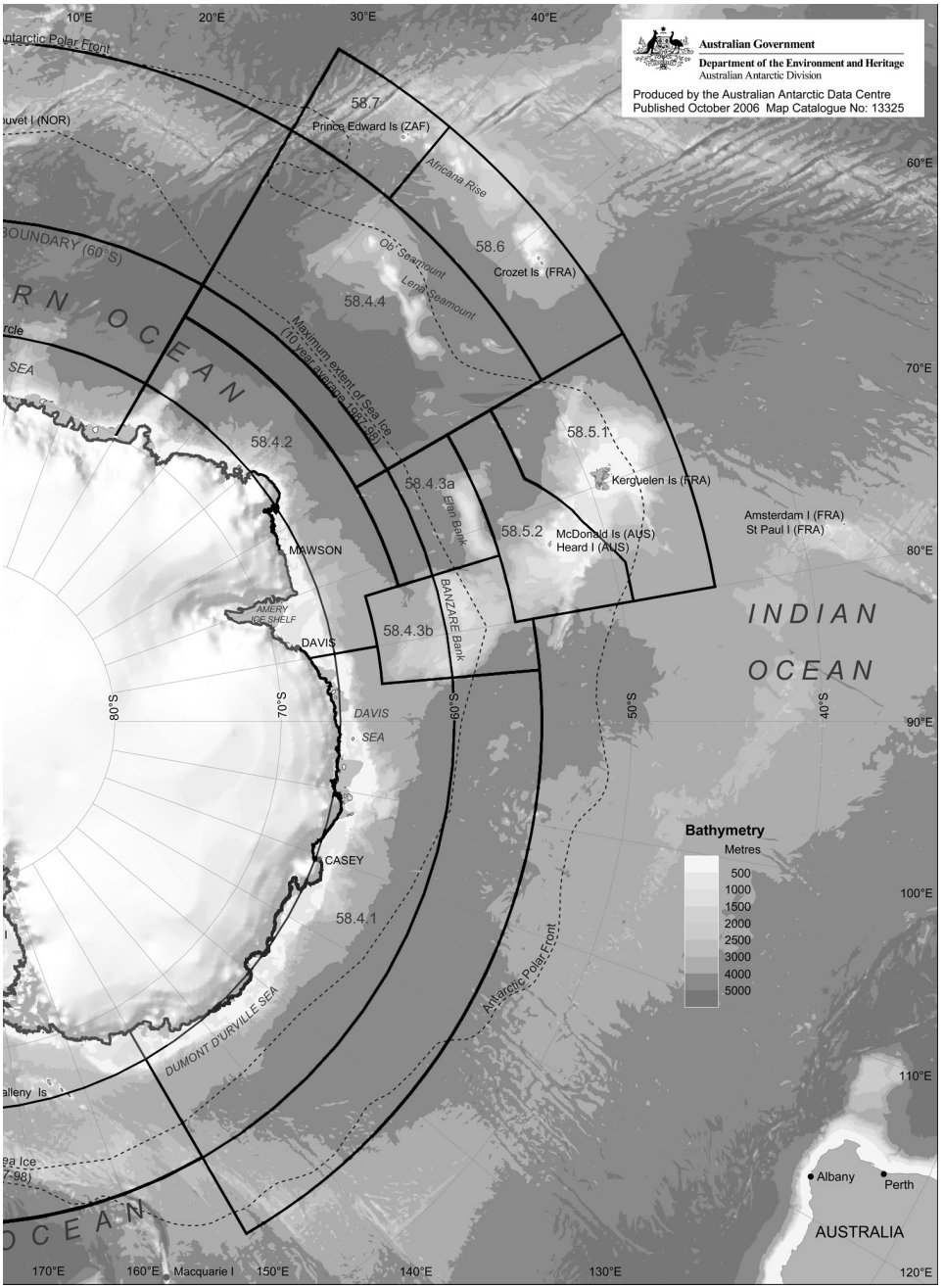

FIGURE 1: Map of Antarctica (Copyright © Commonwealth of Australia, Australian Antarctic Division).

continents, though advancing technology is beginning to erode this gap. Importantly, Antarctica's unique natural resources manifest a strategic interrelationship with global environmental processes, especially in relation to the functioning of the global atmospheric and oceanic commons, inclusive of global weather and climate. This monograph focuses on several problems that pose threats to the efficient economic utilization of the natural resources and commons of Antarctica.

Governing Antarctica

Since Antarctica does not possess a sovereign, decision-making government, policies dealing with these issues must be formulated within an adapted governmental setting. In the absence of a politically sovereign governance body, the economic resources of the so-called seventh continent are under the direction of a non-sovereign international treaty regime, the Antarctic Treaty System.

This system of governance grew out of the Antarctic Treaty of 1959, a remarkable international agreement that provided political stability to a contentious region while, at the same time, opening the door to important scientific research in the highly promising and exceptional natural laboratory of the Antarctic region.[2] Prior to the Antarctic Treaty, political stability in the region was threatened by two problems: (1) claims of sovereignty by seven nations—Argentina, Australia, Chile, France, Great Britain, New Zealand, and Norway—which together claim sovereignty over nearly 80 percent of Antarctica (and with some claims overlapping others), and (2) the Cold War superpowers, the Soviet Union and the United States, perceiving potential military value in the region.

2. Antarctic Treaty (AT), adopted December 1, 1959; entered into force June 23, 1961.

Fortunately, the negotiations leading to the Antarctic Treaty were able to take advantage of the global scientific cooperation that accompanied the International Geophysical Year of 1957-58, which featured multinational, polar, scientific research. Moreover, the scientific community at that time created an important research body, the Scientific Committee on Antarctic Research, which continues today as the primary institution for facilitating and coordinating scientific research under the Antarctic Treaty.

At its inception in 1959, the Antarctic Treaty had twelve signatory nations (the seven claimant nations cited above plus Belgium, Japan, the Soviet Union, South Africa, and the United States). The treaty had great success in diffusing the Antarctic region's political instability and the threat of military conflict. This was accomplished by placing the sovereignty claims of the seven claimant nations in an ongoing moratorium status, the result being no recognition of sovereignty or sovereign nation claims in Antarctica.

Meanwhile, the Soviet Union and the United States, while not claiming sovereignty over any Antarctic territory, reserved the right to make such a claim in the future. Interestingly, the two superpowers became cooperative scientific parties along with the other ten treaty nations. Importantly, building upon its linkage with the International Geophysical Year, the treaty established science as the primary industry of Antarctica.

The Antarctic Treaty applies to the area south of 60 degrees south latitude and remains in force indefinitely. Its success can be measured by the fact that, to date, 45 nations, comprising 80 percent of the global population inclusive of all major industrial and developing nations, have acceded to, or ratified, the treaty—with 28 of these nations having voting power over Antarctic governance (Table 2). Nations with voting power are known as consultative parties, a privilege merited either by being one of the 12 original signatory nations to the treaty or, subsequently, by acceding to the treaty and demonstrating substantial scientific

research in Antarctica. In the absence of a sovereign international government, decisions are negotiated between the 28 consultative parties, utilizing a consensus voting format[3] at annual Antarctic Treaty meetings.

Table 2: Antarctic Treaty Nations
Group I: Original Signatory Nations*
Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, Russian Federation,** South Africa, United Kingdom, United States Total = 12 Nations
Group II: Later Acceding Nations with Substantial Scientific Research in Antarctica*
Brazil, Bulgaria, China, Ecuador, Finland, Germany, India, Italy, Netherlands, Peru, Poland, South Korea, Spain, Sweden, Ukraine, Uruguay Total = 16 Nations
Group III: Later Acceding Nations without Substantial Scientific Research in Antarctica
Austria, Canada, Colombia, Cuba, Czech Republic, Denmark, Estonia, Greece, Guatemala, Hungary, North Korea, Papua New Guinea, Romania, Slovak Republic, Switzerland, Turkey, Venezuela Total = 17 Nations
Total Antarctic Treaty Acceding Nations = 45
* Antarctic Treaty Consultative Parties (ATCP) = 28 Voting Members (Groups I and II above) ** Soviet Union at time of signature and accession

3. In effect, consensus voting amounts to a unanimity-voting rule.

Antarctic Treaty System

The original Antarctic Treaty of 1959 grew into what has become known as the Antarctic Treaty System through a series of additions to its governance structure,[4] including:

- Agreed Measures for the Conservation of the Antarctic Fauna and Flora (1964)[5]
- Convention for the Conservation of Antarctic Seals (1972)[6]
- Convention on the Conservation of Antarctic Marine Living Resources (1980)[7]
- Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol, 1991)[8]

The geographic scope of the original Antarctic Treaty has been broadened through each subsequent addition to the treaty, especially by the Convention on the Conservation of Antarctic Marine Living Resources in 1980. The coverage of the Antarctic Treaty System currently extends beyond the continent itself to include the entire Southern Ocean, which surrounds the continent.[9]

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4. Signatory nations to the Antarctic Treaty are not identical, in all cases, with the nations that signed the subsequent additions to the treaty.
5. Agreed Measures for the Conservation of the Antarctic Fauna and Flora, Antarctic Treaty, adopted June 2, 1964; entered into force November 1, 1982.
6. Convention for the Conservation of Antarctic Seals (CCAS), Antarctic Treaty, adopted June 1, 1972; entered into force March 11, 1978.
7. Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), Antarctic Treaty, adopted May 20, 1980; entered into force April 7, 1982.
8. Protocol on Environmental Protection (Madrid Protocol), Antarctic Treaty, adopted October 4, 1991; entered into force January 15, 1998.
9. The International Hydrographic Organization recognized the Southern Ocean in the Year 2000 as the "fifth world ocean," extending from the southern portions of the Atlantic Ocean, Indian Ocean, and Pacific Ocean toward the South Pole. The boundary of the Southern Ocean is formed by the fluctuating Antarctic Convergence Zone, or Polar Front, which is the middle of the Antarctic Circumpolar Current—the demarcation line between cold Antarctic waters and warmer waters to the north—which forms a biological barrier that essentially results in a closed ecosystem (CCAMLR, 2004).

The Economy of Antarctica

Dome at Amundsen-Scott South Pole Station framed by ridges of snow called *sastrugi*; photograph by Bill McAfee

The Economy of Antarctica: Public Goods, Private Goods, and Commons

As viewed by the discipline of economics, the output of economic goods to satisfy human welfare is made possible by the utilization of economic resources in production. These resources, which are also referred to as the factors of production, consist of land or natural resources, labor, and capital (both money and productive capital such as machinery).

In Antarctica, the land/natural resources factor of production dominates as compared to the labor and capital factors. In other words, Antarctic economic output is land-intensive. This is in contrast to the economies of the other six continents—comprising some 200 sovereign nations—which are characterized by much larger ratios of labor and capital to land/natural resources in the production process.

The primary outputs of the Antarctic economy are the *public goods*, peace and science, the *private goods*, fishing and tourism, and *commons* in the form of the strategic linkage of Antarctic natural resources to the global atmosphere, climate, and oceans as well as certain other commons-like features of Antarctica.

Public Goods in Antarctica: Peace and Science

What is a public good?

A primary feature of a public good is that it is impossible, or very difficult, to price its benefits in the market. Without adequate pricing, of course, it is impossible or difficult to produce the good for a profit and, thus, there is a tendency for the good to be undersupplied in the market if, indeed, it is supplied at all.

This difficulty in pricing stems from two inherent characteristics of a public good: (a) collective or nonrival consumption of the good, which means that the consumption of the good by one person does not prevent another person from enjoying the benefits of the

good—thus creating an incentive for each user to "wait" for other users to pay for the good (the free-rider problem), and (b) the non-exclusion factor, meaning that it is impossible, or very difficult, to exclude persons from consuming the good by charging a price for it since the good cannot be divided into individual (single) units that can be priced.

Due to the inability of markets to capture public-good benefits in a price and, thus, an inability to make a profit from producing the good, some sort of non-market (usually government) intervention may be required if the good is to be supplied in adequate quantities—an important consideration if the economic good in question is a necessity as opposed to a luxury. Meanwhile, the concept of public-good benefits may be broadened to include the collective consumption of such benefits by two or more nations and their citizens—thus, a transnational or global public-good concept emerges depending upon whether a subset of nations (transnational), or all world nations (global), consume the benefits.

Peace as a public good in Antarctica

As noted above, the primary goals of the Antarctic Treaty are political stability and scientific research.[10] Prior to the Antarctic Treaty, political stability had been threatened by tension between three of the seven territorial claimants as well as by a growing sensitivity between the two Cold War superpowers to the presence of each other in the region. To defuse these threats, the Antarctic Treaty established a zone of peace in the region via several key tenets.

Article I(§1) of the treaty stipulates that Antarctica shall be used only for peaceful purposes, thus demilitarizing the region. This goal is reinforced by Article I(§2), which prohibits military

10. For additional coverage of Antarctic political stability and science, see Beck (1986); Herber (1992); and Joyner (1998). For a discussion of peace as a global public good, see Mendez (1999).

bases, maneuvers, and testing while permitting the use of military personnel and equipment to support scientific research.[11] Article IV, which places a moratorium on claims to sovereignty—whether existing or potential—further enhances the goal of peace. The treaty does not specifically renounce existing claims to territorial sovereignty, but does neutralize them as long as the treaty is in existence. In addition, it stipulates that no new claims, nor enlargement of existing claims, may be undertaken as long as the treaty is in force.

Though prohibiting military bases, maneuvers, and testing, the Antarctic Treaty permits the use of military personnel and equipment to support scientific research. Photograph by Mark Sabbatini.

Moreover, the treaty prohibits, in Article V, nuclear explosions and the disposal of radioactive wastes in Antarctica. Meanwhile, Article VII(§3) says that all areas of Antarctica, including stations, installations, and equipment, and all ships and aircraft, must be open at all times to inspection by treaty nations. Finally, Article XI provides a mechanism for the peaceful settlement of any disputes that might arise between treaty nations.

11. The latter was a delicate endeavor that has proven to be largely successful.

Thus, Antarctica is unique among the seven continents as a continent of sustained peace. The citizens of all world nations, and especially those of the treaty nations of the Antarctic Treaty System, collectively consume the benefits of political stability, and the associated absence of military conflict. Indeed, peace in Antarctica is a global public good. Its consumption is collective or non-rival since one person may enjoy the benefits of peace without reducing these benefits to any other person.

Moreover, the benefits of political stability are non-exclusionary since they cannot be divided into individual units capable of being priced. Significantly, once the benefits of peace are attained, it is possible that only minimal economic resource costs will be required to maintain these benefits. This is presently the case in Antarctica. Moreover, if the benefits of peace are achieved in the first place via the low-cost avenue of international negotiations and treaty rather than by military conflict or by sizable war-preventive national defense expenditures—which again is the case for Antarctica under the treaty system—the political stability is quite a "bargain."

Science as a public good in Antarctica

Scientific research in Antarctica also yields important collective consumption benefits. It does so through its intrinsic connection to knowledge,[12] the benefits of which may be consumed by one person without reducing their consumption by other persons. Such non-rival consumption makes knowledge, or science, difficult to appropriate or price to particular individuals, though such appropriation may occur for limited periods of time in such forms as patents and other means of assigning intellectual property rights.[13]

12. See Stiglitz (1999) for a discussion of "knowledge" as a public good with transnational/global characteristics.

13. Some pricing of the benefits of knowledge to particular individuals is also attainable via tuition charges at educational institutions.

Moreover, the collectively consumed benefits of scientific research and knowledge generally transcend the boundaries of nations and assume the proportions of a global public good. Clearly, Antarctic science possesses public good attributes—as does knowledge everywhere—but it also exhibits significant additional multinational public good traits due to the sharing of its research.

For example, Article III(§1) of the Antarctic Treaty stipulates that scientific research plans undertaken by any treaty nation must be made known to the scientists of all other treaty nations and must be accompanied by the free exchange of scientific personnel and research findings among these nations.[14] The absence of sovereign national borders in Antarctica facilitates such cooperation in Antarctic scientific programs.

The benefits of scientific research in Antarctica transcend the boundaries of nations and assume the proportion of a global public good. Photograph by Emily Stone.

Meanwhile, Article III(§2) provides for cooperative working arrangements with specialized agencies of the United Nations and

14. In practice, this article does not ensure complete openness in scientific matters among the treaty nations but, overall, its performance has been very good.

other international organizations having scientific or technical interests in Antarctica. Private and national proprietary interests in scientific knowledge, which normally accompany the gathering of such knowledge, are reduced considerably in Antarctica by these arrangements. The result is an unusually high degree of openness and collective consumption between nations in Antarctic scientific activities. Indeed, science in Antarctica qualifies as a public good with global dimensions, as well as significant commons characteristics that will be discussed below.

Private Goods in Antarctica: Fishing and Tourism

What is a private good?

The primary characteristic of a private good is that most, or all, of its benefits can be priced in the market. This is because the consumption of the good is exclusive to a particular individual (or entity) rather than collective across a larger number of consumers. As a result, there is little, if any, incentive for free-rider behavior whereby one individual waits for other individuals to pay for the good in order to generate a supply of the good. If a person does not pay for a good, he or she can be excluded from its consumption. Hence, there is no inherent tendency for the good to be undersupplied because it can be priced in the market and, given sufficient demand, it can be produced at a profit.

The problem of externalities

Sometimes, however, even though profits may induce the private sector to produce a particular good in the market, unwanted secondary effects (e.g., environmental damage) may accompany its production. Such so-called negative externalities, which escape market pricing, may lead to inefficiency in the overall use of economic resources—a factor worth noting in relation to the Antarctic environment as affected by the various economic uses that are described here. In addition, similar negative economic effects, which may also be classified as externalities, can occur in the utilization of natural resources—of both the renewable and non-renewable variety.

For example, if a renewable resource, such as fish, is exploited at a rate greater than its natural rate of reproduction, negative economic effects will have occurred that escape market pricing. Moreover, if non-renewable resources such as Antarctica's pristine environment and its ecology are depleted, undesirable economic effects, which market pricing does not capture, again may occur. Such considerations are relevant to the search for economic efficiency in the utilization of the unique resources and commons of the continent of Antarctica and its surrounding Southern Ocean.

Fishing as a private good in Antarctica

Commercial (i.e., for profit) harvesting of marine living resources in the Southern Ocean surrounding Antarctica began with the taking of seals during the late 1700s. Much later, the exploitation of marine living resources emphasized the commercial harvesting of krill during the 1970s. Patagonian toothfish (Chilean sea bass) also are taken commercially, as are cod and crab. During the 12-month period, July 1, 2003, to June 30, 2004, the catch of toothfish amounted to nearly 27,000 tons in the Antarctic region—part of which is under Antarctic Treaty System jurisdiction and other parts of which consist of the Exclusive Economic Zone and High Seas areas created by the United Nations Convention on the Law of the Sea (hereafter, Law of the Sea Convention).[15] Overall, fish stocks in the Southern Ocean are not dense.

While the for-profit or commercial characteristics of Antarctic fishing qualify it a private good, the excessive harvesting of a renewable natural resource beyond its natural (i.e., sustainable) rate of regeneration can create unwanted negative externalities. This was the case in the harvesting of krill[16] in the Antarctic region during the 1970s. The over-harvesting of krill resulted in the

15. United Nations Convention on the Law of the Sea (UNCLOS), adopted December 10, 1982; entered into force November 16, 1994.

16. Krill is a highly nutritious shrimp-like invertebrate that is integral to the entire ocean ecosystem in the region.

negotiation of the Convention on the Conservation of Antarctic Marine Living Resources in 1980. The result of this component of the Antarctic Treaty System was a significant reduction in krill over-harvesting.

Tourism as a private good in Antarctica

The commercial tourist industry in Antarctica began during the 1960s and has grown rapidly since the mid-1980s, primarily via shipborne tourism provided by commercial tour operators. The majority of tourist activities occur in the more accessible and climatically less severe north and west parts of the Antarctic Peninsula.

In 1991, the increase in the number of tour operators and concern for the environment led to a voluntary effort at industry self-regulation via the formation of the International Association of Antarctic Tour Operators. At the present time, the Antarctic Treaty System provides only loose oversight of Antarctic tourist activities and related threats to the environment—though the treaty system possesses the legal authority to do more. The total number of tourists for the 2005-06 season was about 29,800, mostly from the United States (39 percent), United Kingdom (15 percent), and Germany (10 percent), with smaller numbers from Australia, Canada, Netherlands, Switzerland, Japan, and other countries.[17]

While the commercial characteristics of Antarctic tourism qualify it as a private good, the impact of such activities on the fragile Antarctic environment raises the issue of possible significant negative externality effects upon the continent's natural resources. Unlike fishing, where the natural resources involved are primarily

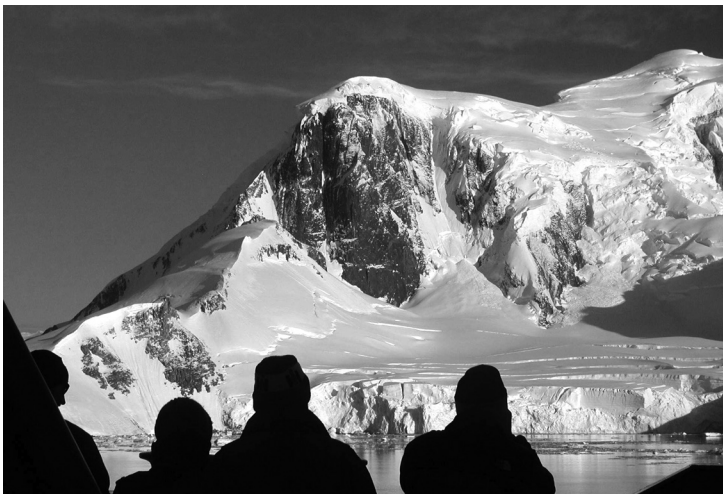
17. See, International Association of Antarctica Tour Operators, "2005-2006 Tourists by Nationality," <www.iaato.org/tourism_stats.html>, last visited December 1, 2006.

of a renewable nature, the impact of tourism, to a large extent, is on nonrenewable resources due to the extremely delicate nature of the Antarctic environment and ecosystems.

Commons in Antarctica

What is a commons?

The concept of a commons is similar, though not identical, to that of a common property resource. The latter is a narrower concept that refers to a stock (fixed quantity) natural resource that is available to users at little, if any, cost of access. A commons, on the other hand, may pertain to more than natural resources, including such things as global knowledge and cultural heritage. Under both concepts, however, the tendency toward open access is present.



The commercial characteristics of Antarctic tourism qualify it as a private good, and its impact, to a large extent, is on nonrenewable resources due to the extremely delicate nature of the Antarctic environment and ecosystems. Photograph by Zee Evans.

Such access may be due to the absence of recognized and/or enforceable property rights to a natural resource or to information, which in turn is likely to be related to the inherent difficulty or impossibility of excluding access to the resource or information.

A natural resource of the commons variety is often a non-renewable natural resource. However, any precise or definitive concept of a commons is very elusive. Although a case can be made for a significant commons presence in Antarctica and for the continent's classification as a global commons, nonetheless, the topic is complex.[18]

The basis for a global commons

The case for Antarctica being a global commons is built upon the following considerations:

A. The strategic Antarctic link to the global atmosphere and oceans

The interaction of global natural processes reveals the critical importance of Antarctica and the adjacent Southern Ocean in determining planetary atmospheric and oceanic conditions that affect global climate. A director of the British Antarctic Survey has observed that scientific investigation in Antarctica demonstrates "clearly and without ambiguity the integral role of Antarctica in the natural systems of planet Earth" and, further suggesting that Antarctica acts as a major heat sink (i.e., by "soaking up" heat from the atmosphere) in driving the global climatic regime (Drewry, 1988, p. 7).

The Southern Ocean likewise plays an important function as a "major sink, particularly for carbon dioxide, for which the estimated uptake is on the order of 30 percent of that discharged into the atmosphere" (Drewry, 1988, p. 8). Meanwhile, the Antarctic ice sheet—which contains a significant portion of the planet's freshwater—exerts a major influence on global ocean levels. The circumpolar current of the Southern Ocean, the largest ocean current in the world, drives the circulation of global oceans. The oceans, in turn, both influence the atmosphere and interact with it as the integral driving force behind global weather and climate.

18. For an excellent discussion of the concept of a commons as well as its application to Antarctica, see Joyner (1998).

Indeed, the Antarctic region supplies an important natural linkage to these global natural processes. A recent United Nations report refers to the "critical role" played by Antarctica and the Southern Ocean in the global environmental system involving "major processes of interaction between the atmosphere, oceans, ice and biota [that] affect the entire global system through feedbacks, biogeochemical cycles, circulation patterns, transport of energy and pollutants, and changes in ice mass balance. In addition, the region is of immense value for the conduct of research essential to understanding the global environment" (United Nations, 2005, p. 10).

B. The absence of sovereignty or property rights in Antarctica

A key feature of a commons resource is free or unrestricted access to its use in the absence of private property rights and, in a political sense, the absence of sovereign national jurisdiction over the resource. Relatedly, the global commons may be described as "those portions of the planet that lie beyond the limits of national jurisdiction" such as the atmosphere, oceans, outer space, and polar regions (Joyner, 1998, p. 25).

Antarctica's resources reflect a close relationship to these global commons, and there is no recognized national sovereignty nor private property rights over the continent's land and resources. Although seven nations hold claims to parts of the continent, these claims were placed in an inactive, moratorium status by the Antarctic Treaty.

In the absence of recognized national political sovereignty and private ownership in Antarctica, access to Antarctic land and natural resources would be open or unrestricted were it not for the presence of an international treaty regime—the Antarctic Treaty System—that manages such access.

Without the international legal presence of the treaty system, a scenario similar to a "tragedy of the commons"[19] might occur. The mere fact that such a risk of serious over-exploitation exists seems to suggest, in itself, an important commons presence in Antarctica. It will be argued later that the comprehensive and effective management of Antarctic natural resources is necessary in order to reduce the risk of such an unwanted long-run scenario.

C. The "common heritage of mankind" principle and the Antarctic world park issue

In addition to Antarctica's critical interrelationship with global natural processes and the absence of national political sovereignty and private property rights, the area constitutes the only remaining continental wilderness on earth. As such, this wilderness encompasses commons features that are beyond national jurisdiction. Meanwhile, the emergence of the common heritage of mankind principle during the latter part of the twentieth century found a popular application to Antarctica, especially among developing nations.

Under this principle of international law,[20] which was introduced in 1967 by Arvid Pardo of Malta during the United Nations Law of the Sea Treaty negotiations, all world citizens own the global commons irrespective of their national citizenship. Hence, the benefits derived from these commons are to be shared by all world citizens. Moreover, if this dictum were followed in concert with a corollary maxim of "redistributive justice," lower-income developing nations would be expected to receive larger per capita shares of these benefits than would higher-income industrial nations.

19. See Hardin (1968) for the origin of this term.

20. This principle functions mainly as a principle of international treaty law, but has not attained widespread legal support by nations (Joyner, 1998).

This thinking led to the application of the common heritage of mankind principle, under the Law of the Sea Treaty, to the International Seabed Authority[21] for the exploitation of minerals in the deep seabed region of the high seas. The common heritage of mankind principle has also been a background to the formal on-going discussion of Antarctica at the United Nations. However, this discussion is now being discontinued on a formal basis. Moreover, the fervor behind the rich nation/poor nation redistributive equity connotation of the common heritage of mankind principle has subsided during recent decades.

Meanwhile, arguments for the establishment of an Antarctic world park surfaced during the 1980s and early 1990s. This topic was part of intense negotiations within the Antarctic Treaty System during this period regarding the possible extraction of minerals through mining operations in Antarctica. The common heritage of mankind principle was introduced into this discussion as a rationale for the creation of an Antarctic world park as an alternative to minerals extraction.

These negotiations ultimately led to the addition of an environmental protocol to the Antarctic Treaty, under which minerals exploitation was deflected via the creation of a 50-year moratorium on such activities. It was replaced, instead, by what might be optimistically considered a de facto world park. However, the formal designation of a world park was not used nor was a linkage to common heritage of mankind established.

21. The United Nations Convention on the Law of the Sea created this body.

The Antarctic Treaty System

Barne Glacier in McMurdo Sound; photograph by Melanie Conner

The Antarctic Treaty System: Policy Goals and Environmental Framework

As described earlier, the economic uses of Antarctica consist of the production of two public goods, peace and science; two commercial (for-profit) private goods, fishing and tourism (which exhibit important externality effects related to natural resource use); and unique commons resources. The latter are integral to global natural processes; they lack private ownership or national sovereignty; and they are consistent with the common heritage of mankind principle embodied in the proposed Antarctic World Park.

While the economic activities that supply the public good, science, and the private goods, fishing and tourism, directly impact the Antarctic commons and natural resources as part of their basic functions, the other public good, peace, is essentially passive in this respect due to its minimal requirement for productive resources. This is the case since political stability in the Antarctic region was attained via international negotiation and treaty, rather than by military action, and continues to be maintained under that treaty without the combative actions of military forces.

Policy Goals for the Antarctic Commons

The pursuit of efficient economic policy to protect the Antarctic commons needs to focus upon the problems that arise from the outputs of science, fishing, and tourism in Antarctica. Importantly, the production of these outputs involves public goods and externalities that, by nature, create circumstances whereby markets cannot readily internalize as prices all of the relevant benefits and costs required to achieve economic efficiency. Economic theory suggests two alternative approaches for solving this dilemma: the Pigovian (Pigou, 1920) and Coasian (Coase, 1960) solutions.

The Pigovian approach relies upon various forms of governmental budgetary and regulatory intervention to address the problem.

The Coasian approach, on the other hand, relies upon changing the assignments and definitions of property rights and economic structures to make it easier for markets to address the problem. It is not the intent of the present monograph to emphasize either approach. Instead, the purpose here is to create an awareness of the basic facts and parameters of the problem so as to help clarify the selection of the appropriate policy responses that ultimately will need to be taken by the Antarctic Treaty System if the globally strategic commons and natural resources of Antarctica are to be utilized in an efficient and sustainable manner.

Meanwhile, in designing an efficient economic policy for the Antarctic commons, it is useful to emphasize the difference (see Sandler and Arce, 2003) between the concepts of a public good, on the one hand, and that of a common property resource or commons, on the other. [22] This distinction centers upon the fact that a common property resource (commons) is a nonrenewable natural resource, the availability of which is already established, whereas a public good relies upon significant inputs of labor and capital for its availability. This inherent difference results in the user of a commons resource incurring few, if any, costs in acquiring its benefits while others may bear significant costs (loss of benefits) if this non-renewable resource is depleted from overuse. This discrepancy has important implications regarding the selection of appropriate policies for a commons resource as compared to those for a public good.

In the case of a global commons, jurisdictions of national sovereignty are absent. No nation holds exclusive property rights to the Antarctic-generated interactive components of the planet's atmosphere, climate, and oceans, nor for that matter, to any land or resources in Antarctica due to the absence of recognized

22. In this discussion, the concept of a "common property resource" is treated synonymously with that of a "commons" since both are characterized by the absence of ownership or sovereignty rights and by difficulty of access.

The Convention for the Conservation of Antarctic Seals to the Antarctic Treaty prohibits the killing or capturing of certain species of seals in the treaty area. Photograph by Steven Profaizer.

sovereign territorial claims in the Antarctic region.[23] Accordingly, there would be no economic incentive to preserve their long-run scarcity value.[24]

Environmental Framework of the Antarctic Treaty System

Although the original Antarctic Treaty does not explicitly emphasize the environmental protection of the Antarctic commons, conserving the environment is implicit in the primary peace and science goals of the treaty. However, four important environmental additions to the original treaty make explicit references to conservation and provide the essence of the present Antarctic Treaty System environmental structure. These are:

23. In effect, the geographical area covered by Antarctic Treaty System includes the continent of Antarctica and the Southern Ocean that surrounds it.
24. "Scarcity value," as used here, refers to the value of these resources to future generations of humans.

Agreed Measures for the Conservation of Antarctic Fauna and Flora

The Agreed Measures for the Conservation of Antarctic Fauna and Flora were adopted in 1964 at the third meeting of the Antarctic Treaty Consultative Parties. The rules provide a comprehensive mandate for treaty nations to conserve fauna and flora within the treaty area in the face of increasing human activity in the region. The Scientific Committee on Antarctic Research plays a major role in the implementation of these measures in addition to its primary support role for scientific research in Antarctica.

Convention for the Conservation of Antarctic Seals

The Convention for the Conservation of Antarctic Seals to the Antarctic Treaty (hereafter, Antarctic Seals Convention), which was opened for signature in 1972, entered into force in 1978. It prohibits treaty nations from killing or capturing certain species of seals within the treaty area, except under specified conditions. The primary purpose of the convention is to conserve this living resource in the event that active harvesting of seals should be resumed[25] in the region. The Scientific Committee on Antarctic Research also plays a major role in the implementation of this convention.

Convention on the Conservation of Antarctic Marine Living Resources

The Convention on the Conservation of Antarctic Marine Living Resources to the Antarctic Treaty (hereafter, Antarctic Marine Living Resources Convention), which was opened for signature in 1980, entered into force in 1982. It provides a comprehensive mandate for treaty nations to conserve marine living resources—such as the populations of finfish, mollusks, crustaceans, and all other species of living organisms, including birds—found in the region. The convention covers a geographical area similar, but not identical, to that of the Antarctic Treaty itself.[26] Any harvesting

25. Sealing began during the late 1700s and continued to be a primary economic activity in Antarctica throughout the nineteenth century.
26. See Figure 1.

of these species is subject to the provisions of the convention. This includes the setting of recommended catch limits for marine species. The convention established a secretariat to help implement its provisions. The Scientific Committee on Antarctic Research also plays a useful role in the convention.

Meanwhile, even though whaling occurs in the Southern Ocean adjacent to Antarctica, the activity is not regulated by the Antarctic Treaty System but, instead, by the International Whaling Commission under the authority of the International Convention for the Regulation of Whaling.[27] The continuance of the Southern Ocean Whale Sanctuary,[28] which prohibits the commercial harvesting of whales (except for scientific purposes), was reaffirmed in 2006 by the International Whaling Commission, despite efforts by Japan and other nations to abolish the sanctuary.[29]

Protocol on Environmental Protection (Madrid Protocol)[30]

The Protocol on Environmental Protection to the Antarctic Treaty, known as the Madrid Protocol, was opened for signature in 1991 and entered into force in 1998. It provides a comprehensive organization for protecting the Antarctic commons encompassing all economic activities that impact the Antarctic environment and natural resources. Its history is both interesting and significant.

This history includes efforts to establish an Antarctic world park, a subject that was introduced previously. In this setting, the protocol became the outgrowth of an earlier convention, the Convention for the Regulation of Antarctic Mineral Resource

27. International Convention for the Regulation of Whaling, adopted December 2, 1946; entered into force November 10, 1948.
28. Created by the convention in 1996.
29. See "Japan fails to abolish Southern Ocean sanctuary," June 19, 2006, <www.abc.net.au/news>, last visited Decemmber 1, 2006.
30. The final agreement on the protocol was reached at a meeting of the treaty nations in Madrid – hence, it has become known as the "Madrid Protocol."

Activities (hereafter, Antarctic Mineral Resources Convention), that was opened for signature in 1988, but which never entered into force.[31]

The Antarctic Mineral Resources Convention represented an effort to reconcile any exploitation of mineral resources that might eventually take place in Antarctica with the goal of protecting the Antarctic environment and minimizing interference with the peace and science goals of the Antarctic Treaty. While mining would not have been cost-effective during the 1980s, there is evidence that deposits of hydrocarbons, oil, natural gas, coal, and copper exist in Antarctica. If mining ever were to become a reality in Antarctica, it would constitute a third private good produced in the Antarctic economy—joining the existing fishing and tourism sectors of the economy and, quite possibly, creating additional significant environmental externalities in the region.

The Protocol on Environmental Protection (Madrid Protocol) to the Antarctic Treaty provides a comprehensive organization to protect the Antarctic commons as a "natural reserve, devoted to peace and science." Photograph by Melissa Rider.

31. Convention for the Regulation of Antarctic Mineral Resource Activities (CRAMRA), Antarctic Treaty, adopted June2, 1988; not entered into force.

However, as the negotiations for the Antarctic Mineral Resources Convention were taking place, an Antarctic world park alternative to a mining regime, linked in concept to the common heritage of mankind principle, was gaining popularity among the treaty nations as well as worldwide.[32] In contrast to mining, a world park regime would seemingly better protect the strategic atmospheric and oceanic commons that link Antarctica with the other continents as well as protect the pristine Antarctic wilderness that possesses commons features. As this viewpoint gained support, the Antarctic Mineral Resources Convention was set aside and attention was turned toward an environmental protocol.

Accordingly, the Madrid Protocol came into existence. This significant addition to the Antarctic Treaty System designates the area south of 60 degrees south latitude, including ocean areas, to be a "natural reserve, devoted to peace and science" (Article 2) and, in addition, requires the treaty nations to comprehensively protect the environment of the region.[33]

The protection of the Antarctic environment—with its dependent and associated ecosystems, intrinsic wilderness and aesthetic values, and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment—shall be a fundamental consideration in the planning and conduct of all activities in the Antarctic Treaty area (Article 3§1).

While not formally establishing an Antarctic world park based upon the common heritage of mankind principle, the Madrid Protocol nonetheless took meaningful action in that direction. Among other things, it placed a long-term (50-year) moratorium on mining in Antarctica.[34] Furthermore, the protocol adopts

32. For an economic argument for an Antarctic world park, see Herber (1992)
33. There are varying interpretations among treaty nations regarding the application of the protocol to ocean areas.
34. The conditions of this moratorium, if examined closely, are seen to be less

a comprehensive environmental strategy for Antarctica that is consistent with the world park concept.

This strategy emanates primarily from its six annexes in the following areas: environmental impact assessment, conservation of Antarctic fauna and flora, waste disposal and waste management, prevention of marine pollution, the establishment and management of protected areas, and liability arising from environmental emergencies. The Madrid Protocol does not replace the earlier environmental measures and conventions that comprise the Antarctic Treaty System but, instead, it provides a structural umbrella over Antarctic environmental protection.

In general, the Madrid Protocol embodies an important advancement for the Antarctic Treaty System through its global perspective and its requirement that treaty nations "efficiently manage and protect the Antarctic commons."[35] Nevertheless, its regulatory mechanisms need further refinement in order to assure appropriate compliance with the provisions of its annexes. Moreover, the adoption of additional conventions to the Antarctic Treaty in specific environmental problem areas, such as tourism and biological prospecting, or bioprospecting, would seem to merit consideration.

The primary policy instruments currently in use are the first-step environmental impact assessment (EIA); the initial environmental evaluation (IEE), when actions are unlikely to have more than a minor or transitory impact on the environment; and the comprehensive environmental evaluation (CEE), when actions are likely to have more than a minor or transitory impact. The protocol created a valuable institution, the Committee on Environmental Protection, to help implement its policies.

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than iron-clad in their prevention of mining during the 50-year period. However, they have proven, so far, to be effective.

35. See the discussion in Joyner (1998).

Issues of Concern and Policy Options

Pancake ice; photograph by Zee Evans

Issues of Concern and Policy Options for the Antarctic Commons

Issues of Concern

Whatever transpires in terms of the economic uses of Antarctica—whether it is with the public goods, peace and science, or the private goods, fishing and tourism—is viewed in the analysis presented here as secondary to the primary goal of preserving the globally strategic atmospheric, oceanic, and wilderness commons resources of the continent. The discussion here takes a closer look at these current activities in relation to their effects on this primary policy goal.

Peace

At the present time, the Antarctic Treaty System is fulfilling its role as a political stabilizer in the region. Nonetheless, a potentially subtle and long-term threat to this stability is the gradual dilution of the Antarctic Treaty System from its original small, close-knit, and science-oriented group of twelve treaty nations to a larger group of forty-five more diverse nations. There is a risk that the larger group may have a weaker link to the original mind-set of the Antarctic Treaty than do the treaty-founding nations.

Moreover, the original signatory nations themselves could open the door to political instability through their increased involvement in commercial activities in such areas as bio-prospecting, fishing, and tourism. Furthermore, any movement toward the assignment of sovereignty[36] in the Southern Ocean or, relatedly, the extension of the Exclusive Economic Zone limits[37] beyond their current 200-nautical-mile/continental shelf dimensions could pose a future threat to political stability in Antarctica.

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36. As noted in an earlier section, the Antarctic Treaty created a moratorium on sovereignty.
37. Created by the United Nations Convention on the Law of the Sea.

Science

Even though the activities of science in the Antarctic have been largely compatible with protecting the Antarctic commons and pristine resources, there have been occasional waste disposal and other environmental degradation practices at scientific stations. This performance has improved, however, since the Protocol on Environmental Protection (Madrid Protocol) entered into force. Meanwhile, several new, and potentially serious, scientific threats to the Antarctic commons and pristine natural resources have emerged.

To support scientific research activities, the United States is constructing a 1,000-mile-long ice highway from the McMurdo Station on the coast to the Amundsen-Scott Scientific Base at the South Pole – with some potentially serious impacts on the pristine natural resources in the area. Photograph by George Blaisdell.

Ice highway

One of these is the construction of a 1,000-mile-long ice highway on the continent by the United States (Lilley, 2004). This project, which began in 2003, was planned for completion in 2006, though completion is more likely to occur in 2007. When constructed, the highway will enable supplies and equipment to be hauled across the ice wilderness on tractor-pulled sleds from the coast

to the American Amundsen-Scott Scientific Base at the South Pole. The highway consists of a packed surface 20-feet wide, lined with green flags, and winding through huge crevasse fields, snow swamps, and flat pack ice.

The route of the highway, the largest activity ever undertaken on the continent in terms of area affected, raises serious issues related to the protection of the Antarctic wilderness as well as human intentions and attitudes toward Antarctica (ASOC, 2004a). For example, it could prompt extensive scientific and tourism activities that would endanger Antarctic resources and commons. One of the arguments used in support of the project is that the environment will gain if fewer aircraft are required to reach the South Pole. However, such an effect would be neutralized if these same aircraft, instead, were used elsewhere in Antarctica. Moreover, the highway itself directly impacts the pristine Antarctic wilderness. The United States has prepared a comprehensive environmental evaluation (CEE) for the project. However, the impacts of the ice highway discussed in the CEE emphasize science and operations rather than negative environmental effects (ASOC, 2004a).

Bioprospecting

Another troublesome science-related issue facing the Antarctic commons is that of bioprospecting—the exploration of microorganisms, plants, and animals for genetic and biochemical resources of commercial value (Herber, 2006). During recent years, commercial pharmaceutical companies have been asserting property rights to the flora and fauna of Antarctica (Stix, 2004). More than 40 patents have been granted worldwide on bacterium and organisms found in Antarctica and more than 90 additional patent applications are pending in the United States alone (Stix, 2004).

A study by the United Nations cautions that the push to exploit extremophiles (novel life forms that are able to withstand cold, aridity, and salinity) requires new rules to protect the fragile Antarctic ecosystem (United Nations University, 2003).

Consortia of public and private entities generally undertake bioprospecting in Antarctica, thus making it difficult to distinguish clearly between pure scientific research and for-profit commercial activities. This creates a dilemma since bioprospecting, as a scientific activity, in Antarctica is subject to management by the Antarctic Treaty System, while bioprospecting, as a commercial activity, does not fit neatly into the Antarctic Treaty System framework for managing scientific activities. Meanwhile, bioprospecting in Antarctica is inconsistent with the rules of international bioprospecting as established by the Convention on Biological Diversity,[38] which recognizes that nations have sovereignty over their genetic resources and, thus, can regulate access to them. In contrast, there is no recognized sovereignty in Antarctica.

Thus, even though bioprospecting may yield important global benefits and, as such, should not be excluded from the Antarctic region, the associated commercial exploitation of Antarctic natural resources raises issues that are, in part, inconsistent with the intent of the Antarctic Treaty. The potential conflict between the freedom of access to scientific information among consultative parties provided by Article III of the Antarctic Treaty, on one hand, and the confidentiality that is associated with the commercial exploitation of bioactive material via patents, on the other, is apparent (United Kingdom, 2002). Indeed, bioprospecting in Antarctica raises significant issues of a legal, equity, and operational nature that will eventually have to be confronted by the Antarctic Treaty System in a suitable manner.[39]

Drilling into Lake Vostok

A third, science-related, issue that has emerged in Antarctica is the interest expressed by both Russia and the United States for drilling into the ice of a huge, apparently fresh, body of water,

38. Convention on Biological Diversity, adopted June 5, 1992; entered in to force December 29, 1993.

39. For a comprehensive coverage of the Antarctic bioprospecting issue, see Hemmings and Rogan-Finnemore, 2005.

Lake Vostok, in East Antarctica.[40] This lake, located below four kilometers of ice, is 250 km long and 50 km wide, with depths estimated to be upwards of 500 meters. Scientific interest in the lake stems from the fact that its features are unknown and could be revealing to scientists. For example, it may contain a new habitat with unique geochemical characteristics, and may also contain new life forms.

While the United States has expressed an interest in using the lake to develop technology for planetary space missions such as a proposed expedition to Europa (one of the moons of the planet Jupiter), the current primary interest in Lake Vostok drilling comes from Russia. Russia's interest in the lake is reinforced by its science-and-technology program involving deep drilling as well as by the fact that the lake is located only three kilometers from one of its scientific stations.

However, there is a concern that penetrating the lake via drilling may disturb and contaminate the delicate ecology of the lake, especially due to the somewhat antiquated nature of Russian technology in this regard. Non-Russian sub-glacial experts prefer to start drilling on a much smaller sub-glacial lake, establish the reliability of a potentially safer technology such as thermal drill, which does not require drilling fluids, and accumulate experience and knowledge for possible later drilling into Lake Vostok. Despite protests from the scientific and environmental community, however, Russia has planned to resume drilling to eventually reach the surface of Lake Vostok.[41]

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40. Antarctic and Southern Ocean Coalition, "Lake Vostok," <www.asoc.org/what_other1.htm>, last visited December 1, 2006.
41. See "Russia ignores plea on drilling Antarctic lake," July 13, 2006, <www.theage.com.au>, last visited December 1, 2006.

Fishing

Commercial fishing in the Southern Ocean is a threat to the entire Antarctic marine ecosystem. At a recent meeting sponsored by the British Antarctic Survey, it was observed that the populations of (Patagonian) toothfish[42] are on the verge of collapse in some locations (Owen, 2003). However, the overall performance of the Antarctic Marine Living Resources Convention in managing the harvest of marine living resources in the region has been respectable, especially in regard to krill fishing. Nonetheless, during recent years, the "illegal, unreported, and unregulated" (IUU) harvesting of toothfish has presented a serious problem (Hemmings, 2004).

In fact, during the 2003-04 season, 2,622 tons of the 15,929 tons of toothfish caught in the area subject to terms of the Antarctic Marine Living Resources Convention were in the IUU category. An additional 3,746 tons of the fish were caught in the high seas outside the convention's area of concern (CCAMLR, 2004). Overall, out of a total toothfish catch of 26,888 tons during the 2003-04 season, a total of 6,368 tons (24 percent) was considered IUU (CCAMLR, 2004).

Meanwhile, some nations are undertaking unilateral as well as collective action outside the legal structure of the Antarctic Marine Living Resources Convention to address the problem of IUU fishing. However, even if these efforts are effective, the resultant weakening of the convention caused by such "extra-convention" regulation is a point of concern. Another concern is that the convention, as observed above, does not possess the authority to manage whaling in the region and, relatedly, that the International Whaling Commission is seemingly under constant pressure from several nations—specifically Japan, Norway, and Iceland—to reconsider its moratorium on whaling in the region.

42. Also, known as Chilean sea bass.

The number of tourists in Antarctica has been expanding rapidly during recent years including an increase in those visiting previously inaccessible parts of the continent. Photograph by Melanie Conner.

Tourism

The number of tourists in Antarctica has been expanding rapidly during recent years, increasing from about 5,000 per year in the early 1990s to more nearly 30,000 estimated for the 2006-07 season.[43] Moreover, there has been a tendency toward the use of larger ships that are not ice-proof in construction (ASOC, 2004b). Until recently, the industry has consisted of small operators using small- to medium-sized vessels that are ice-strengthened in their construction, which land passengers at discrete coastal sites. Also, there has been a growth in specialized and individualized adventure tourism utilizing zodiac boats and aircraft, which can access previously inaccessible parts of the continent.

Meanwhile, it should be recognized that even though tourism is a legitimate economic activity in Antarctica, it is not an embedded part of the Antarctic Treaty System, unlike peace and science, which are the primary goals of the original treaty, and the harvesting of marine resources, which is the primary topic

43. International Association of Antarctic Tour Operators, Tourism Statistics, <www.iaato.org/tourism_stats.html>, last visited December 1, 2006.

of the Antarctic Seals Convention and Antarctic Marine Living Resources Convention additions to the treaty system. Tourism is subject to the jurisdiction of the Madrid Protocol, but its regulation under this protocol has been minimal.

The environmental impact assessment instrument of the protocol has shown only limited effectiveness. However, the fact that tour operators attempt self-regulation via the International Association of Antarctic Tourism Operators is commendable. This organization provides guidelines for both tour operators and tourists and, in addition, provides for the exchange of itineraries and the coordination of schedules among tour operators. The association's members also provide support for scientific research undertaken by treaty nations.

However, there are signs that the present membership of the association may be replaced in the foreseeable future by large, perhaps multinational, companies. If it occurs, this change could lead to a different mind-set than that of the current smaller, owner-operator, arrangements. In any case, voluntary self-regulation efforts may prove to be inadequate for protecting the Antarctic commons and pristine natural resources in an efficient manner since it is difficult to price such collectively consumed resources in the market in a manner that includes their natural resource externalities.

Mining

Though mining in the Antarctic is prohibited under the 50-year moratorium contained in the Madrid Protocol, some subtle threats to this ban currently exist. For example, Exclusive Economic Zones could be used as a circuitous route to legalized international access to mining outside Antarctic Treaty System jurisdiction. Relatedly, there has recently been a growing interest within the world community for partitioning the circumpolar ocean (Southern Ocean) surrounding Antarctica (Sinha, 2000).

Policy Options

The economic efficiency problems described above suggest the need for improved policies if the Antarctic commons and its pristine natural resources are to attain long-run sustainability.

The discussion to follow, which takes a broad-based look at various policy alternatives, is divided into three sections: (1) improvements within the existing Antarctic Treaty System policy framework; (2) structural changes in the existing Antarctic Treaty System policy framework; and (3) the larger picture: Antarctica as a subset of global attitudes and policies.

Improvements within the existing Antarctic Treaty System policy framework

The environmental impact assessment (EIA) and comprehensive environmental evaluation (CEE) instruments have become the primary tools for improving environmental performance under the Madrid Protocol. To date, use of the EIA has been only modestly successful and the number of CEEs employed has been small, with no CEE having prevented an activity from moving forward (Hemmings and Roura, 2003). These instruments could be improved in design and applied more effectively.

In the area of science, policy reaction within the existing Antarctic Treaty System framework to the ice highway issue has primarily taken the form of a CEE prepared by the United States. An analysis of this CEE has been prepared outside the Antarctic Treaty System by a prominent nongovernmental entity, the Antarctic and Southern Ocean Coalition, which raised significant questions. Meanwhile, a CEE has been prepared by Russia regarding the Lake Vostok ice drilling issue with significant questions, again, being raised by the coalition (ASOC, 2004a). Russia's strong interest in such drilling currently threatens to take precedence over the intended constraints of the EIA and CEE instruments of control. However, no coring of the lake has yet occurred and while drilling had been stopped some 100 meters above the lake, Russia is set to soon resume drilling.

Often, EIA and CEE instruments appear to be more administrative than they are substantive in nature and, thus, incapable of preventing possibly undesirable outcomes—an observation that may apply to both the ice highway and Lake Vostok issues. Meanwhile, the Lake Vostok topic received considerable discussion at a recent Antarctic Treaty Consultative Meeting.[44]

Delegates confer at the 2005 Antarctic Treaty Consultative Meeting in Stockholm, Sweden. Photograph by Sara K. Modin.

Policy response to bioprospecting has also been modest. Recent Antarctic Treaty Consultative Meetings have considered discussions of the topic, and at the 2005 meeting, passed a resolution on the matter.[45] This resolution emphasized the importance of preserving Article III of the Antarctic Treaty, which mandates the exchange of scientific plans, personnel, and results among the treaty nations. In addition, the resolution referred to the Madrid Protocol as a means of regulating bioprospecting activities so as to limit adverse environmental impacts. Finally, the resolution called for further studies of the subject by treaty nations with an exchange of such information among the nations. As noted earlier, Antarctic bioprospecting has been the focus of a United Nations study (United Nations University, 2003).

44. Antarctic Treaty Consultative Meeting (ATCM) XXVI, Madrid, 2003.
45. Resolution 7, ATCM XXVIII, Stockholm, 2005.

In bioprospecting, the potential exists for an important new industry in Antarctica that does not have a specific structural framework within the Antarctic Treaty System to deal with it. Nonetheless, the Madrid Protocol clearly does have general jurisdiction on the matter. While the ice highway and Lake Vostok issues could be further addressed via more effective implementation of existing Antarctic Treaty System instruments such as the EIA and CEE tools, it is more difficult to fit bioprospecting into the venue of these instruments. Resolution 7—approved by treaty nations at the 2005 Antarctic Treaty Consultative Meeting—constitutes only an early step toward the adoption of a comprehensive Antarctic Treaty System policy regime directed toward the management of this important developing industry.

Meanwhile, in the fishing industry, it may be observed that some efficiency improvements could be made within the existing Antarctic Treaty System framework. Among other things, greater coordination between the Antarctic Treaty System as a whole and its Antarctic Marine Living Resources Convention component would be useful.

For example, both entities could endorse a recent proposal by Australia for the listing of toothfish in the Convention on International Trade in Endangered Species (CITES) as a means of diminishing the IUU trade in this species. In the meantime, treaty nations such as Australia and South Africa are taking action outside both the Antarctic Treaty System and the Antarctic Marine Living Resources Convention by directly intervening with IUU fishing in their territorial waters.

In addition, an effort has been made to create a blacklist of illegal fishing vessels, but this effort has been vetoed by Russia—one of the nations participating in the IUU activity (Hemmings, 2004). On the encouraging side, at its November 2004 meeting, the Antarctic Marine Living Resources Convention adopted a centralized vessel-monitoring system that requires vessels in

the convention area to transmit position information to the convention's secretariat as well as to the flag state. However, this policy instrument does not apply to adjacent areas outside the jurisdiction of the convention.

Regarding tourism, the Antarctic tourist industry is generally supportive of the preparation of prior EIAs in accordance with the Madrid Protocol. However, it is reluctant to apply levels of the EIA that reduce the certainty of its operations or restrict its freedom of action. In addition, the industry has been reluctant to subject its activities to the more rigorous CEE instrument (Hemmings and Roura, 2003). Meanwhile, it should be recognized that policy alternatives such as regulated growth rates and maximum limits on tourist numbers per season could be considered as effective tools for tourism management in the Antarctic.

Undoubtedly, better design and implementation of existing instruments such as EIA and CEE, as well as the introduction of new tools within the existing Antarctic Treaty System framework, could improve environmental performance in the science, tourism, and fishing areas. Moreover, greater coordination between the Antarctic Treaty System and the Antarctic Marine Living Resources Convention in the fishing industry would be useful. However, although some efficiency gains could result from policy changes within the existing treaty system policy framework, achieving a still higher level of efficiency will require substantive changes in the framework itself.

Structural changes in the existing Antarctic Treaty System policy framework

An important, and overdue, addition to the existing Antarctic Treaty System legal framework—applicable to all aspects of the Antarctic economy, not only the environment—was adopted at the 2005 Antarctic Treaty Consultative Meeting in Stockholm. This consists of a comprehensive liability scheme for damages incurred as the result of accidents in the Antarctic region, and

forms a new annex to the Madrid Protocol.[46] The absence of such a system within the Antarctic Treaty System had been a glaring void and, among its overall advantages, the new annex will provide a useful environmental policy component to the treaty system.

Meanwhile, tourism is an area where structural changes in Antarctic Treaty System environmental policy would seem desirable. Self-regulation by the industry, though useful, cannot be expected to accomplish, by itself, the important and complex task of preserving Antarctica's commons and wilderness values for future generations in relation to tourist activities. The concepts of "self interest" in the market and the "need for regulation," are in many ways contradictory. For example, the environmental externalities that accompany the private good, tourism, are difficult to price via the market mechanism.[47] Moreover, there is a risk that the Antarctic Treaty System may partially default on its regulatory obligations regarding tourism by overestimating the positive environmental management effects of self-regulation.

A major structural change for improving the environmental performance of Antarctic tourism would be the creation of a tourism convention. Such a convention would become part of the Antarctic Treaty System, similar to the Antarctic Seals Convention for the protection of seals, and the Antarctic Marine Living Resources Convention for the management of fishing. A possible name for this new component of the Antarctic Treaty System could be the "Convention for the Regulation of Antarctic Tourism Activities" (ASOC, 2004c).

The proposed convention would leave existing Antarctic Treaty System instruments in place while creating a new institution to

46. Annex VI (to Measure 1) to the Protocol on Environmental Protection to the Antarctic Treaty, "Liability Arising From Environmental Emergencies," June 2005.

47. Although tourism is primarily a private good, the presence of significant externalities in its allocation can be used to justify its classification as a quasi-private good.

focus upon the tourism issue. While such a convention would likely establish an administrative body of its own within the convention framework, the recently established Antarctic Treaty System secretariat could also play a useful administrative role in the functioning of such a new institution.[48]

Meanwhile, a less stringent structural change than that of a new tourism convention would be to add a tourism annex to the existing six annexes in the Madrid Protocol (ASOC, 2004c). The purpose of this annex would be to link the "environmental protection" called for in the protocol to the fundamental "science, peace, and natural resource" underpinning of the treaty system.

However, whatever structural change might be adopted, it is difficult to disagree with the observation that legally enforceable standards, rather than guidelines, are needed to regulate an industry that so significantly impacts the natural resources of Antarctica. Either a new tourism convention, or a new annex to the Madrid Protocol, would produce a restructuring of the Antarctic Treaty System environmental framework that would go beyond the present use of policy guidelines that are self-imposed by the industry that is to be regulated.

On the topic of bio-prospecting, the fact that the EIA and CEE instruments and the overall environmental regulatory framework do not effectively address the nature of bioprospecting suggests that structural changes may be needed to deal with this important issue. Accordingly, it has been suggested that the Antarctic Treaty System undertake a proactive approach toward the regulation of bioprospecting, as was done with seals under the Antarctic Seals Convention and mining under the Antarctic Mineral Resource Convention and Madrid Protocol, before the growing pressures of commercial interests can intervene (United Kingdom, 2002).[49]

48. The Antarctic Treaty System secretariat, located in Buenos Aires, became operational in September 2004.

49. As observed above, the Antarctic Mineral Resource Convention was never

Such an approach would suggest the possibility of adopting a convention to deal with the matter of biological prospecting in the Antarctic.

Another structural environmental policy option would be to create a secretariat for the Madrid Protocol with an environmental policy linkage between the new secretariat and the existing secretariats for the Scientific Committee for Antarctic Research, Antarctic Marine Living Resources Convention, and Antarctic Treaty System. However, even though a new administrative emphasis of this type would be beneficial, it would yield relatively small benefits given the fact that the Antarctic Treaty System is the governance body for an entire continent with no sovereign decision-making government.

This fundamental decision-making difference between Antarctica and other regions explains why the regulatory options available to the Antarctic Treaty System are considerably more restricted than those available to sovereign nations. For example, if the above environmental issues were addressed by a sovereign nation, conventional policy instruments such as fees, resource excise taxes, subsidies, and tradable quotas would be considered as viable, efficiency-oriented, economic instruments. However, within the context of non-sovereign governance by a treaty system, these potentially useful policy tools are seldom, if ever, taken into account as options.

In sum, while current policies to protect the Antarctic commons and pristine natural resources leave much to be desired, some improvement in efficiency is possible via better implementation and design of policy instruments within the existing policy framework. Moreover, even greater improvement is possible via structural changes in, or additions to, the existing policy framework.

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ratified; however, the discussion of mining during the convention negotiations was integral to the signing and ratification of the Protocol on Environmental Protection (Madrid Protocol).

However, even if these policy improvements were undertaken, a concern would remain that part of the factors affecting the usage of the commons and natural resources of Antarctica function outside the direct control of the Antarctic Treaty System.

Antarctica as a subset of global attitudes and policies

It is important to take note of two contemporary global trends that are larger than the scope of the Antarctic Treaty System: (1) the decline of environmental multilateralism in world politics, and (2) the growth of globalization in world economics. For example, in the sphere of multilateralism, recent observers have witnessed a deterioration of international environmental momentum in the absence of unanimity among the major industrial nations in ratification of the Kyoto Protocol to control greenhouse gas emissions.[50] Global warming, the policy target of the protocol, carries a specific threat to the Antarctic region in the form of ice melt and related negative effects from such melting around the world.[51] In the worst-case scenario, the melting of all the ice in Antarctica (which currently contains 90 percent of global ice) and Greenland would cause the world's oceans to rise by over 70 meters (230 feet).[52]

While such an event is extremely unlikely, the threat suggests, nonetheless, the critical need to treat the Antarctic commons with environmental respect via thoughtful global policies, whether these are the policies of the Antarctic Treaty System or those of the wider global community.

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50. Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted December 11, 1997; entered into force February 16, 2005.

51. While an intense scientific debate has taken place during recent decades regarding the primary cause of global warming, whether it is of a natural variation/cyclical nature or is human-caused via the release of excessive carbon into the atmosphere, a growing body of scientific evidence suggests the latter as the primary agency.

52. National Snow and Ice Data Center (NSIDC), "Is global sea level rising?," March 14, 2005, <nsidc.org/sotc/sea_level.html>, last visited August 15, 2006.

The accelerated melting of polar ice sheets could become irreversible, resulting in a rise in sea levels of about 0.5 meter (1.5 feet) during the next 100 years. Photograph by Josh Landis.

Moreover, even a much smaller melt than the extreme case could be enough to cause significant global problems, since a significant segment of the world's population lives on coastal plains. For example, a recent scientific study observed that, by the end of this (21st) century, the accelerated melting of polar (Greenland and Antarctic) ice sheets could become irreversible, resulting in a rise in sea levels of about 0.5 meter (1.5 feet) during the next 100 years and an additional rise of nearly 0.5 meter per century thereafter—culminating in a total increase of about 6 meters (20 feet)—human emissions of greenhouse gases are reduced (Overpeck et al., 2006).[53]

Even though the Montreal Protocol[54] has successfully dealt with atmospheric ozone depletion—another human-introduced problem—it is predicted that ozone recovery to 1980 levels will still not occur until the mid-21st century (United Nations, 2005).

53. See also a summary of this research in Toner, 2006.
54. Montreal Protocol on Substances that Deplete the Ozone Layer (Protocol to the Vienna Convention for the Protection of the Ozone Layer, 1985), adopted September 16, 1987; entered into force January 1, 1989.

Significantly, even though Antarctic ice is one of the major recipients of negative externality effects from excessive greenhouse gas emissions that originate, almost exclusively, on the other six continents, the Antarctic Treaty System possess no political authority to address this "foreign-caused" problem.

This is not to say, of course, that a neglect of the pristine Antarctic environment by the Antarctic Treaty System would not make things worse. However, it is important to appreciate the fact that Antarctic governance is a subset of a much larger global playing field—even though the same nations that are dominant players in the Antarctic Treaty System (such as France, Russia, the United Kingdom, and the United States) are also dominant players on the global political and economic scene. Yet, until global political leadership exhibits a greater awareness of environmental and natural resource needs and a willingness to act accordingly, the subset of authority embodied in the Antarctic Treaty System to protect the Antarctic commons and pristine natural resources, by itself, will be inadequate to fully attain these goals.

Globalization, the second global trend that overreaches the Antarctic Treaty System, is a pervasive economic force that transcends national political boundaries and, thus, takes on a worldwide dimension. In this context, the Antarctic Treaty System must work under the constraints of an international treaty framework whose governance authority is restricted to a "single continent" in the absence of sovereign decision-making authority. For example, since even sovereign nations find it difficult to control the large multinational corporations that globalization has spawned, how can the non-sovereign Antarctic Treaty System entity be expected to regulate them in an effective manner?

Meanwhile, the emergence of new commercial interests in the Antarctic fishing and tourism industries and, increasingly, in the developing relationship between the bioprospecting industry and Antarctic science, presents management problems of their own within the Antarctic Treaty System. The fact that such industries

are dominated by Antarctic Treaty System member nations presents a potential conflict of interest between the legitimate commercial self-interest of these industries, on the one hand, and the mandate of the Antarctic Treaty System nations in which they reside to protect the commons and pristine natural resources of Antarctica, on the other.

One observer has noted the irony that even as the Madrid Protocol has come into effect, globalizing activities aimed at commercialization in the Antarctic could threaten grave degradation of its pristine environment and, further, that successful policies directed at controlling these problematic trends will be crucial to protecting and conserving the "frozen commons" in the twenty-first century (Joyner, 1998).

The Antarctic Treaty System, originating in 1959, developed under very different circumstances than exist today. It began at a time when a handful of nations were involved in the economic uses of Antarctica, with these uses centering upon scientific research and the attainment of political stability while still protecting the Antarctic environment. The global characteristics of the present Antarctic political and economic agenda are now very different. The "cold war" between the Soviet Union and the United States is over; the sovereign territorial claims of seven nations in Antarctica have been successfully muted by the moratorium on claims to sovereignty that was part of the original treaty; and global commercial interests are threatening to replace scientific research and peace as the primary orientation of the treaty system. At the same time, effective political multilateralism among nations, at least on environmental issues, is on the decline while economic globalization is expanding.

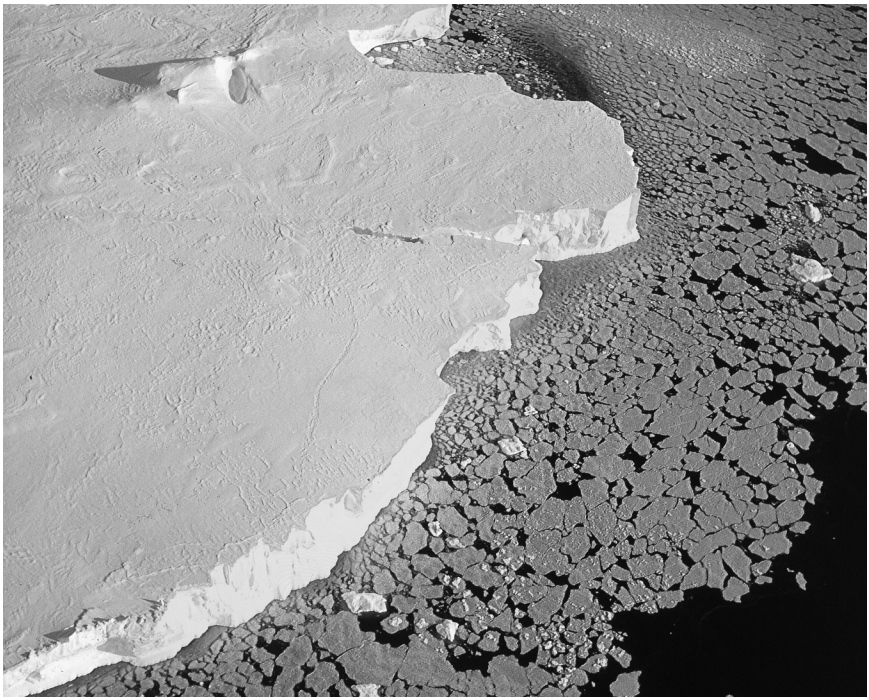
Although globalization yields many economic benefits, there is nonetheless a very real risk that such benefits may be offset by the economic costs resulting from a deterioration of the commons and natural resources of the last undeveloped and pristine continent on Earth. Selecting the appropriate policies to protect this

Antarctic environment, and especially as an engine of the global atmospheric and oceanic commons, is extremely important.

While the undersupply of a public good (such as the benefits of education) can be corrected via the application of additional labor and capital inputs in production, the depletion of nonrenewable commons and natural resources cannot be similarly replenished. If the strategic link that exists between the Antarctic environment and the global atmospheric and oceanic commons is allowed to diminish in quality, the critical role of Antarctica in the welfare of all humankind will diminish as well. In the event this should happen, a "tragedy of the commons" could be at hand—gradual, perhaps, but nonetheless, very real.

The market system that underlies economic globalization would be unable, by itself, to avert this tragic outcome, since these unwanted economic effects would occur in the form of collective consumption and externalities that are not measured by the price system. While the Antarctic Treaty System can play the dominant role in the policy response to this challenge, other forms of multilateral political cooperation among nations will be necessary to supplement the Antarctic Treaty System in this strategic economic undertaking.

Meanwhile, the lessons to be learned from the Antarctic case, in addition to their direct value for the global atmosphere and oceans, may also prove valuable in protecting other strategic global commons and natural resources. An awareness of the global importance of the Antarctic commons and natural resources both from within and outside the Antarctic Treaty System, and the actions of cooperative leadership in taking appropriate policy steps for their long-run sustainability, are of the utmost importance to future generations on planet Earth.



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Aerial view of Ross Sea ice edge (1957); photograph by Commander Jim Waldron USNR (Retired)

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Internet Resources *

International Organizations

Antarctic and Southern Ocean Coalition
www.asoc.org

Antarctic Treaty Secretariat
www.ats.aq

Committee for Environmental Protection
www.cep.aq

International Association of Antarctica Tour Operators
www.iiato.org

International Hydrographic Organization
www.iho.shom.fr

International Seabed Authority
www.isa.org.jm

International Whaling Commission
www.iwcoffice.org

National Snow and Ice Data Center (U.S.)
www.nsidc.org

Scientific Committee on Antarctic Research
www.scar.org

United Nations Convention on the Law of the Sea
www.un.org/depts/los

*All URLs last verified December 3, 2006.

National Antarctic Programs

Council of Managers of National Antarctic Programs
www.comnap.aq

Original Signatories to the Antarctic Treaty

Argentina
www.dna.gov.ar

Australia
www.aad.gov.au

Belguim
www.belspo.be/antar

Chile
www.inach.cl

France
www.ipev.fr

Japan
www.nipr.ac.jp

New Zealand
www.antarcticanz.govt.nz

Norway
www.npolar.no

Russian Federation
www.aari.nw.ru

South Africa
www.sanap.org.za

United Kingdom
www.antarctica.ac.uk

United States
www.usap.gov

Other Consultative Parties to the Antarctic Treaty

Brazil
www.mar.mil.br/secirm

Bulgaria
www.bai-bg.net

China
www.coi.gov.cn/eoverview/ejd

Ecuador
www.inae.gov.ec

Finland
www.fimr.fi/en.html

Germany
www.awi-bremerhaven.de/index-e.html

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www.ncaor.nic.in

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www.mec.es/ciencia/comPolar

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Ukraine
www.uac.gov.ua

Uruguay
www.iau.gub.uy

List of Acronyms

ASOC	Antarctic and Southern Ocean Coalition
AT	Antarctic Treaty
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATS	Antarctic Treaty System
AWP	Antarctic World Park
CBD	Convention on Biological Diversity
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources
CCAS	Convention for the Conservation of Antarctic Seals
CEE	Comprehensive Environmental Evaluation
CEP	Committee for Environmental Protection
CHM	Common Heritage of Mankind
CRAMRA	Convention for the Regulation of Antarctic Mineral Resource Activity
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
IAATO	International Association of Antarctica Tourism Operators
IEE	Initial Impact Assessment
IGY	International Geophysical Year
ISA	International Seabed Authority
IUU	Illegal, Unreported, and Unregulated
IWC	International Whaling Convention
NSIDC	National Snow and Ice Data Center
SCAR	Scientific Committee for Antarctic Research
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea

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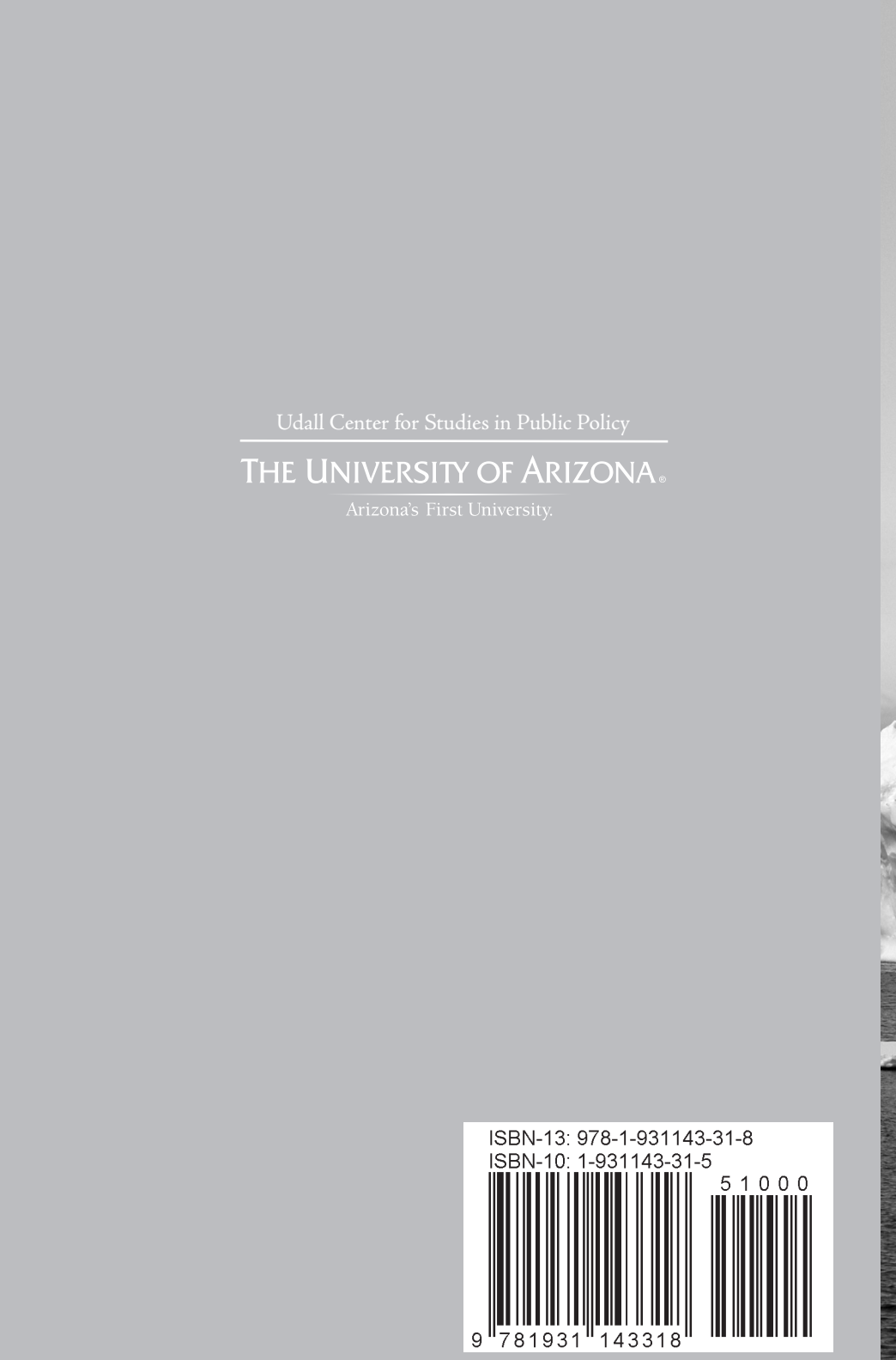

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