International biodiversity governance and the outpacing of policy by threats: How can conservation regimes address global climate change?

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Abstract

Over the past century international conservation governance has had to adapt to an increasingly complex set of threats, and this trend only promises to accelerate with global climate change. The outpacing of biodiversity policy by threats occurs in two ways. First, prolonged negotiations forestall addressing threats in a timely fashion and often lead to time lags that make correction all the more costly and less likely. Second, the split between legal primacy over a threat (recognized ability to enact and enforce regulation) and competency over a threat (mandate to address a threat) requires policies to cooperate or else leave threats unaddressed. In this essay illustrate these issues with a series of policy case studies relevant to the conservation of large marine mammals (whales, seals, polar bears, and sirenians) over the past 100 years. The characteristics of these policies reflect on general trends in international biodiversity governance and illustrate the outpacing of policy by threats.

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Introduction

Humans are removing species from the biosphere at rates commensurate with those of past mass extinctions (Millennium Ecosystem Assessment 2005), and global change only promises to exacerbate this alarming trend. Historically, directed harvest of species was the most common threat that international conservation conventions attempted to address, but current treaties are increasingly designed to address a multitude of threats that act directly, indirectly, and synergistically. At the same time, the decentralized nature of international environmental governance often causes a split between primacy (legal authority to regulate actions relevant to a threat) and competency (mandate to address a threat), meaning that policies must be executed within a cooperative context or threats will go unaddressed.

Threats to biodiversity have often outpaced policy development on two fronts. First, prolonged negotiations exacerbate the time required for biological systems to recover once effective policy is finally put into place. Second, threats act synergistically across multiple sectors, meaning that biodiversity treaties must contend with problems outside their sphere of primacy such as global warming, ozone depletion, and globalization. Unfortunately, global change only promises to exacerbate the outpacing of policy by threats.

The central thesis of this essay is that we must structure international environmental governance so that policies can accurately "see" and respond to complex threats. In the first section I delineate the problem of time lags. Essentially, time lags in negotiations can elongate time lags in biological recovery. In the second section I develop the concept of the "threat matrix," which is a network of threats and their interactions. Through time threat matrices have become increasingly complex. In the third section, I provide policy suggestions relevant to the first two issues. My fundamental conclusion is that the dissociation between primacy (legal capacity to regulate) and mandate (accountability for an entity) in international conservation governance disallows us from "seeing" a threat matrix as it is experienced by biodiversity. If not managed correctly, this fragmented approach will only exacerbate time lags between policy implementation and biological response, making recovery all the more costly and, in some cases, irreversible.

As a vehicle for this discussion I focus on regimes pertinent to large marine mammals (LMMs): cetaceans (whales), pinnipeds (walruses and seals), sirenians (manatees and dugongs), and polar bears. Although these species constitute a limited set of all life on Earth, for several reasons agreements designed to manage and protect them offer a unique opportunity for an exploration of the issues affecting biodiversity conventions at large. First, the evolution of LMM regimes mirrors that of less tightly targeted biodiversity conventions because over time they have moved from a focus on single, direct threats to a focus on multiple, indirect threats (Hoffman 1995). Second, there is a large but limited set of LMM regimes that have been negotiated over the past century in contrast to a sparser set for plants, for example. Third, the ecological similarities between LMMs make comparison easier than an evaluation of conventions that attempt to be universal in scope, such as the Convention on Biological Diversity (CBD). Finally, people in many cultures feel strongly about LMMs (whether for their nonconsumptive or consumptive value). This charged public space creates a social/legal environment which contains sharp contrasts in opinion and thereby a more crisp “lens” through which we can view policy debates affecting biodiversity as a whole.

Table 1 provides a list of the abbreviations with their respective definitions that are used in this work.

Etiology Lags and Response Lags

Time lags are commonplace in social and biological systems, and a lag in one system can cause and extend a lag in the other. Here I delineate two types of lags that are relevant to biodiversity policy. An “etiology lag” is the time taken between problem identification and policy implementation. Etiology lags arise most commonly when 1) there is a lack of technical and scientific understanding necessary to define the problem and provide solutions, 2) actors do not share a common understanding of the issue, 3) actors do share a common viewpoint but are otherwise intransigent, and 4) there are intervening distractions that push the issue lower on the diplomatic list of priorities. As I show below, etiology lags can extend for decades.

A “response lag” is the time taken between policy implementation and recovery of the population, biological community, or ecological process of concern. Response lags are inherent properties of biological systems and arise because most ecological processes do not occur instantaneously. Although they are an intrinsic part of any biological system, response lags can be extended by etiology lags, making recovery all the more costly and delayed.

I illustrate the problem of etiology and response lags with by tracing two historical policy dialogues, the establishment of the North Pacific Fur Seal Treaty (NPFST) of 1911, and the International Whaling Commission’s (IWC) effort to manage whale harvest sustainably. Each illustrates the concept and implications of etiology and response lags.

The North Pacific Fur Seal Treaty of 1911

The North Pacific Fur Seal Treaty (NPFST) of 1911 was negotiated between the United States, Russia, Japan, and the United Kingdom (on behalf of Canada, which was part of the UK at the time) to resolve conflict over the harvest of the North Pacific fur seal. Described as one of the most successful treaties of all time, the NPFST persisted with minor modification until the commercial harvest of fur seals in the North Pacific ceased in 1986 (Barrett 2005, Ch. 2). Despite its success, the etiology lag leading up the negotiation of the treaty lasted about 25 years, and the ensuing response lag lasted at least another three decades.

Although fur seals had been harvested in the North Pacific for several centuries (Dorsey 1991), conflict at the international level only came to a head in the second half of the 19th century. The cause of the conflict revolved around mainly around economic and territorial concerns which in turn were determined by the life history of the seal. Fur seals form harems in which one male presides over many tens of females, meaning that fewer males than females are required for population persistence. Seals could either be harvested terrestrially (on land) or pelagically (at sea). Terrestrial harvest could be practiced sustainably because it was possible to separate excess males from the herd. In contrast, pelagic sealing was inherently unsustainable: 50 to 90% animals killed at sea sank before being brought on board and the large majority of those taken were female (Dorsey 1991, Gay 1987).

The North Pacific fur seal has rookeries (terrestrial breeding grounds) on only a handful of islands in the Pacific: the Kurile Islands (long a focus of conflict between Japan and Russia, and currently part of Russia though parts are claimed by Japan), the Commander Islands and Robben Island (part of Russia), and the Pribilof Islands (once part of Russia but sold to the US as part of the Alaskan Territory). Canadian and Japanese sealing depleted herds on the Kuriles to the extent that they were extinct by the time the NPFST was negotiated (though they have since been repopulated) (Dorsey 1991, Gay 1987), but the Commander and Robben herds were only ever really contested by Canada and Russia. Thus, much of the conflict centered on the seals that utilized the Pribilof Islands, which came into US ownership in 1867.

The conflict began shortly after the US's Alaska Commercial Company acquired a 20-year lease to harvest seals on the Pribilofs in 1870. Within a few years Canadian vessels were spotted sealing in nearby waters, and despite diplomatic protests, seizure of ships, and even threats of war by the US, pelagic sealing continued. At the heart of the conflict were three issues (Gay 1987). First, the US claimed that the sale of the Alaskan Territory made the Bering Sea a *mare clausum* (closed sea) to which all other nations were interlopers. Second, since the seals spent several months at sea (and females foraged at sea during the mating season), proponents of pelagic sealing argued that the seals were under no one's jurisdiction. And third, there was debate between the two sides as to whether pelagic sealing really depleted the herd.

Matters came to a head in the 1890s when the UK (on behalf of Canada) and the US attempted to settle the dispute by means of a tribunal in Paris. Despite a clear verdict which seemed to satisfy both sides, both parties soon reneged on the settlement (Gay 1987). Meanwhile, Japanese vessels began sealing pelagically and even staged shore raids to drive seals into the water. On the western side of the Pacific Russia and the UK came to an agreement over the Commander and Robben herds, but tensions remained.

Despite repeated invitations to parlay, Japan and the UK (Canada) were not interested in negotiation so long as profit margins remained high. However, as the herds became increasingly decimated interest in a settlement began to grow.

Despite pressure for negotiations progress on the issue was delayed by diplomatic distractions. The First Sino-Japanese War (1894-1895) disrupted relations between those countries. A few years later Canadian attentions were directed to the US's territorial claims over the Alaskan Panhandle which stood between would-be prospectors and the Klondike gold find. Only once these issues were resolved were the actors able to turn their attention to declining seal populations, by which time nearly 25 years had passed since the start of the conflict.

The resolution came in the form of the NPFST, which was negotiated and came into force in 1911. President Taft of the US proclaimed that the treaty "furnishes an illustration of feasibility of securing a general international game law for the protection of other mammals of the sea, the preservation of which is of importance to all the nations of the world" (New York Times 1911, p. 6). Specifically, the NPFST required rookery-holding nations to pay a share of the skins harvested to the other nations, in exchange for their forbearance from pelagic sealing. The agreement persisted in its basic form until 1986 when sealing ceased as a result of public concern over animal rights (National Advisory Committee on Oceans and Atmosphere 1985).

At least two factors contributed to the 25-year etiology lag between the time pelagic sealing began and the successful negotiation of the treaty in 1911. Most importantly, the profit potential of pelagic harvest discouraged agreement so long as the seals were numerous enough to make pelagic sealing profitable. The industry itself was indeed lucrative. For example, between 1870 and 1890 the

Alaska Commercial Company, which held a monopoly license to harvest the seals on the Pribilofs, paid the US government enough in fees and taxes to nearly recoup the amount paid to Russia for the entire Alaskan Territory (Gay 1987).

A second contributor to the etiology lag was diplomatic distraction. As mentioned above, war and other territorial disputes claimed the majority of each actor's attention from the 1890s to 1910. Moreover, some observers contend that 1911 was a fortuitous year in the sense that the treaty could probably not have been negotiated after then because of distractions caused by rising global tensions which eventuated in World War I (Mirovitskaya et al. 1993). In other words, had the NPFST not been negotiated successfully in 1911, the etiology lag could have persisted even longer.

Both of these factors contributed to the etiology lag, during which pressure on the seal populations continued unabated. This elongated etiology lag then exacerbated the response lag. Over the 25-year course of the etiology lag seal populations on the Pribilofs dropped by 95% relative to levels they later achieved under sustainable management (Gay 1987)[1]. Upon the treaty's negotiation, the Pribilof herd was allowed a 5-year respite from harvest. Between 1911 and 1912 the herd nearly doubled, and by 1940 the population had increased by 17 times relative to its abundance in 1911 (Gay 1987). Had the parties been able to come to agreement earlier, the population would have required less time to recover. The duration of this response lag is actually fairly abbreviated compared to that of the great whales, discussed in the next section.

The International Whaling Regime

The history of 20th century whaling provides a clear example of the linkage between etiology and response lags. It also illustrates the disproportionate effect that short extensions of an etiology lag can have upon the duration of a response lag.

At present, the International Whaling Commission (IWC) maintains a worldwide moratorium on taking any great whale (baleen whales and sperm whales) with a few exceptions. This ban was instated in 1986 and divides governance of whaling issues into two eras. In this section I will focus on the pre-moratorium era, leaving the later era for discussion below. The pre-moratorium whaling regime grew out of several whaling agreements from the 1930s and 1940s. Compiled and codified

[1] Henry Wood Elliot, the US government biologist sent to assess the state of the seals, estimated 4.7 million seals in 1874. By 1907 others' estimates put the herd at 140,000 individuals (Elliot 1881). Elliot's methods were roundly criticized and probably very inaccurate, but the 1907 estimates are more reliable. In 1911 the Pribilof herd numbered 123,000, rising to 2.1 million in 1940 (Gay 1987). If we take the latter figure to be the more accurate indicator of potential population size (even though it was still under hunting pressure), then the population dropped from 1.2 million to 0.123 million, a 95% decline during the etiology lag period.

in the International Convention for the Regulation of Whaling (ICRW) of 1946, this regime was the *modus operandi* for all issues affecting great whales until the 1980s when those who were displeased with the moratorium began to challenge both its primacy and competency. The encyclopedic history of this period by Tønnesson and Johnson (1982) serves as an invaluable resource for this discussion.

During the pre-moratorium era most whaling was conducted in the Antarctic by Norway, the Netherlands, Japan, and the USSR, although several other nations also engaged in near-shore whaling off of their respective coasts. The history of whaling in the Antarctic is a history of overexploitation; even modern proponents of whaling decry the failure of the IWC to stay declines during this period.

Here I outline the torturous negotiations that led to the instantiation of species-specific quotas in 1972 because this moment marks the end of a long struggle over an inefficient regulatory structure for managing whale stocks. Species-specific quotas are important because they allow biologically realistic management: individual stocks of each species are treated as separate populations with their own carrying capacities and rates of growth, decline, and harvest. However, between 1946 and 1972 whales were managed collectively as if they constituted a single, trans-Antarctic population composed of just one species. An overall quota was set annually, and whatever mix of whales needed to meet the quota was taken. This "single-unit" management strategy contributed significantly to the fishery's eventual collapse because it hid the serial decline of each species' stocks.

In reality the imposition of species-specific quotas did not lead to sustainable management because excessive earlier depredations had reduced stocks to such low levels. However, we can presume that had species-specific quotas been established earlier, the crash would have not occurred to the degree that it did. This presumes that realistic quotas for each species could have been agreed to, but realistic quotas were in no way possible within the single-unit management strategy. Thus, the IWC's decision to adopt species-specific quotas in 1972 marks a turning point at which we could in theory suppose that the regulatory tools necessary to maintain sustainable harvest were in place. Therefore, for the purpose of this discussion, I will assume that the etiology lag came to an end with the adoption of species-specific quotas.[2]

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[2] In practice several other issues, such as the adoption of a neutral observer scheme, continued to thwart successful management. I ignore them in this discussion, but they would only serve to extend the etiology lag

Etiology lags begin when the potential for a threat to biodiversity has been identified (although ostensibly the lag could be said to begin with the onset of a threat, whether it is noticed or not). In the case of deep-water whaling, the etiology lag began in 1951 when the IWC's Scientific Committee first alerted the Commission to the problem of a single-unit regulatory practice. Despite this and repeated warnings, the IWC took over 20 years to adopt species-specific quotas. The manner in which the species-specific quotas were arrived at further illustrates causes of the etiology lag, and so I will summarize this portion of the history of the international whaling regime.

The single-unit approach resulted from establishment of the Antarctic quota in terms of the Blue Whale Unit (BWU), which is the amount of oil that one average-sized adult blue whale (the largest of the whales) yields when reduced (about 100-110 bbl.). Other species are not as productive; one BWU is roughly equivalent to two fin whales, two and a half humpbacks, six sei or Bryde's, or 30 minke (Tønnesson and Johnson 1982, Ch. 1). In 1946 the Antarctic quota was (rather arbitrarily) established at 16,000 BWU and held there for the next 25 years. The adoption of species-specific quotas abandoned the BWU in favor of establishing quotas in units of individuals to be taken for each stock of each species.

The etiology lag leading to species-specific quotas can be divided into two stages. The first consisted of the negotiations that led to national quotas. Only after these were successfully adopted could negotiations for species-specific quotas begin. National quotas were important to lowering overall catch: no nation wished to forego harvest if other nations were not also withholding effort, and there was great pressure to cover the costs of overcapitalized fleets.

In the meantime, the incentive was for each country to invest as much as possible in its whaling fleet in order to cover costs. In this respect nations were a different advantage. Norway's fleet was composed of aged factory ships and whale catchers. The Netherlands' enterprise was state-subsidized, and the Soviet fleet was wholly state-owned. The latter was awesomely inefficient; it was estimated that by the late 1960s the Soviets could have bought the whale oil on the market for half the cost expended to procure it. Japan enjoyed a comparative advantage in having low crew costs and a domestic market for whale meat (as profit margins for whaling shrunk, European actors

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and emphasize its importance. The moratorium of 1986 is a less-well defined "stopping" point for the etiology lag than the adoption of species-specific quotas because the necessity of the moratorium is still debated by some countries. Indeed, the IWC's own Scientific Committee expressed doubt over the need for the moratorium once species-specific quotas were established (Knauss 1997). It is evident that some stocks are still depleted to the point that they require complete protection, but by imposing a worldwide ban on all species, the IWC has implicitly reverted to its former "single-unit" management strategy.

also began turning to utilization of the meat as a way to maintain profitability; some of it was sold to the Japanese and some used for pet food; Tønnesson and Johnson 1982, Ch. 35).

Increasingly frustrated with the lack of movement toward national quotas, Norway finally left the IWC in 1959, and in reaction the Netherlands followed suit. Essentially Norway's reason for protest was that a national quota system was needed to rationalize fishing efforts and allow it to become more competitive despite its outdated fleet (Tønnesson and Johnson 1982, Ch. 32). In reality, Norway's fleet was becoming less efficient not just because other nations adopted new technologies, but because whales were becoming fewer in number. The Netherlands had similar motives in mind, arguing instead that the overall quota should be raised to 24,000 BWU. In 1962 a national quota system was finally instated, by which time the Netherlands and Norway had rejoined the IWC (Tønnesson and Johnson 1982, Ch. 33). By then total catch began to drop precipitously, and it was not a debatable question of *if* quotas should be reduced but by how much.

Once national quotas were instated, the regime began a slow move toward species-specific quotas. In 1961, 1962, 1963 and 1964 the IWC's Scientific Committee recommended the adoption of species-specific quotas, but the IWC continued to ignore its own scientists (Heazle 2004). By 1964 the situation became so obviously untenable that the FAO, in attendance at IWC conferences since inception of the Commission, threatened to quit its advisory role if species-specific quotas were not adopted because the FAO did not want to be associated with the "destruction of the whales" (Gillespie 2005, Ch. 1). The bloc in favor of maintaining a single-unit management scheme was in the majority however, and argued that scientific stock assessments were too uncertain to justify single-species quotas (Heazle 2004, 2006).

The whaling industry became ever more inefficient as whale stocks declined. Beset by rising costs and diminishing returns, Netherlands and Norway abandoned the industry in the 1960s, leaving only Japan and the Soviet Union (Tønnesson and Johnson 1982, Ch. 33). Pressure for species-specific quotas mounted as those opposing the quotas left the market and it became increasingly evident that stocks were crashing.

After long negotiation, species-specific quotas were established in 1972, ending this 22- year etiology lag. This policy "success" occurred not-so coincidentally with a resolution adopted at the 1972 UN Conference on the Human Environment for a 10-year moratorium on commercial whaling. (The moratorium was not actually adopted until 1984, coming into effect in 1986.)

Several factors worsened the struggle for species-specific quotas. First, the technical ability to identify and assess the status of stocks was not adequately developed when the ICRW came into force. However, techniques were in place by the early 1960s with the establishment of the IWC's "Committee of Three" (discussed below), and possibly could have been available earlier had the IWC decided to devote resources to that end.

Second, the etiology lag was elongated by diplomatic diversions. In this case, the negotiations first had to pass over the hurdle of establishing national quotas. These came to a head in 1958 when Norway threatened to leave the IWC if national quotas were not adopted. Threats by other nations to leave ensued, and the situation soon endangered the very legitimacy of the IWC. "The 18 months that followed [February 1961] will stand as the most tragic, or possibly tragi-comic, in the entire history of whaling control" (Tønnesson and Johnson 1982, p. 602). The Netherlands continued pushing for either higher quotas or none at all until it was demonstrated that it could not even catch half of its allotted quota. Negotiations often deadlocked over the allotment of just 10 BWU, or did not occur at all when (for example) the Soviet Union simply refused to answer the invitation to a conference. Norway eventually left the IWC and in reaction the Netherlands followed suit, though both rejoined upon promises of progress towards national quotas. Finally, in 1962 the IWC voted to establish national quotas. Thus, while diplomatically necessary, national quotas only served as a distraction to the eventual negotiation of species-specific quotas.

Third, the etiology lag was a result of the intransigence of actors, though evidence suggests that they increasingly shared the view that whales were overhunted (Tønnesson and Johnson 1982). Even with the technical capacity to assess stocks and the distraction of negotiations over national quotas out of the way, the IWC took another ten years to adopt the species-specific quota system. During this time the overall quota was reduced from 15,000 BWU to a little more than 100, and actual catch almost always fell below the quota. The primary forces motivating intransigence were economic gain and geopolitics. Japan, with low wages and a domestic market for whale meat, was able to maintain a profitable fleet. In contrast, the USSR's gross inefficiency was partially offset by illegal hunting (Tormosov et al. 1998, Ivashchenko et al. 2007) and by the desire of the Soviet Union in to maintain a geopolitical presence in the Antarctic, a utility not captured in the whale oil market (Turchetti et al. 2008).

With the etiology lag come to an end, the response lag began. The etiology lag allowed such decimation in whale stocks that many have yet to recover to levels that would justify harvest. The magnitude of this lag period is made clear in the report by the IWC's "Committee of Three" in 1963, which provided the Commission its first species-specific stock assessments. The results of that report, regardless of later refinement, emphasize the extreme seriousness of coupled etiology and response lags. For example, the Committee estimated that the Antarctic humpback stock in Group IV (one of the six sectors in which the Antarctic was divided) would require 80 years to recover to the level that it was in 1940 when hunting started if harvest ceased immediately. For every year hunting continued at then-current intensities, recovery would be pushed back another 23 years. Other humpback stocks in other sectors had similar response lags, and other species also had response lags on the order of several decades (Tønnesson and Johnson 1982, Ch. 33). Hunting of humpbacks in the Antarctic was only banned in 1966. This is a fairly rapid policy response: only 3 years passed between the Committee's report and action to ban harvest. But in biological terms, it translates into a decades-longer response lag on top of the time already necessary.

Long response lags are not uncommon. For example, unregulated whaling in the 18th and 19th centuries diminished the Northwest Atlantic stock of right whales to such a degree that it now numbers ca. 300 individuals (IWC 2009) (from an estimated abundance of at least 1000 individuals in the 17th century; Waring et al. 2007). The population is still so low that ship strikes and entanglement are serious threats to its persistence. The response lag may be even more serious than these figures suggest; some suspect that the removal of such a large amount of whale biomass from the oceans caused an ecological regime change in food web structure that may make recovery of some species impossible (Reeves et al. 2003).

The linkage between the etiology and response lag is important for several reasons. First, benefits derived from biodiversity are diminished during the response lag period. For example, in their encyclopedic history of modern whaling, Tønnessen and Johnsen (1982) calculate economic losses from the response lag:

> *According to the forecast of the Scientific Committee [in 1963] a permanent catch of 17,800 units (6000 blue whales, 20,000 fin whales, 1000 humpbacks and 8400 sei whales) could be caught from the optimal stocks of the four species mentioned. If we estimate that only 3000 units can be caught annually during the first 20 of the 50 years required to restore total stocks to their optimum level, and then 10,000 units annually during the remaining 30 years, we shall find . . . a net loss of 470,000 units . . . the loss amounts to [1.4 billion 2005 USD][3]. This is the price the next generation will have to pay. (p. 620)*

[3] The original text reads "£260 million"; converted using Sahr (2008).

Clearly, policy delays can translate into loss of food security, economic gains, and other forgone benefits. Seldom is this cost of policy delay taken account of.

Second, the etiology-response lag linkage is important because it can endanger species persistence for a long time to come, even if populations recover quickly. This is because populations tend to lose genetic diversity when reduced to low levels as a result of “bottleneck” effects (effectively, a small population can only represent a limited sample of the genetic diversity that a large population would have). This situation is exacerbated when populations remain small for several generations because inbreeding is more common when there are fewer mates to choose from and because rare genes are lost by chance (Groom et al. 2005). These effects can have consequences for many generations because genetic diversity which can remain low even if the population becomes large again. For example, the northern elephant seal was hunted almost to extinction in the 19th century, and even though its population has rebounded to ca. 175,000 individuals it now has very low levels of genetic diversity (Busch 1985, Weber et al. 2004). Genetic diversity is important because it provides the potential for evolutionary in response to environmental change, whether that change is anthropogenic or “natural.” Therefore genetic response lags can last far longer than population response lags.

The NPFST’s struggle with harvest methods and the IWC’s debate over quotas exemplify the critical contexts in which the policy development occurs: etiology lags (identification of threats and appropriate action, then implementation of that action) and response lags (the biological response to policy implementation). These lags form the background against which we can see the exigency of dealing with complex threats “matrices” discussed in the next section.

Modern technical developments do not obviate concern for etiology lags. For example, the first scientific assessment of cetaceans in the Baltic and North Seas conducted for the ASCOBANS treaty reported a sensitivity analysis demonstrating that even if there were a substantial decline in whale populations, it could take up to 20 years to detect the decline even with an active monitoring process in place (Nijkamp and Nollkaemper 1996).

In the extreme, response lags last forever when species go extinct. Although new species will always evolve to take the place of those that have disappeared, recovery from large extinction events like the ones humans are currently exacting upon the biosphere can require 10 million years or more—far longer than humans have existed as a species (Pimm et al. 1995, Kirchner and Weil 2000).

In summary, etiology lags constitute a "meta-threat" to biodiversity in that they allow actual threats to continue unabated while negotiations occur. In the rest of this essay I will argue that the international environmental governance is structured in a manner that can only be expected to exacerbate etiology lags.

Threat Matrices and Policy Networks

In this section I discuss the nature of threats to biodiversity, the structure of contemporary biodiversity policy, and how the mismatch between threats and policy contribute to gaps in coverage. The lags I discuss in the preceding section make these gaps all the more probable and all the more salient. When our institutional networks are not structured to "see" a threat, designing and implementing a policy to address that threat will take more time and thereby exacerbate time lags inherent in the system.

In the first part of this section I describe the concept of the "threat matrix," which is a set of threats that directly and indirectly affect biodiversity. In the second part I discuss the legal and political concepts of primacy and competency. In the final section I demonstrate how issues of primacy and competency fail to address the ever-increasingly complex threat matrix that faces LMMs and all biodiversity in general.

Threat Matrices

A threat matrix is the set of threats, and interactions between threats, that endanger biodiversity. Threats can directly or indirectly affect biodiversity, and they can interact amongst themselves, ameliorating or exacerbating their net effect. It is important to distinguish the threat matrix seen from a policy perspective and a threat matrix seen from a natural sciences perspective. When these align, we should expect that the potential exists for implementing adequate policy. When they do not align (i.e., when a threat is outside the mandate of a particular policy) policy instruments need to cooperate. If they do not, a threat-policy gap exists and the threat goes unaddressed. The concept of a threat matrix presented here is based on a threat-focused approach to conservation management (Whitehead et al. 2005).

The simplest situation is a one-threat matrix, which I illustrate in Figure 1a. In this example, harvest is the only threat. Many regimes are designed to address such simple matrices. For example, NPFST and ICRW were both negotiated to regulate hunting (although the ICRW's IWC is now attempting to expand its purview beyond just harvest to non-consumptive uses). Other treaties intended to manage harvest of LMMs include the 1973 Agreement on Conservation of Polar Bears and the 1974 Convention for the Conservation of Antarctic Seals. CITES also addresses a single threat, but its threat matrix is even simpler because it can only restrict harvest that is intended for international trade. The simplicity of a threat matrix does not necessarily connote the ease of policy development and implementation as the previous section on etiology and response lags clearly illustrates.

Threat matrices, as seen from both a policy and a natural science perspective, are becoming inexorably more complex. Greater complexity is a result of our expanded scientific knowledge (identifying new threats) and the increasing number and kind of activities humans engage in that affect the environment which cause new threats (Hoffman 1995). For example, threats to LMMs not present 100 years ago include high concentrations of pollutants, elevated ultraviolet radiation as a result of stratospheric ozone depletion (Karentz and Bosch 2001), tourism (Higham and Lusseau 2007), and global warming (Smith 2009). Increasing complexity does not preclude designing policies that can anticipate and adapt to threats as they emerge (e.g., Healey 2008). In order for this to occur though, policies must be designed with flexibility in mind.

Recently three “daughter” agreements to the Convention on Migratory Species (CMS) have been negotiated to address complex threat matrices: the Agreement for the Conservation of Seals in the Wadden Sea, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS). Here I discuss the characteristics of each of these agreements to illustrate the increasing complexity with which biodiversity treaties must contend.

The Agreement for the Conservation of Seals in the Wadden Sea (hereafter the “Wadden Seal Agreement”) was negotiated on account of concern over the Wadden Sea seal (*Phoca vitulina*), which suffered a series of virus-induced die-offs in the 1980s. Signed by Denmark, Germany, and the Netherlands in 1990, the agreement addresses four threats: habitat degradation, pollution, and harvest, and bycatch (incidental catch in fishing gear). Figure 1b shows the threat matrix for this agreement.

This threat matrix is still fairly simple because threats affect the species directly and do not interact with one another except through their effect on the seals. The matrix in Figure 1b illustrates an increasingly common aspect of modern threats: some of them do not have direct policy solutions. In this example, disease was the primary threat, but as of yet there is no technical solution for this threat. Where there is no technical solution there can be no direct policy solution; at best we can hope that other conservation measures make up for losses imposed by these kinds of threats.

The second agreement, ASCOBANS, was opened for signing in 1992 and protects all small cetaceans in the North and Baltic Seas and the Northeast Atlantic (Gillespie 2005, Ch. 10). Signed by 10 range states[4] (states with national waters in the geographic area of interest), ASCOBANS has successfully initiated research on and monitoring of the status of small cetaceans, but the agreement's effectiveness has been limited by range states not translating its measures into national legislation (Caddell 2005). ASCOBANS is open to "regional economic coordination organizations" (the European Community), but to date the EC has yet to join the agreement.

Despite its shortcomings, ASCOBANS attempts to address a moderately-complex threat matrix (Figure 1c). The agreement encompasses threats from harvest, pollution, bycatch (entanglement in fishing gear), and acoustic pollution which disrupts the sonar used by small cetaceans to locate prey and discern the environment (Tyack 2008)

The ASCOBANS threat matrix (Figure 1c) illustrates another dilemma with which modern biodiversity conventions have to contend: the increasing "removal" of cause of threat from the ability of the convention to manage it. In this case, bycatch is the most significant cause of non-natural mortality for many of the species in the area. It is also the primary threat to the IUCN Critically Endangered Baltic harbor porpoise (Strempel 2003). Bycatch is the direct physical threat, but its solution requires management of fisheries, a sector over which ASCOBANS does not exercise primacy (Figure 1c). Rather, fisheries are managed by each states' respective fisheries institutions and (for EU members) by EC Common Fisheries Policy. Thus, in order for ASCOBANS to exercise control over bycatch, it must work with other policies and their institutions.

Bycatch is not the only threat caused by an external factor outside ASCOBANS's direct control. Indeed, nearly all of the threats depicted in Figure 2 are only proximate, not ultimate, causes of species decline. For the purposes of visual clarity I have not included in Figures 2 most of the secondary and tertiary threats (threats that act through one or two other factors). For example, the Wadden Seal Agreement, ASCOBANS, and ACCOBAMS each addresses pollution, but pollution is the product of relationships between industrial practices, environmental law, and economic policies that cause and allow pollution—over none of which any of the agreements has direct primacy. I will

[4] ASCOBANS's signatories include Belgium, Denmark, Finland, France, Germany, Lithuania, the Netherlands, Poland, Sweden, and the United Kingdom.

return to the dissociation between treaties' coverage of proximate threats and the ultimate causes of threats in the next section.

The third and newest LMM treaty, ACCOBAMS, came into force in 2001 and has a current membership of 21 range states.[5] As with ASCOBANS, "regional economic coordination organizations" are allowed to join, but the EC has yet to do so. This is a major impediment to progress on issues involving fisheries, and other marine environmental issues (Burns 1998). I will discuss this aspect in later sections.

Figure 1d shows the ACCOBAMS threat matrix, which is the most complex of any LMM regime to date. ACCOBAMS addresses the same threats that ASCOBANS attempts to manage, but within its mandate are also issues associated with tourism (whale watching and "dolphin-assisted" therapy) and the potential for competition between whales and fisheries. In this case, it is suspected that whales and fisheries compete for the same fish, and to the degree that fish stocks are depleted, cetaceans suffer for want of food resources. To date, no strong linkage to this effect has been demonstrated for this geographic area, although human-LMM competition has a long history of being a political issue (Read 2008).

Threat matrices only promise to become more complex as global warming proceeds (Jackson 2008). Figure 2a illustrates a hypothetical threat matrix affecting LMMs in general. This threat matrix is "hypothetical" in that there exists no coherent policy apparatus to address all of these threats, but it is not hypothetical in that each of these threats has either been documented or is expected to have detrimental effects on LMMs. These include pollution (Kamrin and Ringer 1994), disease (Seibel et al. 2007), harvest (Tønnessen and Johnsen 1982), bycatch (Lewison et al. 2004), competition with fisheries (Read 2008), acoustic pollution (Weilgert 2007, Tyack 2008), ultraviolet radiation (Karentz and Bosch 2001), ocean acidification (Bass et al. 2006), effects of warming on prey distributions (Burek et al. 2008), tourism (Higham and Lusseau 2007), habitat degradation (Harwood 2001), and interactions between ocean acidification and acoustic pollution (Hester et al. 2008). In other words, the threat matrix in Figure 2a is a matrix from a natural science perspective, not a policy perspective, because it depicts threats as experienced by LMMs, not necessarily threats "seen" by policy.

[5] ACCOBAMS signatories include Albania, Algeria, Bulgaria, Croatia, Cyprus, France, Georgia, Greece, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Portugal, Romania, Slovenia, Spain, Syria, Tunisia, and Ukraine.

Threat matrices are also becoming increasingly synergistic, meaning that threats interact with one another to exacerbate their net effect (Figure 2; Hoffman 1995, Gillespie 2005, Ch. 3). For example, global warming is unlocking a cascade of direct and indirect threats affecting LMMs (Gillespie 2002). The most obvious is a change in temperature, which has already been shown to cause species to shift in their biogeographic ranges (Perry et al. 2005). If they do not respond themselves to changes in temperature regimes, cetaceans could be affected by geographic shifts on their food supply (Smith 2009).

Another example of threat synergy is the relationship between carbon emissions, ocean acidification, and acoustic pollution. Higher atmospheric CO_2 concentrations are expected to further acidify the oceans as CO_2 is dissolved in water and taken up by phytoplankton (ocean pH has already dropped 0.1 point and under business-as-usual scenarios is expected to drop another 0.7 units; Bass et al. 2006, Hofmann and Schellnhuber 2009). Sound transmits farther in acidified waters (Hester et al. 2008), meaning that as oceans acidify, they will become more confusing and louder acoustic environments for cetaceans, exacerbating the problems that cetaceans already face which acoustic pollution (Tyack 2008). Problems begat problems.

Policy networks designed to address complex threat matrices will have to become synergistic themselves, or else fail in their mandate. As noted above, many emerging threats are beyond the immediate purview of the policies designed to address them. ASCOBANS and ACCOBAMS, for example, do not have as much formal influence over the ultimate cause of bycatch or competition with fisheries as does the EC Common Fisheries Policy, the FAO's North East Atlantic Fisheries Commission (for ASCOBANS), or the FAO's General Fisheries Commission for the Mediterranean (for ACCOBAMS). In order for ASCOBANS and ACCOBAMS to adequately address these threats, they will have to cooperate formally with these institutions.

In summary, these matrices increasingly consist of threats that:

- Have no direct technical solution and thus no direct policy solution (e.g., disease).
- Are "removed" from the direct control of the agreement in question either because other agreements have primacy over them (e.g., fisheries) or because ultimate causation is not within the purview of any existing environmental treaty (e.g., industrial and economic practices which externalize pollution costs).
- Are becoming increasingly complex and synergistic (e.g., carbon emissions cause ocean acidification which elevates acoustic pollution).

If the policy process were able to "see" a threat (as it might be seen by natural science perspective), we might expect there to be a least potential for appropriate action. However, in the next section I argue that the issue of primacy and competency disrupt policy coverage of complex threat matrices.

Threat-policy Networks

A threat-policy network is formed by combining a threat matrix with the policy network that is designed to address the threats. Figure 2b is the threat-policy network relevant to the ACCOBAMS Mediterranean area. This particular threat-policy network includes both regional threats like bycatch and harvest and global threats like global warming and ozone depletion. In theory, ACCOBAMS has competency over every issue that affects cetaceans in the Mediterranean. In practice, it has relatively little primacy (legal capacity to supersede other law or policy when conflict occurs) over most of the issues that directly and indirectly affect cetaceans. For example, ACCOBAMS has to work with relevant fishing institutions to address the problem of bycatch. At the extreme, it must address threats that are global in coverage, such as ozone depletion (which has been shown to damage cetaceans' sight and reduce their immune system function; Clark 2002) and global warming (discussed above).

Figure 2b clearly demonstrates the potential for "treaty congestion," a state engendered by the uncorrelated confluence of too many conventions trying to do the same thing (Brown-Weiss 1993). Here, ACCOBAMS's primacy is limited by the primacy of other conventions designed to address threats relevant to cetaceans (Caddell 2003). For example, ACCOBAMS has very limited jurisdiction over fisheries in the Mediterranean Sea (it can proscribe certain types of fishing gear, but cannot establish fishing quotas), even though it is suspected that humans directly compete with whales for food resources.

This situation necessitates cooperation between relevant parties, which in the very least is indicated by formal contact:

> *[T]he coordination that happens across institutions focused on different aspects of species and biodiversity conservation happens because of the actors involved in more than one organization. Sometimes it is individual scientists or representatives of governments who attend COP meetings for more than one conservation institution, and in other cases it is the fact that UNEP plays the secretariat role for the most important of the conservation institutions. (DeSombre 2006, p. 65).*

As the first section of this essay illustrates with case studies of the NPFST and IWC, differences in viewpoint (not technical competency) are often the cause of etiology lags. While we cannot always obviate conflicts between actors, we can at least establish platforms for common understanding. Put simply, if parties do not have a forum in which they normally talk with one another, then we can expect that when the time comes for debate, etiology lags and ensuing response lags will only be lengthened.

Taking ACCOBAMS as an example we can ask, How well does ACCOBAMS itself serve as such a forum? Figure 2c shows the restricted threat-policy network for ACCOBAMS. This diagram is the same as Figure 2b except that it takes into account the record of attendance at the three ACCOBAMS MOPs to date (ACCOBAMS 2002, 2004, 2007). Figure 2b show that attendance by representatives from other relevant conventions and international governance bodies is limited. By itself, ACCOBAMS can only attempt to regulate tourism and harvest (though the IWC and CMS also add weight to injunctions against harvest), and in cooperation it can partially address pollution. Notably lacking is formal cooperation with the EC. Though the EC has been sending a delegation to ACCOBAMS MOPs, its influence and obligations regarding the agreement are limited because it is not an official member (though it is allowed to be so). The lack of coordination leave most of the other threats only incidentally addressed, at best. The threats that ACCOBAMS can affect either by itself or cooperatively are severely curtailed: it cannot even adequately address the threats over which it has a mandate (i.e., acoustic pollution, bycatch, food and fisheries; Figure 2c).

When there is no dialogue between relevant policies, we should expect lengthening of etiology lags with ensuing worsening of response lags. Below I suggest measures to enhance cross-policy dialogue.

Policy Suggestions

Recommendations for the European Union

Recommendations relevant to the EU are fairly straightforward. As noted above, the EC has yet to become a member of ASCOBANS and ACCOBAMS, where it would have a very influential voice over fisheries policy, *inter alia*. Likewise, it is possible that were the EC to join ACCOBAMS, other relevant parties would follow suit. For example, Turkey and the Russian Federation are "sympathetic" to ACCOBAMS, but remain outside its membership even though they are range states. The primary reason for their reluctance to engage ACCOBAMS as members lies in disputes over fishing rights within the Black Sea (Gillespie 2005, Ch. 10). This is a very clear example of the kind of diplomatic distraction that elongates etiology lags. In this case, several serious issues face cetaceans in the Black Sea, including the use of gill nets, which have extremely high rates of bycatch (Gillespie 2005, Ch. 4). Moreover, the three resident species of small cetaceans in the Black Sea are listed as IUCN Endangered and are known to have been declining in the past (Reeves and Notarbartolo di Sciara 2006). However, until all relevant parties are able to meet in the appropriate forum the etiology lag will only persist.

At present, there are two primary policies in development relevant to the conservation of LMMs. First, the EU is in the midst of implementing one of the world's most comprehensive protected areas networks as mandated by the EU Habitats Directive (92/43/EEC) and encouraged by the Bern Convention on the Conservation of European Wildlife and Natural Habitats. Combined with the areas protected by the Birds Directive (79/409/EEC), these sites constitute the Natura 2000 network. To date, members states have been successful in designating Natura 2000 protected areas, but legal obligations pertaining to these areas have yet to be decided. Relevant to this essay is the fact that while terrestrial protected areas have been delineated, marine protected areas (MPAs) have not. Likewise, it is not yet clear what Natura 2000 designation would mean for MPAs, but draft documents exist on guidance for restricting fishing and harmonization with EC Common Fisheries Policy (DG Environment *No date*). Furthermore, because Natura 2000 sites in the Mediterranean Sea are limited to national waters (12 nautical miles from the shore; DG Environment 2007), their overall efficacy relevant to LMMs is questionable in this area because most LMMs spend little of their lives within this zone. In short, even when Natura 2000 becomes fully operational in the marine realm, it will not constitute the comprehensive conservation strategy that a complex threat matrix requires, at least in the Mediterranean Sea (national waters extend to ca. 200 nautical miles for states that border non-Mediterranean waters).

The second relevant policy is the EC's Marine Strategy Framework Directive (MSD) (2008/56/EC; Juda 2007) which would require states to achieve "Good Environmental Status" (which is as of yet only generally defined) by 2021 (though this may be moved up to 2017; Mee et al. 2008). The MSD is an important initiative that could address some of the issues raised here. Namely, it encourages cooperation between member states (Article 16) and non-member states (Article 20), and harmonization between the MSD and relevant conventions related to pollution (Article 19). The MSD also specifically targets biodiversity in its Article 18, noting that the Directive should support the EC's decision to halt the loss of biodiversity within its borders by 2010 (a stronger version of the commitment that members to the CBD committed to in 2002; CBD 2006).

However, aside from the measures necessary to attain "Good Environmental Status," the MSD's primary instrument for conserving biodiversity appears to be the establishment of MPAs as indicated by wording that the Natura 2000 network will "will make an important contribution to this process" of halting biodiversity loss (Article 18).

Despite the value of MPAs for conservation (Agardy 1994) a strategy based solely upon protected areas is inadequate (Gray 1997). MPAs under the Habitats and Birds Directives are geographically limited (in the Mediterranean) and as of yet are not well-defined in terms of what obligations they would place upon member states. Moreover, although MPAs can serve as the cornerstone for a proactive marine conservation policy, they cannot by themselves address complex threat matrices such as those facing LMMs (Gray 1997). Likewise, Natura 2000 and the MSD are EU-specific and even where cooperation with non-EU members is encouraged, are limited policy platforms for limited environmental issues. No MPA can handle adequately threats engendered by global change because these threats do not respect jurisdictional borders.

Given the complex, interacting, evolving nature of threats to biodiversity and the need for institutional cooperation between relevant actors and policies, forums larger than a single convention's COP or MOP are required.

An existing institutional structure already exists that could serve as the forum for a variety of issues affecting LMMs: the 35-yr old UNEP Regional Seas Programme's (RSP). The most successful of these is the Mediterranean Action Plan (MAP; DeSombre 2006). The MAP gave birth to the Convention for the Protection of the Mediterranean Against Pollution (the Barcelona Convention) in 1976, which has under it a number of protocols for reducing pollution and protecting biodiversity. The Barcelona Convention is notably the most successful of these programs, but like other RSPs, it is hobbled by the limited funding UNEP can provide it (DeSombre 2006). Nonetheless, the MAP has the added advantage of being pan-Mediterranean, meaning that non-EU (i.e., African and Middle Eastern) states are members.

Though currently limited, the RSPs could serve as a platform for all pertinent members to engage in discussion on all pertinent threats. RSPs also have the advantage of being geographically-based, meaning that new innovations in policy such as place-based management (Young et al. 2007) are congruent with its existing structure. Place-based management is a solution to the "implementation problem" inherent in ecosystem-based management. Properly instituted, ecosystem-based management manages processes, not just specific entities (e.g., certain species), to produce a desired outcome while maintaining ecosystem integrity. Such an approach is required by complex threat matrices. Despite several decades of experience with the concept of ecosystem-based management, actors have found it difficult to put into practice because of overlapping jurisdictions and multiple stakeholders who have different aims and efficacies over relevant ecosystem processes. One solution to this dilemma is place-based management, which brings all affected parties together to produce coherent strategies that are intended to be at least sympathetic to each party's goals (Young et al. 2007).

UNEP's MAP provides a pre-existing forum for the development of coherent, comprehensive marine policy in the Mediterranean Sea, but it will require stronger commitment from interested parties. Other relevant RSPs include the Black Sea Region (administered by the UNEP), and the Baltic Sea, Caspian Sea, and the North-East Atlantic Regions (each administered independently). Whatever the administrative structure, these RSPs could provide a foundation for cooperative, place-based management that integrate a wide variety of sectors and policies with intersecting goals and causes. As such these RSPs (including the MAP) require more attention if they are to serve as the organizations of integration they were designed to be.

Recommendations for the US

The US is in a very different policy space vis-à-vis the EU in terms of conservation of LMMs. The US is not a member to the CMS nor even the CBD, but it is a vocal member of the IWC.

Despite its general lack of participation, the US has cause to enter into such agreements. For example, the vaquita (*Phocoena sinus*) is a rare porpoise endemic to the northern part of the Gulf of California in Mexico, where it resides in shallow waters fed by the Colorado River (Reeves et al. 2003). Massive water consumption by the US drains the Colorado nearly dry before it enters Mexico which contributes to the poor conservation status of the vaquita (Culile 2004). Although the US is obliged to provide Mexico with a certain amount of water from this river, in practice the river is almost dry before it reaches the Gulf, and climate change is expected to further reduce flow (NRDC 2008). Another example occurs off the coast of Okinawa, Japan, where the US is planning construction of a naval base that could negatively affect habitat important to manatees (*Dugong dugon*).

Thus, recommendations for the US are fairly simple, although it seems unlikely that the US will soon become member to the CMS or initiate agreements. One way forward would be to use the Endangered Species Act and Marine Mammal Protection Act (the cornerstone of US domestic conservation policy) to exact limitations on federal activities that could harm such species. This is already a requisite part of these laws, but in practice there has been comparatively little action on enforcement and fair use of science in the past 8 years. Thus, at most it seems plausible to hope for a change in how the Acts are administered.

Conclusions

In conjunction with "conventional" threats like directed harvest, bycatch, and pollution:

> *[LMMs] will face additional threats via anthropocentric environmental change . . . These threats will be less visible than traditional ones, but ultimately, they may be just as deadly as the oceans become increasingly at risk and the international community struggles to come to terms with these risks in a multitude of other indirectly related forums. (Gillespie 2005, Ch 3, p. 71)*

Threats to marine biodiversity act simultaneously and synergistically, but international marine governance is fragmented among many different regimes. Conservation biologists now understand that in many cases coincident threats can affect biodiversity more than just the sum of their effects separately (Isaac and Cowlishaw 2004). In many cases, the threat that is most predominant when a species is rare is different from the one that brought it to the point of rarity in the first place, meaning that the etiology of threat and appropriate policy response is that much more complicated. Most marine environmental regimes focus on single issues (pollution, harvest, invasive species), but conservation efforts must address threats as they impinge upon biodiversity (i.e., synergistically).

Several LMM regimes are capable of perceiving complex, synergistic threat matrices. The three modern European LMM regimes (ASCOBANS, ACCOBAMS, and the Wadden Seal Agreement) are examples of these. Nevertheless, although these institutions can "see" and have mandates to address larger threat matrix, they have insignificant primacy where action needs to be taken to address these threats. This gap in efficacy will only worsen as global change adds new threats and acts synergistically to exacerbate present threats.

All of the deficiencies—etiology lags, response lags, policy-threat gaps, and issues of primacy and competency—constitute a form of institutional blindness. An institutional "eye" with properly coordinated primacy will better perceive threats and reduce the problems of etiology and response lag. As I have done here, speculating on the consequences of a warming world for LMMs is not wild prognostication; there is an unfortunate precedent for institutional "blindness":

> *[R]ecall at the time of the first major international conference on the environment in Stockholm in 1972, there was next to no mention of what have now become established as front-rank problems: global warming, acid rain, and tropical deforestation. Environmental scientists could have gone at least partway toward anticipating these problems. They had had 100 years of warning from the Swedish scientist Arrhenius about the possibility of global warming. For decades acid rain impacts were accumulating unseen and unsuspected; could we not have asked whether all of those SO_2 and NO_x pollutants would eventually have an adverse effect on biotas? We could readily have alerted ourselves to tropical deforestation through remote-sensing surveys if only we had thought to identify it as a problem. So does the difficulty lie with "ignorance" or "ignore-ance"? (p. 358, Myers, 1995).*

In this passage Normal Myers admonishes the natural sciences for myopic vision. The point I stress in this essay is that even if scientific perception is accurate and timely, the policy "eye" has to map to the problem at hand or our intentions will remain shortsighted.

The issues discussed in this paper are cast in light of LMM conservation but pertain just as much to the conservation of all of the world's species and ecosystems. Although LMMs and their conventions form a convenient vehicle for this discussion, the threats facing them are not peculiar to their particular life form. Habitat degradation, pollution, non-natives, harvest, competition with humans for resources, ultraviolet radiation, warmer climate, and other threats affect diversity, whether terrestrial or aquatic. Indeed, for all their problems LMMs may be at the vanguard of protected species given the targeted nature of regimes specifically designed to conserve them. *In toto*, all life on Earth is ostensibly protected under the auspices of the CBD, but in practice the promise of this treaty has yet to unfold, and biodiversity has yet to become even marginally incorporated as a concern in most economies, let alone mainstreamed. In the meantime perhaps the best we can do is to design place-specific instruments (*de novo* or cobbled together from existing instruments) to address diffuse threat matrices and direct global regimes to better serve regional initiatives.

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Tables and Figures

Table 1 Abbreviations used in the text and figures.

Acronym	Meaning
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
COP	Conference of the Parties
DG	Director General
EC	European Commission
EU	European Union
GFCM	General Fisheries Commission for the Mediterranean
ICCMSBWS	International Convention for the Control and Management of Ships' Ballast Water and Sediments
ICRW	International Convention for the Regulation of Whaling
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
LDC	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
LMM(s)	large marine mammal(s)
MAP	Mediterranean Action Programme
MARPOL	International Convention for the Prevention of Pollution from Ships
MOP	Meeting of the Parties
MPA(s)	marine protected area(s)
MSD	Marine Strategy Directive
NPFST	North Pacific Fur Seal Treaty
RSP	Regional Seas Programme
UK	United Kingdom
UNCLOS	UN Convention on the Law of the Sea
UNEP	UN Environment Programme
US	United States

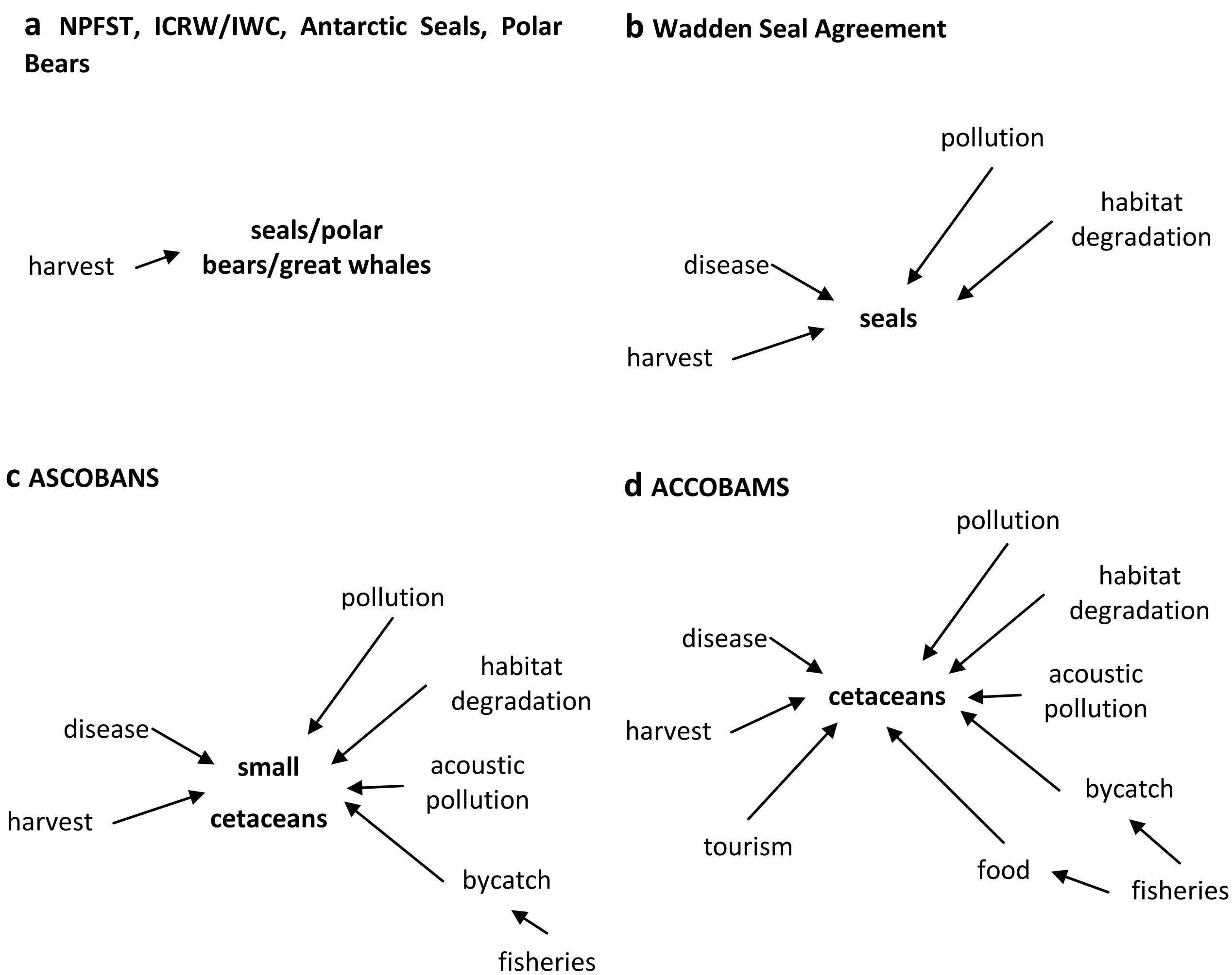
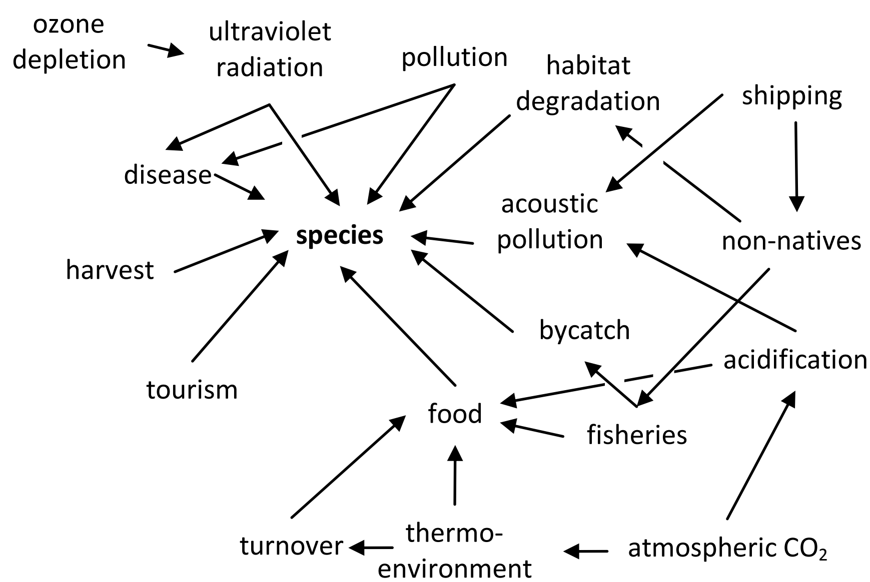


Figure 1 Threat matrices from a policy perspective. The threat matrix from a natural science perspective may be even more complex than those depicted. Not all documented linkages between threats and not all known threats are shown. **a)** The threat matrix for the NPFST, ICRW, the Convention for the Conservation of Antarctic Seals , and the Agreement on Conservation of Polar Bears. These regimes address only commercial and/or sport harvest. The threat matrices for the three CMS treaties are increasingly complex: **b)** the Wadden Seal Agreement, **c)** ASCOBANS, and **d)** ACCOBAMS.

a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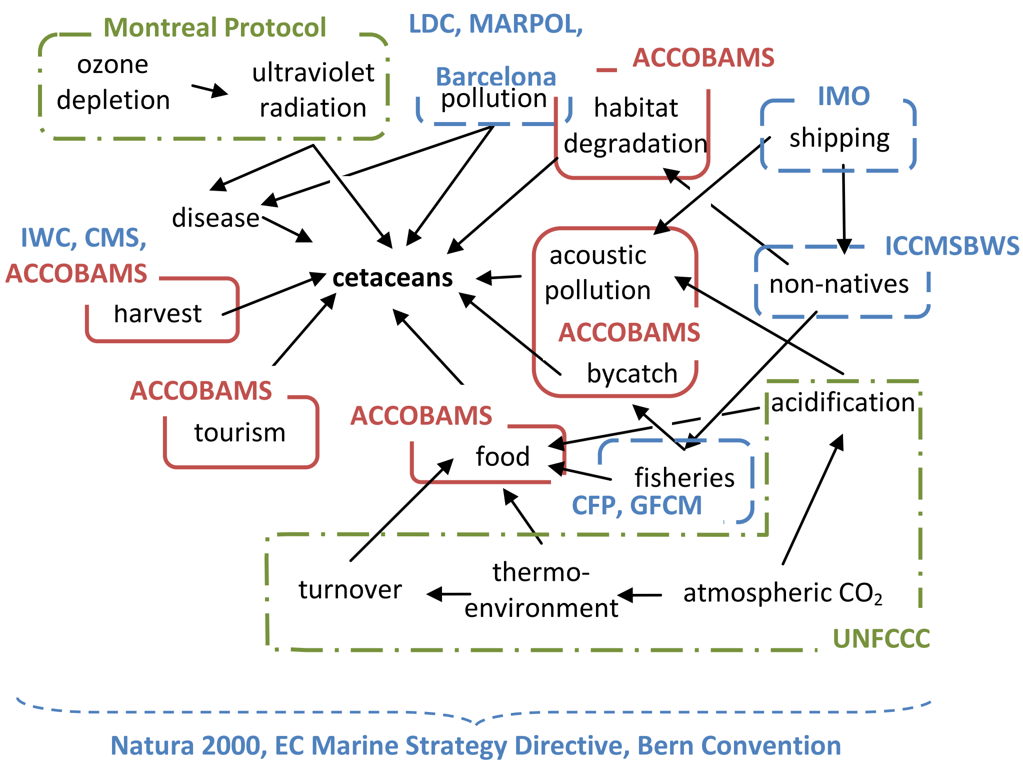
ultraviolet radiation
pollution
habitat degradation
shipping
disease
species
acoustic pollution
non-natives
harvest
bycatch
acidification
tourism
food
fisheries
turnover
thermo-environment
atmospheric CO_2

b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ozone depletion
ultraviolet radiation
LDC, MARPOL,
Barcelona
pollution
ACCOBAMS
habitat degradation
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shipping
disease
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harvest
cetaceans
acoustic pollution
ACCOBAMS
bycatch
ICCMSBWS
non-natives
ACCOBAMS
tourism
ACCOBAMS
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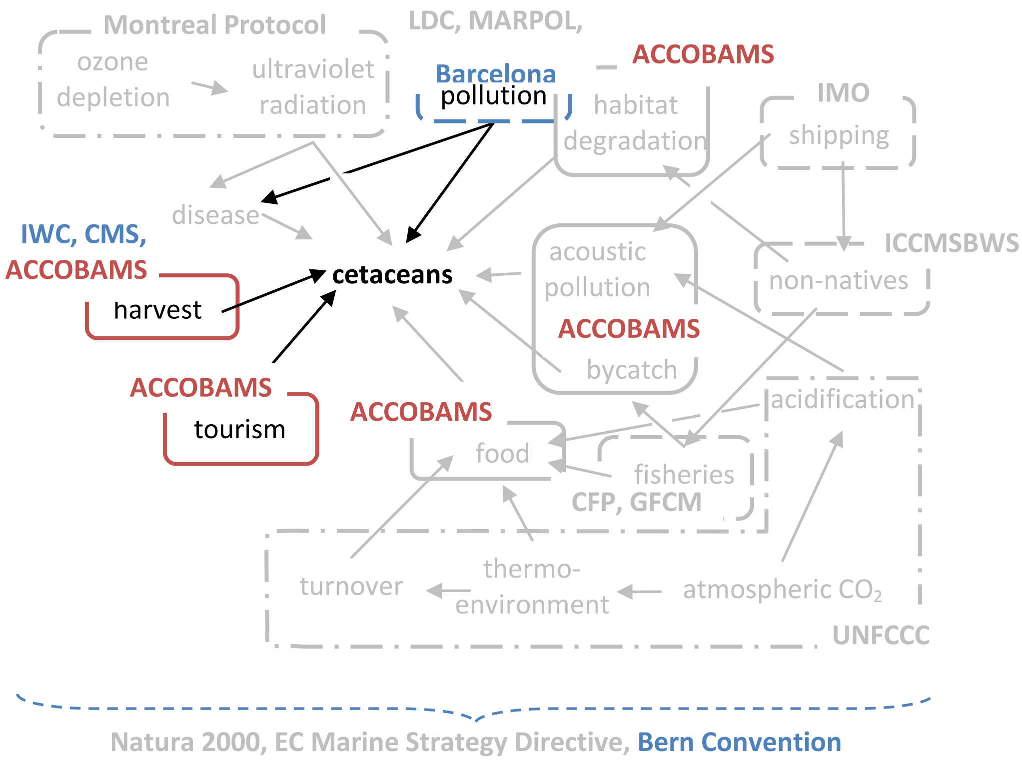
acidification
fisheries
CFP, GFCM
turnover
thermo-environment
atmospheric CO_2
UNFCCC
Natura 2000, EC Marine Strategy Directive, Bern Convention

c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thermo-environment
atmospheric CO2
UNFCCC
Natura 2000, EC Marine Strategy Directive, Bern Convention

Figure 2 Future threat matrices complicated by further global change (ozone depletion and global warming). **a)** The threat matrix for an unnamed LMM. **b)** The same threat matrix for the Mediterranean region of ACCOBAMS with most of the relevant regimes mapped onto the matrix. ACCOBAMS currently has a mandate to address issues so indicated. However, even with the relatively diminished threat matrix of the present, the efficacy of ACCOBAMS is challenged because it does not exercise full primacy over the causes of the threats. National legislation is not shown in the network. **c)** The threat matrix as it is addressed by policy coordination. Here, the network has been grayed out where representatives from policies in charge of overseeing a threat do not attend ACCOBAMS meetings (in the case of other agreements) or are not official members of ACCOBAMS (as with the EC). ACCOBAMS has extremely limited primacy by itself. Its effective primacy is only slightly expanded when attendees are considered as part of its policy network. (Only the IWC, CMS, Bern and Barcelona Conventions send representative to ACCOBAMS MOPs. The EC also sends a delegation, but is not a member, although it could join.) Abbreviations: LDC (London Dumping Convention), MARPOL (International Convention for the Prevention of Pollution From Ships), Barcelona (Barcelona Convention for Protection against Pollution in the Mediterranean Sea), IMO (International Maritime Organization), ICCMSBWS (International Convention for the Control and Management of Ships' Ballast Water and Sediments), CFP (EU Common Fisheries Policy), GFCM (General Fisheries Commission for the Mediterranean).