

APPENDIX O

D. Squires and P. Dutton. *Reconciling Fishing with Biodiversity:  
A Comprehensive Approach to Recovery of Pacific Sea Turtles*

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Reconciling Fishing with Biodiversity: A Comprehensive Approach to Recovery of  
Pacific Sea Turtles

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## 1. Introduction

No single approach by itself has worked to recover endangered Pacific sea turtles. Populations still continue to decline. A variety of factors have contributed to the continued population decline, which is primarily due to human interactions. Sea turtles and their eggs are prized worldwide for human consumption. Furthermore, their oils are used for lubricants and ingredients in cosmetics, and their shells for jewelry and eyeglass frames. Nonetheless, mass slaughter of turtles and plunder of their nests have been and remain a prime cause of population declines (National Research Council, 1990). Encroachment of human populations into coastal habitats further contributes to population declines by degrading nesting beaches. Harvesting of sea turtles for subsistence or commercial purposes and incidental mortality in commercial fishing and other such activities further diminish sea turtle populations. There continues to be considerable uncertainty over the status of key stocks and the extent to which bycatch in various fisheries has, and continues to contribute to declines in Pacific sea turtles. Lack of information has made it difficult to evaluate management options in a rigorous scientific manner, and this has led to controversy over best approach to take. Given this uncertainty, there is a need to evaluate a broad suite of approaches that that can be enacted that in the short run will prevent extinction of populations that are clearly in crisis, and in the long run, lead to recovery.

Sea turtles are migratory, weaving their way in and out of Exclusive Economic Zones of different nations and through the high seas. Breeding habitat can lie in one nation and their developing and foraging habitat in another nation's waters or in the high seas where this is little or no governance.<sup>1 2</sup> This creates a trans-boundary resource and jurisdictional problems, since there is no central authority to organize and enforce conservation. Property rights are absent or insufficiently well developed in Exclusive Economic Zones and the high seas for this Pacific common property resource. As a result of the trans-boundary and migratory nature of sea turtles, conservation strategies are required to tackle the trans-boundary issue and avert this Pacific "Tragedy of the Commons." Conservation and recovery limited to unilateral measures by individual nations are likely to fall short of the required conservation level, which instead requires cooperative and multilateral conservation, involving the efforts of multiple nations acting in tandem. Because there is no central authority to organize and enforce conservation, self-enforcing and voluntary arrangements are required.

The benefits of sea turtle conservation and recovery are diffuse across entire populations, but because costs are concentrated on particular groups, there is a misalignment of incentives for conservation and recovery. A potential "free rider" problem arises in such instances, in that there are incentives to "free ride" on the conservation and recovery efforts, including money paid by others. (A free rider is a party or person who receives the benefit of a good or service but avoids paying for it. This includes nonparticipation in international environmental agreements but nonetheless enjoying the benefits.) That is, there are few incentives to pay one's fair share. These "free rider" problems can be overcome by collective action and increasing participation in cooperative, multilateral conservation.

A unique life history makes populations vulnerable to several sources of mortality at critical stages in their life, which is aggravated by the several decades required to reach sexual maturity for many species<sup>3</sup>. Effective recovery requires an integrated and

comprehensive approach that concentrates on recovery of sea turtle populations. A piecemeal approach, concentrating on a single component, such as nesting site protection or fisheries bycatch reduction, simply is not enough. One example of this is the Kemp's ridley, once the most endangered sea turtle on the planet, that now appears to be on the road to recovery. The Kemp's ridley is unique, in that almost all the critical life history stages occur within the territories of two countries, Mexico and USA, and so the transboundary issues could be addressed under a bi-lateral framework. Nevertheless, there are important lessons from this case, since recovery only began to occur once a broad suite of measures were put in place.

To date, one of the most sustained, vigorous, and successful conservation efforts among nations has been the bilateral, joint program between the governments of Mexico and the United States for the Kemp's ridley. Mexico initiated conservation efforts in 1966 at Rancho Nuevo, Tamaulipas, the species' only nesting area; however, the population continued to decline for the next two decades<sup>4</sup>. The bilateral program was established in 1978 and by the late-1980s the decline stabilized, and since then this species appears to be on the road to recovery. It now appears that this early intervention pioneered by scientists at the Instituto Nacional de Investigaciones Biologicas Pesqueras was important in preventing the imminent extinction of the Kemp's ridley; however, the recent signs of recovery are generally acknowledged to be the result of the expanded bilateral effort that provided additional resources and a forum to craft and implement a broader recovery strategy. This bilateral program has involved both formal and informal collaboration between government agencies, including the Instituto Nacional de la Pesca (INP), U.S. Fish & Wildlife Service (USFWS), the U.S. National Marine Fisheries Service (NMFS), and the U.S. National Park Service, and private institutions, which include the Gady's Porter Zoo, HEART (Help Endangered Animals Ridley Turtle). Bilateral conservation programs have focused on the nesting process and have included beach and nest protection, establishment of additional nesting areas to extend the range and reduce risks, headstarting programs, and implementation of measures to reduce fishing mortality<sup>5</sup>. Much of this collaborative work has been done under a formal bilateral Cooperative Agreement between the NMFS and INP, known as MEXUS-Golfo. The Kemp's ridley program is a success story that has served as a model for sea turtle conservation, providing the framework for a similar approach currently underway with the Pacific leatherback under the MEXUS-Pacifico Cooperative Agreement between NMFS and INP. However, unlike the Kemp's ridley, the leatherback is pelagic and highly migratory, whose nesting and foraging habitat encompass the entire ocean basin<sup>6</sup>. Clearly the bilateral approach that appears to have been successful for Kemp's ridley is inadequate to address recovery in the case of the severely depleted nesting population in Pacific Mexico. While mortality of eggs and adult female leatherbacks has been reduced as a result of bi-lateral (US-Mexico) conservation efforts since 1995, the population continues to decline. Although progress has been made on protection of nesting populations, current efforts in the Pacific are limited by insufficient financial resources and competing economic interests from land development. In Mexico, a dedicated group of people from private and governmental institutions have undertaken an effort to protect nesting leatherbacks and their eggs. However this work is logistically challenging, and there is insufficient money to implement a completely effective program, so at best 45-50% of the nests are afforded protection each year. In addition, critical nesting habitat is being encroached by land development; for instance in Costa Rica, one of the most important nesting areas comprises 3 beaches in Guanacaste. A national Park was established (Las Baulas) recently to protect most of this nesting area, however, the land (high dune area inland)

adjoining the nesting beaches is not protected, and the habitat has been encroached by development of luxury homes. The Costa Rican government is interested in embarking on an ambitious program to purchase land, however does not have the funds available to implement this immediately. With the eastern Pacific leatherback at such critically low numbers, it is unlikely that the present level of beach protection will be sufficient to reverse the population decline.

In some instances, fisheries management has attempted to conserve Pacific sea turtles. One solution has been simply shut down fisheries. But with trans-boundary turtles migrating across exclusive economic zones and through the high seas, fish formerly caught in the closed fishery are likely to be caught by other nations and imported back into the nation with the closed fishery – production and trade leakages -- and little or no net conservation gain is likely for sea turtles. Vessels might also reflag or shift their operations to other fisheries that remain open, also a form of production leakage and export their fish or shrimp to the now open market – a trade leakage.. Shutting down all or most longline and gillnet fisheries in the Pacific plugs these production and trade leakages, but this may not come to pass or could require considerable time – time which vulnerable sea turtle populations may simply not have.<sup>7 8</sup> In this instance, fishing and sea turtle mortality will continue, which then begs the question of the best conservation and recovery approach to take in a world of continued fishing.

In this scenario of continued fishing, the bycatch and mortality of sea turtles in commercial fisheries would be reduced as much as possible by adopting appropriate fishing practices and gear technology standards. Nonetheless, even reduced mortality from commercial fishing may be insufficient to induce the recovery of sea turtle populations, since there are other important sources of mortality. The reduction of sea turtle populations to critically low numbers aggravates and compounds the problem of reducing sea turtle mortality from fishing alone. Instead, a broader-based and integrated recovery approach is required that tackles all of the sources of sea turtle mortality and at critical stages in the life cycle by an integrated conservation and recovery package and recognizes the entire suite of existing biological, ecological, political, legal, economic, and social factors that need to be faced. The several decades required to reach sexual maturity compounds the difficulty faced.

In contrast to conservation challenges of many marine mammals, such as dolphins or whales, sea turtles offer a unique opportunity to increase population levels through a broad-based recovery strategy. Thus rather than a defensive strategy simply focusing on reducing at-sea mortality from commercial fishery interactions, a recovery strategy can become proactive and widen its approach to include measures that directly increase the population and address all sources of mortality. These recovery measures include protecting nesting females, protecting against harvest of eggs and killing of adult females at nesting sites, protecting against beach degradation, collecting eggs and incubating them, head starting, relocating eggs to minimize risk, hiring local villagers to protect nesting sites, introducing alternative sources of income to substitute for subsistence or small-scale commercial harvests, egg rescue schemes, grassroots environmental education programs, bilateral conservation programs such as between Mexico and US, improving habitat at all stages of life cycle, along with technology or even production standards.

This paper addresses this requirement of an integrated, multilateral recovery strategy that deals with multiple sources of sea turtle mortality at different life stages in the face of

continued fishing, and explores a variety of policy tools that can be used. We consider the myriad sources of sea turtle mortality at different life-cycle stages and evaluate the approaches that can address these different sources. We discuss the roles played by harvesters and consumers of sea food, and the provision of economic incentives where practicable to bring about recovery rather than through direct fiat or laws. Positive economic incentives help contribute toward self-enforcing, cooperative recovery strategy. This overall approach has been codified by the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (hereafter MOU) and its Conservation and Management Plan.

Three broad components comprise the different recovery approaches. First, they must cover the entire life cycle, migration range and habitat, and users and sources of anthropogenic mortality in the Pacific Commons. Second, multilateral and cooperative conservation efforts among nations and other parties are required, i.e. international agreements. Third, a comprehensive conservation framework is necessary that is a mixture of biological, economic, political, and legal conservation measures.

## 2. Economic Incentives

Adverse economic incentives threaten sea turtle populations (Conservation and Management Plan, MOU).

Market-based approaches to environmental protection are premised on the idea that it is possible to confront private firms, individuals, and even other levels of government with the same kinds of incentives they face in markets for labor, capital, and raw materials – that is prices that force them to economize. The rationale for market-based approaches is thus to try to put the powerful advantages of markets to work in service to the environment.

An agreement on sea turtle conservation should produce for its parties a favorable benefit-cost ratio or else it may either never enter into law or collapse (Barrett 1998, p. 38). Reducing sea turtle mortality in general, or even achieving a prescribed overall level of mortality, that is cost-effective raises the benefit-cost ratio. Performance and/or technology standards will have to be negotiated for both developed and developing countries. Offsets will necessarily require investments in the developing countries where almost all of the nesting beaches are located and where an important source of mortality from harvests of eggs and adults is found. As discussed above, this developing country participation does not necessarily mean that the developing countries need to pay for all of these conservation measures. Broadening participation is not to redistribute costs so much as to lower the total costs and raise the total benefits of conservation, since the marginal mortality reduction may be higher and marginal cost of implementation may be lower in these countries. The Montreal Protocol capped emissions of ozone-depleting substances in developing countries, and these countries did not have to pay to stay within these limits; instead, the incremental costs of their compliance were paid by the developed countries. Broadening participation to developing countries also raises the benefits and thereby the benefit-cost ratio. The problems of non-compliance and free-riding would at the same time be eased, since the incentives to deviate in these ways would be reduced.

### 3. Different Sources of Pacific Sea Turtle Mortality

Sea turtles are subject to mortality at every stage in their life cycle. The relative impact of these sources of mortality may be different for each species, and in many cases is unknown. Mortality sources include directed take of adult turtles and harvest of their eggs on nesting beaches; directed take of juveniles and adults on their foraging areas; indirect take as a result of fishing activity, land development, human encroachment and pollution; "natural take" from predation, disease, and environmental perturbation (storms, floods, etc); and finally largely unknown effects from long-term global climactic and environmental change that may include long-term natural cycles (Southern Oscillation; global warming).

#### 3.1 Pacific Leatherbacks

Sea turtles have been around for 30-100 million years, and have evolved to withstand high mortality of eggs and hatchlings. They are long-lived and have high reproductive output, producing tremendous quantities of eggs over their lifetimes. In general therefore, sea turtles populations can, in theory, withstand a high level of take of eggs, as long as survival of later stages remains high (e.g. later juvenile through adult). However, the wholesale harvest of eggs that occurred when this practice became commercialized this century has rendered populations vulnerable to the other impacts in the marine environment, and most likely set the stage for the rapid catastrophic declines that we are now seeing in some populations. This has been well documented in the Malaysian leatherback population that nested in Terengganu, once one of the largest rookeries in the Pacific, that now is all but extinct (Chan & Liew 1996). For almost 50 years every egg laid at this beach was harvested, and in the late 1970's there was a sudden decline in numbers of nesters from several thousands, to just two or three nesting annually since the 1990's. There were attempts to reverse this decline by protection measures (harvest quotas, beach hatcheries), but these appear to have been too little, too late. In addition, habitat degradation on the nesting beaches now appears to have contributed to the inability of these measures to be effective at increasing hatchling production. The extent that impacts at sea contributed to the Malaysian population collapse is unknown, but clearly the demographic erosion caused by the total harvest of eggs over at least one leatherback generation (9-20+ years), would have meant that any take of adults had a relatively larger impact, than had there been a large pool of younger generations to sustain this population.

This may be a pattern that is repeating itself to some extent for leatherbacks in the eastern Pacific, although this is not as well documented. The nesting populations in Mexico and Costa Rica have recently collapsed, most likely as a result of convergence of several factors; mortality caused by the high seas driftnet fisheries of the 1980's, coastal artisanal gillnet fisheries in South America into the 1990's, and a long history of intensive egg harvest beginning in the 1970's, killing of females on nesting beaches, and possibly environmental factors that we have yet to understand. It is possible that by the time high-seas driftnetting was banned in the 1980's, the damage had been done to the breeding population, as harvest of eggs continued unabated until relatively recently (1990's-see Dutton *et al.* 2002). Take of eggs has been significantly reduced now in Costa Rica and Mexico, but with the breeding population reduced to such critically low numbers, the take of any leatherbacks from this breeding stock will have a relatively

large negative impact on recovery than for populations with a healthy pool of younger generations on their way to maturity. There is great controversy and uncertainty over the extent of impacts of longlining on leatherbacks. Although historically gillnetting and drift netting may have been more destructive to turtles than longlining<sup>9</sup>, (turtles have a high probability of drowning in nets, and may have a better chance of survival if entangled or caught on longlines), the cumulative effect of low levels of mortality most likely now plays a relatively greater role in preventing the recovery of these species, (despite reduced mortality on the nesting beaches), since there are now so few turtles. In addition the indirect take of leatherbacks in high seas fisheries, illegal take of leatherbacks continues in the subsistence fisheries in Peru (Alfaro *et al.*, In Press).

Perhaps the largest leatherback population that remains in the Pacific comprises rookeries that occur in Papua and Papua New Guinea in the western Pacific. While there is uncertainty over historic status of this population, data from recent surveys do not indicate that the Papua population has collapsed in the way that the Malaysian and eastern Pacific populations have (Hitipeuw, 2003). Also, there is not a history of whole scale commercial harvest of eggs. There is however, directed take of reproductive adults on foraging grounds around Indonesia (Suarez and Starbird 1996, Hitipeuw, pers comm.), feral pig predation, beach erosion and human subsistence harvest of eggs in Papua and PNG. In addition, evidence suggests that leatherbacks from these western Pacific stocks migrate to foraging and developmental areas across the North Pacific and off the west coast of North America (Dutton *et al.*), and it is these turtles that are caught incidentally in high seas longline fisheries and coastal driftnet fisheries. It appears that these last remaining western Pacific populations have so far been better able to withstand the impacts at sea than the Malaysian, and eastern Pacific populations, perhaps because the absence of intense historic egg harvest in Papua has allowed somewhat of a demographic buffer. Given the broad suite of mortality factors affecting this population, long-term decline of these populations may be inevitable; however, the fact that there still relatively large numbers of turtles nesting means there is better opportunity for population recovery through enactment of a broad suite of conservation measures, and in particular for aggressive beach conservation measures to be effective (as opposed to the case of Terenganu, where it was too late).

### 3.2 Olive Ridleys

The eastern Pacific Olive ridley "arribada" populations have increased dramatically in the last decade, since closure of the nearshore fishery for olive ridleys in 1990 (Marquez *et al.*). Prior to that large scale commercial harvest of eggs and directed commercial take of juveniles and adults for leather were the primary sources of mortality that led to a decline in the nesting populations. The large scale commercial harvest of turtles occurred exclusively in Mexican EEZ, and appears to have dwarfed other sources of mortality. Furthermore, this fishery appears to have targeted sub-adults, effectively removing animals from the population before they had had a chance to breed. The dramatic and rapid recovery of this population following cessation of this mortality probably occurred because there were sufficient hatchlings and juveniles recruiting into the population to allow recovery once this pressure point on a crucial life stage was removed. Presently illegal harvest of eggs and incidental take in pelagic longline fisheries, and coastal gillnet fisheries, artisanal fisheries throughout central and South America, and trawl fisheries are primary sources of mortality. There is a legal harvest of eggs in Costa Rica at Playa Ostional carried out by the local community that has been



acclaimed as a rare example of rational use. The harvest is carefully controlled by stakeholders, and takes advantage of millions of eggs that are laid during the first "arribada" or mass nesting of olive ridleys each year. These eggs would all be destroyed by seasonally poor beach conditions and by the second arribada, where tens of thousands of turtles dig up and destroy the nests from the first arribada before they have had a chance to hatch. Revenues from the sale of eggs in part go towards conservation effort to ensure success of the second arribada, the rationale being that the first arribada would have been destroyed.

### 3.3 Loggerheads

In the North Pacific loggerheads nest almost exclusively in Japan, and these stocks have declined greatly. Sources of mortality include human encroachment and egg harvest on nesting beaches; incidental take in coastal fisheries (which take larger juveniles and adults; incidental capture in high seas fisheries all across the North Pacific (longline, drift/gillnet), and massive mortality due to incidental and directed take in artisanal and commercial fisheries operating in areas where juvenile feeding aggregations occur off Baja California, Mexico<sup>10</sup>. In the Southern hemisphere, the primary nesting beaches occur on the Southern Great Barrier Reef, Australia, and this stock has declined greatly over the last 30 years (Chaloupka and Limpus 2001). Sources of mortality include drowning in Australian otter trawl fisheries, feral fox predation of eggs in the 1960's and 1970's, and incidental capture in longline fisheries operating in the South Pacific including in the southeast Pacific (Alfaro et al., in press; also see Chaloupka 2003).

### 3.4 East Pacific green turtles

Eastern Pacific populations that nest in Mexico have declined considerably, despite ongoing beach conservation that began in the 1970's. Historic sources of mortality included harvest of eggs and directed take of breeding adults near nesting beaches, which have been largely reduced following legislation and conservation, although some level of illegal take occurs. The primary source of mortality has recently been identified as massive illegal take of juveniles and adults at foraging grounds around Baja California (Nichols et al, 2000), and it is likely that this mortality has negated conservation efforts on the nesting beaches and continues to prevent recovery. Since green turtles are largely coastal foragers, they are also caught incidentally in trawl and coastal artisanal fisheries throughout Mexico, Central and South America (see NOAA-NMFS 2002).

## 4. At-Sea Measures: Performance and Technology Standards for Responsible Fishing

Performance standards directly address the issue of sea turtle mortality through limiting the incidental take and mortality of sea turtles in pelagic longlining or drift gillnetting and shrimp trawling or direct takes through small-scale non-commercial and commercial activities. Dolphin Mortality Limits used in the International Dolphin Conservation Program or caps on emissions of greenhouse gases in the Kyoto Protocol are prominent international examples.

Technology standards refer to mandatory design and equipment requirements and includes operating standards. Restrictions on tuna purse seine fishing in the

International Dolphin Agreement, such as use of the fine-meshed Medina panel, prohibitions on sundown sets and requirement of the backdown procedure. Turtle excluder devices with shrimp trawling and the use of circle hooks and mackerel bait rather than J hooks and squid bait with pelagic longline fishing are important examples of technology standards aimed at reducing the incidental take of sea turtles.

The Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia's Conservation and Management Plan includes a provision to "Mitigate Threats and Bycatch," by reducing "...the incidental capture and mortality of marine turtles in the course of fishing activities to ensure that any incidental take is sustainable through regulation of fisheries and through development and implementation of measures such as turtle excluder devices (TEDs) and seasonal or spatial closure of waters."

In order for a technology standard aimed at lowering sea turtle takes and mortality to be effective there must be a transparent monitoring system, not only to verify compliance with standards, but also to quantify the sea turtle bycatch and scientifically evaluate the effectiveness of the measures in reducing bycatch mortality. Presently, most fisheries in the Pacific do not have observer programs in place to collect information on sea turtle bycatch, and this lack of information in itself is an impediment to sea turtle recovery. There is also often a fear on the part of fishers, industry and governments that reporting this information will encourage efforts to shut down fisheries, and this too, is an impediment to establishing transparent and effective monitoring. Provision of incentives to participate in standardized and verifiable monitoring programs would greatly enhance efforts to develop and implement effective measures to reduce at-sea mortality of sea turtles. Unlike TEDs that were developed some time ago as a technology standard for shrimp trawling, there are no well established technological fixes as yet that allow fishing without sea turtle mortality for the longline and gill net fisheries. Recent research using circle hooks and various baiting techniques shows great promise in this regard, but up to now the approaches used to mitigate sea turtle mortality in longline fisheries have depended primarily on time-area closures and procedures to remove hooks and line (using specially designed line-cutters and de-hookers) and resuscitate turtles in order to enhance post-release survival<sup>11</sup>.

Performance standards tend to require cooperation among nations, rather than simply coordination of activities (Barrett 2003, in press). Turtle mortality limits, for example, would require real cooperation among nations to determine the overall turtle mortality limits and allocation among nations, develop a compliance system through an observer or other program, and other such factors.

Technology standards, in contrast, tend to require coordination rather than the more demanding cooperation among nations (Barrett 2003, in press). Thus it is often the case that technology standards are easier to implement than performance standards. For example, with TEDs, a technology standard, nations do not have to actually cooperate. Instead nations simply adopt TEDs and coordinate their technical designs, and compliance is far easier to verify. International environmental agreements based on performance standards thus tend to be comparatively narrow but deep and in contrast, international agreements built on technology standards tend to be comparatively more broad but shallower.

## 5. Offsets and Mitigation Projects

Performance standards or technology standards can be coupled with offsetting measures that together limit *net* emissions or mortality.<sup>12</sup> For example, the Kyoto Protocol provides allowances for “sinks” – credits for the absorption of carbon dioxide by forests, cropland management, and re-vegetation (Barrett 2003, p. 371). These “sinks” offset the emission of greenhouse gasses through the sequestration of CO<sub>2</sub> (sucking CO<sub>2</sub> out of the atmosphere through growing trees, storage in the soils and oceans, etc.). The Clean Development Mechanism for the Kyoto Protocol, which allows an Annex I country to offset its emissions by undertaking abatement within a non-Annex I country (Barrett 2003, p. 380).<sup>13</sup> Within the domestic United States, the Endangered Species Act allows for offsets to environmental degradation. For example, timber companies in the southern U.S. are allowed to purchase timber lands with sufficiently high densities of nesting sites for a listed woodpecker (red-cockaded woodpecker) to satisfy the Endangered Species Act requirements, i.e. to serve as an offset, which allows harvests of timber from other lands with lower densities of woodpecker nesting sites (Heal 2000).<sup>14</sup> In the USA, the new policy of Wetlands Mitigation Banking (WMB) focuses on curtailing wetlands loss and regaining acres (Fernandez 1998). The WMB policy encourages protection and rehabilitation of wetlands as a precondition for developing other areas. In order to obtain permission to develop a different wetlands area, a developer is required to have credits from investment in the completed rehabilitation of a WMB site. The developer is allowed to use these credits in exchange for permission to develop other wetlands. Restoration activity is required prior to further development.<sup>15 16</sup> For example, a coastal wetlands (lagoon) in San Diego County was restored by the Port of Long Beach to offset a loss in wetlands that occurred when the port was expanded.

Sea turtles provide a unique opportunity for offsets through formal mitigation programs because they return to nesting sites to lay eggs. Conservation measures to protect the turtles, sites, eggs, and hatchlings can serve to actively increase the sea turtle population beyond that which would otherwise occur in the absence of such conservation policies (Dutton, Sarti, Márquez, and Squires, 2002). In short, depending on the program design, offsets can actually create a net increase in turtles, even after explicitly accounting for uncertainty.<sup>17</sup>

Mitigation projects (offsets) can be directly established between developing and developed countries.<sup>18</sup> Both the Montreal and Kyoto Protocols established a mechanism that could support offsets - emission reductions in ozone-depleting or greenhouse gasses – in developing countries, through the Multilateral Fund for the Montreal Protocol and the Clean Development Mechanism for the Kyoto Protocol (which allows an Annex I country to offset its greenhouse gas emissions by undertaking abatement within a non-Annex I country) (Barrett 2003, p. 380, Victor 2001, p. 39, Victor, Raustiala, and Skolnikoff 1998, pp. 16-17) and the Global Environment Facility, which was established to provide help for developing countries with climate change, threats to biodiversity and water pollution.<sup>19 20</sup>

Polovina and Dutton (2003) have identified several specific offsets for leatherback and loggerhead turtles in the Pacific that are expected to yield a net increase in turtles. These offsets for leatherbacks include hiring villagers to protect nests from predation by feral pigs in West Papua (Irian Jaya) War-non Beach, working with villagers to reduce and/or eliminate the harpooning of adult females in coastal foraging grounds in West Papua (Irian Jaya), and to eliminate harvesting of eggs, dog predation on eggs, and moving eggs laid in areas likely to be lost to beach erosion in Papua New Guinea

nesting beaches. These offsets for loggerhead turtles include mortality reduction workshops with fishers and placing observers on local boats to insure that all the live loggerheads caught in halibut gillnets are returned to the ocean in Baja, Mexico and moving eggs from locations prone to washing out or that experience extreme temperature at two nesting beaches in Japan (Polovina and Dutton 2003). These offsets are in addition to work that is already ongoing, so that funding them would result in an expansion of conservation that is already underway. Although beach protection is being carried out, this work is under-funded, and the full potential of many conservation initiatives remain unrealized. For instance, opportunities exist for expanding effort for the critically endangered populations in the eastern Pacific. There is a major initiative underway to purchase critical nesting habitat adjoining the recently created Baulas national Park in Costa Rica, however, progress has been slowed by lack of funds. In Mexico, the tremendous progress that has been made over the last few years (Dutton et al 1999) has at best achieved protection of only 50% of the total nests laid by leatherbacks. Other species and populations, such as the eastern Pacific green turtle populations and hawksbills remain critically endangered, and there are many opportunities to greatly expand beach conservation work so that ideally at-sea mortality measures will be enhanced and more effective at recovering populations, (and at least, so that declining populations continue to remain viable).

A mechanism with sea turtles that is analogous to the Montreal and Kyoto Protocol offsets would be a whereby industry, conservation, or government parties finance or establish turtle mitigation conservation projects that at a minimum prevent decline in populations or even lead to a net increase in population, after allowing for uncertainty in both cases.

## 6. Taxes or Fees Levied on Producers and Consumers

Taxes, fees, or charges can be levied on swordfish or shrimp landings, on the basis of sea turtle mortality, or on consumption of swordfish or shrimp. These (Pigouvian) taxes or fees can be levied either unilaterally on domestic producers or consumers or multilaterally through the auspices of an international agreement.

Taxes or fees levied on the swordfish or shrimp landings of producers and/or on consumers of these catches, when these seafood products are caught with interactions with sea turtles, can potentially yield several dividends.<sup>21</sup> The first dividend is reduced sea turtle mortality. The second dividend is to raise revenue to finance sea turtle conservation and recovery.

There is an equity argument in favor of fees in that the users of the globe's resources – the producers who initially exploit the resources and environment and the consumers who consume the final products – should bear the costs and compensate the public for their use.

### 6.1. Taxes or Fees, External Costs, and Market Failure

Producers and consumers of seafood do not pay the cost of sea turtle mortality when there are sea turtle interactions with fishing gear. This creates adverse economic incentives. Instead, producers and consumers pay only the direct costs associated with harvests.<sup>22 23</sup> These “external costs” of sea turtle mortality are not included in the price of swordfish or shrimp; instead, only the direct production costs are incorporated these

prices. Because the economic value of unpriced swordfish and shrimp resources and external costs of sea turtle mortality are excluded from seafood prices, the incomplete and "low" seafood prices contribute to consumer demand for seafood which is too high, which in turn contributes to excessively high fishing pressures and turtle takes. Seafood consumers also do not pay their share of the full costs of swordfish or shrimp consumption when there is sea turtle mortality. Other consumer benefits from sea turtles – such as sea turtle existence – are not captured by markets and there is "market failure."

## 6.2. Taxes or Fees Levied on Swordfish or Shrimp Landings or Consumption

A tax or fee unilaterally levied on domestic producers and/or consumers of swordfish or shrimp would help to incorporate the otherwise unaccounted for "external" cost of sea turtle mortality into the market price of seafood. The proportion of the tax that is borne by producers and consumers is *a priori* indeterminate,<sup>24</sup> but the higher cost of production will help lower sea turtle takes<sup>25</sup> and the higher seafood price will reduce consumption of seafood to some degree as seafood markets fully price the entire cost of swordfish or shrimp production.

A tax or fee unilaterally levied on domestic swordfish or shrimp producers with an aim to reduce sea turtle mortality does not fully accomplish its ostensible goal, since sea turtles are migratory and swordfish and shrimp are caught throughout the Pacific Basin. The domestic tax, to the extent it raises domestic producers' harvesting costs of swordfish or shrimp, lowers the scale of domestic catches and hence lowers domestic sources for consumption which can be replaced by lower-priced imports. As a result of these production and trade "leakages," the problem of sea turtle mortality is not fully addressed.<sup>26</sup>

A tax or fee levied on production of swordfish or shrimp within a multilateral agreement can plug production and trade leakages as well as help to incorporate the full external costs of swordfish and shrimp production (i.e. sea turtle mortality) into the seafood price. The multilateral context will only plug the production and trade leakages to the extent that all producers are part of a collective agreement and are effectively taxed; otherwise, leakages will persist, albeit dampened, and swordfish or shrimp catches will not be fully priced – market failure will persist.

A tax or fee can be either lump sum, such as part of an annual license fee, or if on production can be levied on swordfish or shrimp landings at either the ex-vessel level or at some point in the processing chain. The details and ramifications remain to be worked out. Nonetheless, one advantage of a tax or fee related to production of swordfish and shrimp is that larger producers pay more tax, reflecting their generally greater probability of turtle interactions.<sup>27</sup> Swordfish or shrimp are jointly harvested with sea turtles. To the extent that sea turtle mortality is roughly proportional to swordfish or shrimp landings, there is more direct control over sea turtle than initially appears. An analogous situation occurred with the transferable permit system that accomplished the U.S. phase-out of leaded gasoline. Stavins (1998, p. 487) observes, "The currency of that system was not lead oxide emission from motor vehicles, but the lead content of gasoline."

The size of the tax or fee that fully costs the otherwise unaccounted for cost of turtle mortality is difficult to estimate. As a consequence, any tax may over- or under-charge for the unaccounted for cost of sea turtle mortality. Ideally, taxes or fees that aim to

exactly capture these unpriced costs would also have to be continuously recalculated as the costs of production and market conditions change, and most importantly, to ensure that the sea turtle mortality standard is attained.

The problem with a tax on swordfish or shrimp is that the sea turtle mortality standard is not directly addressed, but only indirectly through a tax or fee on its joint product, swordfish or shrimp. Hence, reliance on a tax or fee on swordfish or shrimp landings or consumption to reduce sea turtle mortality to its "optimal" level (rather than simply nudging it in the desired direction) could require a large tax and could make seafood production prohibitively expensive. In addition, the presence of inflation lowers the real rate of taxation (adjusted for inflation) over time, unless the process to determine the fee includes some on-going means of temporal adjustment.

### 6.3. Tax or Fee Levied on Sea Turtle Interactions or Mortality

A tax or fee can also be levied on the number of sea turtle interactions or on sea turtle mortality. Ideally, the tax or fee sums up to the expected mortality from the accumulation of sea turtle mortality of adults and sub-adults. This approach is very similar to the cap-and-trade or sea turtle mortality limit approach, since this system creates the same set of incentives. That is, the vessels that can reduce their sea turtle interactions inexpensively will invest in doing so because each interaction or turtle killed reduced is that much less paid in taxes or fees. Vessels that find it very expensive to reduce their sea turtle interactions will continue to interact and pay the taxes and rely on offsets. A similar tax was levied on the production of chlorofluorocarbons (CFCs) during the time mandatory phase-out was taking place under the Montreal Protocol, creating a hybrid system under which a phased decline in CFC production was augmented by a pollution tax (Portney 2003).

A limitation of a tax on sea turtle interactions to directly control sea turtle mortality is the uncertainty about the effect on sea turtle mortality, although it is certain that the higher the tax, the lower amount of sea turtle mortality.<sup>28</sup> It is also well known that setting the optimum tax – in order to achieve an exact level of control – is notoriously difficult and that recomputing the tax as the underlying conditions change is equally difficult. An advantage with a tax, however, is that sources of sea turtle mortality know that they will never have to pay more for sea turtle mortality than the tax. In addition, imposition of a sea turtle interaction or mortality tax requires an observer system to monitor the interactions and achieve compliance. In contrast, a tax on swordfish or shrimp landings does not require at-sea observers, but it also has an even more indirect effect on reducing sea turtle mortality.

Spatial differentiation is an important issue arising with taxes or charges. Sea turtles nest in different hemispheres and different countries and their migrations also vary spatially. In addition, sea turtle mortality varies spatially, even within a hemisphere, with some "hot spots" of high frequency mortality and others with lower frequency of interactions and mortality. Lump sum fees would have to be explicitly tailored but fees on landings might roughly correspond to spatial variations in sea turtle mortality. A direct tax on sea turtle mortality obviates the issue of spatial differences.

### 6.4. Second Dividend: Revenue to Finance Conservation and Recovery

The second dividend of a tax or fee, particularly on landings of shrimp or swordfish, is to raise revenue to finance conservation and recovery measures for sea turtles.<sup>29 30 31</sup> The primary benefit of a tax or fee on swordfish or shrimp production or consumption is to raise revenue for conservation and only incidentally to directly lower sea turtle mortality. Pacific sea turtles, because they are a Pacific common property resource, are subject to excessive mortality from takes and insufficient "investment" in conservation and recovery, such as beach protection or adoption of technology standards that require new investment and which raise production costs and lower productivity. The revenues raised help to finance this new investment.

Stavins (1998) observes that while taxes in the U.S. have been imposed on certain products that are limited to pollution, like gasoline and chemicals, this has typically been done as a way of raising revenue, such as with gas taxes to fund highway construction or chemical taxes to fund cleanup of Superfund toxic waste sites, rather than as incentive devices intended to reduce externalities (such as sea turtle mortality from fishing).

#### 6.5. In-Kind Taxes and Fees

In-kind taxes or fees occur when producers or consumers directly finance and sponsor conservation and recovery measures. For example, direct sponsorship of a nesting site by a fisher or fishing groups or by a restaurant, processor, or retail chain represents an implicit tax that is paid in kind rather than an explicit tax where funds are collected.

#### 6.6. Fees versus Subsidies<sup>32</sup>

A direct subsidy or tax break to swordfish or shrimp producers can also lower interaction rates with, and mortality of, sea turtles by subsidizing adoption of a technology standard. Such a subsidy can be effective in adopting new technology or altering fishing practices. A subsidy can even be paid to producers to produce no swordfish or shrimp, i.e. to shut down through vessel buybacks or to switch to say longline tuna through deeper sets. However, a subsidy from the public sector to producers for an external cost of sea turtle mortality raises the issue of whether the "polluter" or the damaged party pays.

Another potential problem with subsidies for adoption of a technology standard is that they can unintentionally counter reductions in sea turtle mortality or perhaps even increase mortality. A subsidy lowers costs and allows higher-cost producers to continue fishing that otherwise may have gone out of business. A subsidy also promotes or sustains fishing effort, which in turn counters reductions in sea turtle mortality. A subsidized performance standard does not face this problem found with a technology standard, but nonetheless represents an expenditure of real resources by the public and also confounds price signals in the market by masking the direct costs of fishing and the unpriced external costs of sea turtle mortality.

The research required to develop a new technology standard is often considered to be a public good (a good or service which can be consumed by all without depleting or diminishing the good or service). In these circumstances, research to develop a new technology, such as a technology standard that lowers turtle mortality, can legitimately be financed by the public sector since the benefits accrue to all. Without subsidies for research or finance by the public sector, there are often insufficient incentives for individuals to conduct this research, since the investors do not capture the full benefits of

their investment. Public finance or subsidy of research for a new technology standard that reduces sea turtle mortality is also a way to funnel the intangible benefits the public enjoys from the existence of sea turtle mortality, which otherwise do not have a means of expression.

#### 6.7. Tax or Fee Combined with Import Tariff

A tax, fee, or charge on domestic producers and/or consumers can be combined with a tariff on imports of swordfish or shrimp – an “eco-tariff.”

#### 6.8. General Considerations with Taxes, Fees, and Charges

Taxes or fees have to be determined by an administrative process. When the function of the charge is to raise revenues for conservation and recovery, charge rates may be determined by the costs of achieving that process. When the costs of achieving the purpose rise, the level of the charge must rise to secure the desired outcome.

Taxes or fees levied raised to finance conservation and recovery can be levied and collected by individual governments, international commissions and through international agreements, or by producers, processors, or final markets. Revenues can also be voluntarily raised by industry, environmental, or consumer groups.

Taxes or fees work particularly well when transactions costs associated with bargaining and transfer of transferable turtle mortality limits are high. When transactions costs are high, due perhaps to widely dispersed vessels or many small vessels or infrequent need for trades, only large trades can absorb the high transactions costs without jeopardizing the gains from trade. “For this reason charges seem a more appropriate instrument when sources are individually small, but numerous (such as residences or automobiles). Charges also work well as a device for increasing the rate of adoption of new technologies and for raising revenue to subsidize environmentally benign projects.” (Tietenberg, p. 391)

### 7. Performance Standards

Performance standards directly address the issue of sea turtle mortality through limiting the incidental take and mortality of sea turtles in pelagic longlining or drift gillnetting and shrimp trawling or direct takes through small-scale non-commercial and commercial activities. Performance standards have serious compliance requirements through monitoring, verification, and enforcement, both to punish identified cases of non-compliance and to deter non-participation. A free rider problem (enjoying the benefits without bearing the costs through nonparticipation) can arise without effective compliance.

The Inter-American Convention for the Conservation and Protection of Sea Turtles prohibits the intentional capture or killing of sea turtles (with exceptions of subsistence takes under specific conditions), a performance standard (Gibbons-Fly).<sup>33</sup> The Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia’s Conservation and Management Plan includes a provision to “Mitigate Threats and Bycatch,” by reducing “... the incidental capture and mortality of marine turtles in the course of fishing activities



to ensure that any incidental take is sustainable through regulation of fisheries and through development and implementation of measures such as turtle excluder devices (TEDs) and seasonal or spatial closure of waters.” The Conservation and Management Plan of this Memorandum of Understanding similarly lists a program to “Reduce to the greatest extent practicable the incidental capture and mortality of marine turtles in the course of fishing activities.”<sup>34</sup>

Performance standards can be strengthened to form use or property rights. Strengthening the characteristics of property rights, most notably exclusive use, transferability, duration, and divisibility, leads to a stronger property or use right (Scott \_\_\_). Dolphin Mortality Limits are a form of use right, since they allow exclusive use for a single year and are not transferable. Marketable emission permits, such as those in the Kyoto Protocol, are a property right since they contain the stronger characteristics of exclusive use, transferability, divisibility into smaller or larger units, and relatively long duration.

## 8. Marketable Turtle Mortality Limits As A Transferable Property Right and Wildlife Use Rights

### 8.1. Marketable Turtle Mortality Limits

When there are performance standards for takes or mortality of sea turtles, introducing transferability with a use right of at least one year’s duration creates a market-based approach to environmental protection. One approach is a “cap-and-trade” system, whereby each vessel is given an initial turtle mortality limit. It can elect to meet this limit any way it sees fit, through a technology standard, redirecting its fishing operations to other times and places, or any other means. Each vessel can elect to reduce its sea turtle interactions using the least expensive approach available to it. An additional option is available under the cap-and-trade system: a vessel actually increases its interactions with sea turtles more than it is required so long as it buys at least equivalent turtle mortality limits from one or more other vessels or through offsets (discussed below). All that matters is that the total amount of sea turtle mortality reductions that take place from all sources are equal to the total turtle mortality limit established at whatever level is required for recovery of each affected species’ population. Those vessels that will elect to make significant sea turtle mortality reductions under this cap-and-trade system are those that can do so easily or inexpensively, while those that elect to buy transferable sea turtle mortality limits will be those that find it expensive or difficult to reduce. In addition, all vessels, or sources of sea turtle mortality in general, have a continuing incentive to reduce their sea turtle mortality, since the more a vessel’s sea turtle mortality falls short of its limitation, the more sea turtle mortality limits it will have to sell to other vessels. The overall sea turtle mortality limit and the individual holdings can also be progressively tightened over time. The transferable sea turtle mortality limit and trading area would correspond to the nesting sites and migratory routes of each species.

A cap-and-trade approach is used in the United States to control emissions of sulfur dioxide with the 1990 amendments to the Clean Air Act.<sup>35</sup> More than 100 coal-fired power plants were given initial emissions reductions, and these plants could meet their emissions reductions targets themselves, through any means they selected, including purchase of excess emissions reductions by other plants that found it easy to reduce their sulfur dioxide. Cap-and-trade approaches have also been proposed to reduce

water and smog pollution. The European Union will use a cap-and-trade system to control carbon dioxide to comply with the Kyoto Protocol.

Transferable turtle mortality limits could conceivably be used in the year it is issued or "banked" or stored for use in any subsequent year. With banking, allowance could be made for expected growth in sea turtle numbers. In addition, transferable turtle mortality limits could be allocated gratis or auctioned off (which would give an effect similar to a tax); the key issue is the distribution of the rents. (Auctions do have the advantage of facilitating the price discovery process and the development of a market.) Transferable sea turtle mortality limits may work best when there are wide divergences in producers' costs and costs of transactions, monitoring, and enforcement are not excessive.

Transferable sea turtle mortality limits might also provide economic incentives for induced process innovations, such as bundling of limits with swordfish or shrimp supplies or the invention of new or modified technology standards, such as TEDs or circle hooks, in exchange for generated limits. The flexibility of a transferable limit also accommodates dynamic market changes, allowing shifts in industry structure and production methods while assuring that total mortality does not increase.

Monitoring and enforcement of an international transferable turtle mortality limit system could well prove a formidable and costly task. Regional or national programs might prove more feasible. Similar issues confront the international system for transferable emissions of greenhouse gasses, particularly CO<sub>2</sub>, with the Kyoto Protocol and for sulfur dioxide (SO<sub>2</sub>) with the Helsinki Protocol.

## 8.2. Wildlife Use Rights

International environmental agreements based on an allocation of internationally transferable rights to wildlife use would be analogous to the Kyoto Protocol. Wealthier nations, or their citizens and civic groups, could purchase rights to wildlife from poorer nations for the purpose of conservation or preservation (Giordano 2002, p. 626). Poorer nations would then have the option of benefiting from the sale of non-consumptive wildlife use rights rather than finding themselves limited to a derivation of wildlife value through extractive means only. Such an approach serves the same goal as side payments in which developed countries directly or indirectly provide compensation or economic incentives to developing nations for biodiversity conservation.

The notion of benefiting those in developing nations who may bear much of the burden of conservation from resource use foregone is an important one. Wildlife use values may be stripped away while the costs of wildlife conservation remain (Giordano 2002, p. 626). Economic incentives for conservation and compensation to communities and subsistence users of sea turtles and their eggs is thus an important element not to be overlooked.

## 9. Trade Restrictions

Trade restrictions achieve two things: they can be used to punish countries that do not cooperate and to correct for a loss in competitiveness of the countries that do cooperate (Barrett 2003, p. 307). A trade restriction, to be effective, needs to be sufficiently severe (so that, when imposed, behavior will be changed) and credible (meaning that, given that

a country chooses not to participate, or not to comply, the cooperating countries are better off for imposing the restrictions) (Barrett 2003, p. 388).

Trade restrictions restructure incentives by providing positive economic incentives to countries that participate in, and comply with, an international environmental agreement or technology standard such as with the use of turtle excluder devices. Trade restrictions also provide negative incentives by punishing those countries that fail to participate in, and comply with agreements or standards. Trade restrictions also plug production and trade leakages. Trade restrictions impose a cost on member nations of an international sea turtle agreement by foregoing the gains from trade, which reduces the credibility of trade restrictions.<sup>36</sup> Trade restrictions also face legality issues with the World Trade Organization.

“Eco-tariffs” on imports are a price form of a trade restriction on quantities of imports allowed into a country. Eco-labeling, in contrast to trade restrictions and “eco-tariffs” can provide a positive incentive, and when used in conjunction with a trade restriction, import tariff, or side payments, can provide additional and positive incentives for compliance and participation.

A licensing system for imports of “turtle safe” shrimp and swordfish provides one means of implementing a trade restriction. A licensing system and other steps would reduce black market trade in shrimp and swordfish that is not “turtle safe.”

Production and trade leakages can arise with protection for sea turtles when participation in an agreement is not full. Sea turtles migrate for long distances, weaving in and out of Exclusive Economic Zones of coastal countries and the high seas. Efforts at protection in one or more nations can shift harvests of swordfish or shrimp, and hence incidental takes of sea turtles, to harvesters of other nationalities, a production leakage. Attempted protection of turtles and the subsequent production leakage might well not change sea turtle mortality rates, since swordfish or shrimp harvests from non-protecting nations can replace the diminished harvests of protecting nations through the active global import markets, a trade leakage.

#### 10. Eco-Labeling and Environmental Product Certification

Eco-label or environmental product certification offer a way to provide economic incentives to adopt technology or even production standards – a “carrot.” At a minimum, they certify turtle friendly standards defined as adoption of technology standards such as mortality reduction measures (e.g. line cutters, de-hookers, etc.), or more strongly, participation in verifiable observer program (100% coverage). Such certification also guides consumers to make ecologically responsible decisions on seafood and thereby help convey consumer preferences to markets and from there to the fishing and processing sector.

#### 11. Direct and Indirect Conservation

Performance and technology standards can be combined with direct conservation payments or actions, such as payments for wildlife use rights, to communities for nesting site protection and egg collection and protection, and for education of small-scale commercial fishers or exploiters of turtles, or for indirect conservation payments, such as

to establish eco-tourism. Such direct or indirect conservation payments can occur as side payments from developed to developing nations in the context of an international environmental agreement. Direct conservation payments can be made from producer and consumer groups in developed nations to recipients in developing nations.

## 12. Side Payments

Side payments have both distributive and strategic functions (Barrett in press). Side payments, such as through technology transfers, payment of incremental costs to adopt technology standards by developing country fleets, and access to otherwise restricted markets for shrimp and swordfish, may help increase participation and help make the agreement fair.<sup>37 38</sup> Side payments, by which gainers of a policy can compensate those who bear the burdens, help insure that nations that would otherwise lose by participating instead gain.<sup>39</sup> Side payments also acknowledge the "common but differentiated" responsibilities to biodiversity conservation of developing and developed countries, as explicitly recognized by the London Amendment to the Montreal Protocol in 1994.

This factor of fairness may be especially important if trade restrictions are included in the agreement by legitimizing these restrictions. The Inter-American Convention for the Protection and Conservation of Sea Turtles addresses this issue, as for example, Article XII, "International Cooperation," where rendering assistance to developing States is explicitly mentioned.

Several key factors pertaining to sea turtle conservation complicate side payments by which gainers compensate those who bear the burdens. First, beneficiaries of conservation, who gain through sea turtle existence, are in both the present and future generations (where the latter do not have a voice). Second, benefits are non-market, that is, they are unpriced and a market for these benefits does not exist, so that benefits are uncounted. Third, benefits are diffuse throughout the population of present (and future) generations and are spread across many countries. The voice by which benefits of preservation are expressed, through willingness to pay, is louder in richer countries. Fourth, losers tend to be concentrated among localized and specific groups, who largely bear the full burden of conservation. Fifth, producers and consumers of seafood do not pay the full cost of production and consumption, which is not captured by any market (an external cost and market failure). Sixth, the absence of property rights for sea turtles and over the oceans in general, and especially on the high seas, can complicate the issue of compensation. Producers have made investments to harvest an unpriced migratory resource (swordfish). Lastly, ostensible benefits from unilateral or limited multilateral conservation of sea turtles can be illusory and dissipate because sea turtles and swordfish are highly migratory, so that conserved turtles in one area are simply taken in another area. In sum, the heart of the compensation issue is to collect from diffuse beneficiaries who receive unpriced benefits and transfer some of these gains to localized and specific losers.

Side payments or compensation to private landowners of nesting site beaches raise another set of issues. Papers in Shogren and Tschirhart (2001) discuss this issue in considerable detail.

In sum, side payments can be an important component to any international agreement for both distributive and strategic purposes. Side payments contribute to the effectiveness of an international agreement through compensating those who bear the

burden of environmental regulations; ensure that developing countries do not lose by participating in an agreement; help provide technology transfers; legitimize the threat of trade restrictions; pay the incremental costs of adopting technology standards; and foster fairness.

### Concluding Remarks

In order to reconcile continued fishing with sea turtle recovery, it will be necessary to adopt a comprehensive approach that goes beyond merely reducing fishery bycatch mortality of sea turtles. A broad suite of approaches are needed that include effective beach conservation to protect nesting females, their eggs, and critical breeding habitat in order to maximize hatchling production for all depleted populations, reduce subsistence takes of turtles, as well as measures to enhance at-sea survival of juveniles and adults at critical foraging areas and as they move into different developmental habitat. The current level of conservation effort appears to be inadequate in reversing the decline of several critically endangered species of sea turtles in the Pacific, and if fishing is to continue, these efforts must be greatly enhanced by integrating fishery management into a more comprehensive sea turtle recovery strategy.

If fishing is to continue and sea turtle populations are to recover, some important building blocks of a comprehensive recovery strategy include offsets (such as nesting site and other habitat protection, community involvement in conservation, or financing of adoption of technology standards by developing country fleets); technology standards to reduce bycatch of sea turtles; possibly performance standards; side payments to increase participation and compliance, to equitably distribute the burdens, and to finance offsets and adoption of technology standards in developing nations; and trade restrictions to provide positive economic incentives for responsible fishing and negative economic incentives to deter destructive fishing practices, and to also plug trade leakages. Additionally, taxes and fees (including in-kind) deserve consideration as a way of raising revenues to fund some of these offsets and side payments, as opposed to the traditional role of taxes and fees of solely trying to correct the unpriced external cost of sea turtle mortality.

There are opportunities to immediately implement these recovery measures under existing global international treaties and possibly augmented by additional bilateral or broader multilateral agreements. Furthermore, there is considerable precedent, and lessons to be learned, to comprehensively begin recovery of Pacific sea turtle populations in existing international agreements for other environmental issues that contain these fundamental building blocks that we have outlined in this paper.

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<sup>1</sup> This creates a transboundary resource externality, where the outcome that any one country can realize depends not only on its own actions, but also on what others do. Thus, there is interdependence among nations.

<sup>2</sup> Habitat, as defined by the Memorandum of Understanding for the Conservation and Management of Sea Turtles and their Habitats of the Indian Ocean and South-East Asia, "...means all those aquatic and terrestrial environments which marine turtles use at any stage of their life cycle."

<sup>3</sup> The endangered or threatened status of sea turtles and the difficulties in their conservation and management stem from a number of factors, but most importantly are due to: a unique life history that makes their populations vulnerable to several sources of mortality at critical stages in their life, which is aggravated by the fact that many species require decades to reach maturity; their generally migratory nature, where their migrations may extend across national jurisdictions and the high seas, creating a transboundary resource and jurisdictional problems; degradation of nesting sites; incidental mortality in harvesting of shrimp, swordfish, and other fisheries; and the open-access nature of extended economic zones and the high seas. Conservation and management strategies thus need to focus on the implications of different conservation measures on different stages of sea turtle lives for overall population growth and on strategies that tackle the transboundary issue requiring cooperative conservation and management by many different nations.

<sup>4</sup> Based on an amateur film by Andrés Herrera in 1947, Hildebrand (1963) and Carr (1963) guessed that 40,000 turtles nested at Rancho Nuevo (Márquez, 1999). No data were available until 1965, at which point the biggest *arribada* numbered less than 5,000 turtles. In 1973, the largest *arribada* contained only 200 individuals. Despite beach protection, this number continued to drop for the next 20 years, by which time total nestings for the season were only numbered in the hundreds. Surveys conducted between 1978 and 1988 indicated an average of about 800 nests per year, declining at about 14 nests per year, to an all time low in the late 1980s (Marquez et al., 1999). The total number of nesting females may have been as low as 350 on beaches where tens of thousands of Kemp's ridley used to nest. This initial failure to respond to protection indicates that recruitment was jeopardized by prolonged near-total harvest of eggs and shrimp trawling in the Gulf of Mexico, the primary juvenile and sub-adult habitat and the only habitat of adults (Pritchard). In 1990, the mortality from shrimp trawling was estimated to lie between 500 and 5,000. Collectively, other trawl fisheries, passive gear fisheries, and entanglement fisheries were estimated in 1990 to yield between 50-500 deaths a year. Deaths due to dredging and collisions with boats were estimated in 1990 to lead to a further 5-50 deaths every year. Additional sources of anthropogenic mortality were estimated in 1990 to come from oil-rig removal, intentional harvests, entrapment by electric power plants, ingestion of plastics and debris, and from accumulation of toxic substances, especially from ingested petroleum residues. Mortality also occurs from human and non-human predation of eggs in nests, predation of hatchlings and juveniles by crabs, birds, fish, and mammals. The nesting population reached a low in the mid-1980s and in the last few years has begun to modestly and steadily increase (Marquez et al 2001)

<sup>5</sup> Turtle Excluder Devices were implemented in Gulf of Mexico to eliminate sea turtle mortality in shrimp trawls.

<sup>6</sup> Recent studies using satellite telemetry and molecular genetics have shown that leatherbacks migrate from their nesting beaches in Papua, Indonesia to foraging areas found across the North Pacific as far as waters off US West coast. In the eastern Pacific adult females migrate from nesting beaches in Mexico and Costa Rica to the southeast Pacific to forage off the coast of Peru and Chile.

<sup>7</sup> For example, the Inter-American Tropical Tuna Commission (IATTC) vessel data base indicates 1,156 IATTC-authorized longline vessels in the Eastern Pacific Ocean from 12 nations as follows: 23 from USA, 140 from Taiwan, 1 from Peru, 53 from Panama, 9 from Mexico, 177 from Korea, 516 from Japan, 14 from France, 125 from Spain, 20 from Ecuador, 1 from Costa Rica, and 77 from China. In addition, there are longline vessels fishing in the Eastern Pacific Ocean from nations that are not members of the IATTC.

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<sup>8</sup> The Pacific high seas drift gillnet fishery was shut down by the United Nations in the 1980s. However, only a handful of nations were involved and it is questionable whether the extensive longline fleets of the entire Pacific can all be effectively shut down. A more likely scenario is termination of some fleets and continued, and perhaps even expanded, longlining by the remaining fleets, which leads to production and trade leakages and continued sea turtle mortality. Moreover, there still remains the source of sea turtle mortality from shrimp trawling.

<sup>9</sup> See NOAA-NMFS Endangered Species Act Section 7 Consultation 2002 Biological Opinion for more detailed synopsis of fishery and non-fishery related take and mortality of sea turtles. Includes estimates of take and kills for Pacific longline fisheries.

<sup>10</sup> See NOAA-NMFS 2002 BiOp for details of loggerhead take and kills in Pacific.

<sup>11</sup> See NOAA-NMFS Observer Manual for Hawaii-based Longline Fishery; NOAA Tech Report on NED Experiments.

<sup>12</sup> Offsets are sometimes called "shadow projects" in the sustainable development literature (Hanley, Shogren, and White 1997, Hanley and Spash 1993). These are projects or policies designed to augment then stock of natural capital (in this case sea turtles) to offset reductions in the stock of natural capital from a specified collection (portfolio) of projects or policies. The idea is to impose either a "weak" or "strong" sustainability constraint as a rule for sustainable development. In its weak form, the discounted sum of environmental costs must be no greater than the discounted sum of offsetting benefits over the time period in question. In the strong form, not only is the total natural capital stock non-declining, but the environmental costs are no greater than environmental benefits in each time period, a more restrictive condition. In addition, it recognizes some elements of "critical" natural capital such as biodiversity. The definition of weak sustainability corresponds to "favorable conservation status," of the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia.

<sup>13</sup> For example, Barrett (2003, p. 380) observes that a US company might convert a power station in China from coal to natural gas, claiming credit for the associated savings in greenhouse gas emissions. Annex I countries face an emission ceiling and Annex II countries do not face an emission ceiling. (Annex I countries are the industrial countries listed in the original climate convention that preceded the Kyoto Protocol, the Framework Convention on Climate Change, which was signed by over 150 countries at the Rio Earth Summit in June 1992.)

<sup>14</sup> See also Bean (1993), Olson, Murphy, Thornton (1993), Robert (1999), and Welch (1995).

<sup>15</sup> Credits are denominated in Habitat Units (HUs) and are a measure of habitat value (Fernandez and Karp 1998). The number of HUs is the product of the number of species or functions per acre of a wetlands times the number of acres. WMB is intended to create large, high-quality habitats which incorporate entire ecosystems and bugger areas. Multiple investors in the WMB can pool their financial resources, planning and scientific expertise. The value of restored wetlands can be viewed as an option value. If wetlands are restored in the current time period, a developer preserves the option of cashing in for future development.

<sup>16</sup> The heterogeneity of wetlands poses problems is determining offset values (Polasky 2002). Wetlands provide many different ecosystem functions. Polasky (2002, p. 1379) observes, "Comparing wetlands is difficult because wetlands can differ on a number of different dimensions, with one wetland providing more of some services and less of others. Because there are typically no markets for these services, and so no market prices, there is no direct way to aggregate across services to calculate the value of a wetland or to establish whether different wetlands are in any real sense equivalent."

<sup>17</sup> One issue with offsets is the "moral hazard" problem that vessels taking sea turtles as incidental catches will have less reason to avoid interactions.

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<sup>18</sup> Care must be taken that country investing in offsets in other countries is not investing in offsets that would have been taken anyway. Not only do recipient countries have incentives to offer projects they would have undertaken anyway, but investing countries have incentives also to select these projects. (This adverse selection problem is a manifestation of the free-rider problem in international environmental agreements. Barrett 1998, p. 30)

In addition, some investments in offsets are lumpy and costs, and when combined with the relatively delayed age at sexual maturity for sea turtles, mean that offset projects require very long lifetimes.

<sup>19</sup> The Kyoto Protocol's Clean Development Mechanism encourages investment in economies where control of greenhouse gas emissions is least costly and where investments in new technologies today can "lock in" cleaner development paths that will persist into the future. It exists because emissions from developing countries are growing rapidly, so that significant effort to control world emissions should include controls in the developing countries. (Victor 2001, pp. 40-41).

<sup>20</sup> The Global Environmental Facility is an example of countries paying other countries to supply public goods, such as biodiversity preservation. The Global Environmental Facility was established in 1991 by the World Bank, the United Nations Development Programme and the United Nations Environment Programme. The Global Environmental Facility was relaunched at the 1992 Earth Summit in Rio.

<sup>21</sup> This discussion is based, in part, upon Goulder (1998), Kolstad (1999), Cropper and Oates (1992), Baumol and Oates (1988) and Tietenberg. In addition, shrimp and swordfish markets are predominately competitive and most producers, processors, and restaurants and fish stores are limited in size and scale of production. Thus, the (implicit) assumption of price-taking behavior may be reasonable.

<sup>22</sup> These external costs include foregone benefits from the continued existence of sea turtles and the preservation of sea turtles for future generations, and any foregone benefits (indirect use values) derived from non-consumptive uses as eco-tourism.

<sup>23</sup> The detrimental externality is not fully domestic, but instead is transboundary, requiring a multilateral and cooperative solution. Thus both consumers and fishers harvesting the population elsewhere are free riders to unilateral or bilateral conservation measures, and the social benefits provided by this global common property resource exceed the private. This free rider problem among both individuals and nations leads to substantial under-investment in conservation and management measures, and an increase in the investment needed to augment the population of turtles will have to be undertaken under the auspices of cooperative multilateral agreements.

<sup>24</sup> They depend on the elasticities of supply and demand.

<sup>25</sup> A higher cost of production through the Pigouvian tax which raises the private marginal cost of harvest to the social cost of harvest (by the amount of the external cost) introduces both a substitution effect, whereby incidental takes of sea turtles are minimized to the extent practicable for any level of swordfish catch, and an expansion effect, where the higher cost of production lowers the amount of fishing effort and thus the quantity of interactions. Over a longer time period, there is a dynamic effect through induced innovation. When producers and consumers of swordfish or shrimp must now pay the full cost of production and consumption, the higher swordfish price and costing of sea turtles could induce technical change that lowers the take rate of sea turtles. This point has been raised in the context of pollution by Wenders (1975) and Magat

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(1978). Completely shutting down a fishery in effect raises the sea turtle cost to infinity and can lead to technical change that lowers takes of sea turtles.

<sup>26</sup> The full economic consequences of taxing consumers or producers is unknown in this instance of joint production of a desirable output (swordfish or shrimp catch) and an undesirable output (sea turtle mortality) with and without full cooperation and participation in an international environmental agreement. In a somewhat analogous situation, Hoel (1994) and Bolombek, Hagen, and Hoel (1995) show that when all countries participate in an agreement to reduce CO<sub>2</sub> emissions, taxes on the consumption and production of fossil fuels have identical economic consequences, provided the tax revenues are identical in the two cases, but that this is no longer true when there is only limited participation in the international environmental agreement.

<sup>27</sup> Much depends not only on time spent fishing, but fishing gear and practices, which can differ by vessels and between larger and smaller producers.

<sup>28</sup> Weitzman (1974) is the classic paper in this area. With perfect information, tradable permits sold at auction have the same effect as a tax. Under uncertainty, the relative efficiency of transferable permits and fixed tax rates depends on the relative slopes of the relevant marginal benefits and marginal cost functions. If uncertainty about marginal conservation costs is sizeable, and if marginal conservation costs are relatively flat and marginal benefits of conservation fall relatively quickly, then a quantity control, such as a transferable turtle mortality limit, is more efficient than a price control, such as a tax. When there is also uncertainty about marginal benefits, and marginal benefits are correlated with marginal costs, then there is an additional argument in favor of the relative efficiency of quantity controls (Stavins, p. 486).

<sup>29</sup> In a revenue-neutral framework, the tax revenues are rebated to the payors. This revenue recycling is not considered here. Revenues from taxes, fees, or charges are designated for sea turtle conservation rather than as a source of overall tax revenue.

<sup>30</sup> Comparable charges are used in Europe and Japan to address water, and to a lesser extent, air pollution (Tietenberg, p. 377). France and the Netherlands use charges designed to raise revenues to fund activities that improve water quality. Water discharges in Germany give incentives to firms to meet minimum standards of waste water treatment for a number of defined pollutants. Discharges meeting or exceeding standards have to pay only half the normal rate. The Italian effluent charge system encourages pollutees to achieve provisional effluent standards as quickly as possible. The charge is nine times higher for non-complying firms and is scheduled to expire once full compliance is achieved. The French air pollution charge encourages early adoption of pollution control equipment with revenues returned to those paying the charge as a subsidy for installing the equipment. Charges in Sweden increase the rate at which consumers purchase cars equipped with a catalytic converter. Cars without one are taxed and new cars with one are subsidized.

<sup>31</sup> In theory, taxes intended to raise revenue in competitive markets distort resource allocation and create economic inefficiency through what is called a dead weight loss. However, when there is a pre-existing market failure and inefficiency due to an external cost (like sea turtle mortality from fishing), a tax or fee both raises revenue for conservation and recovery and addresses the market failure, thereby inducing efficiency.

<sup>32</sup> This discussion draws from Kolstad 1999, pp. 124-128.

<sup>33</sup> The Convention provides a general prohibition on the takes of sea turtles and their eggs in the territories of the Parties and in waters under their respective jurisdictions, but allows subsistence take to satisfy the needs of traditional communities under certain circumstances (Gibbons-Fly). The Convention requires that the take be reported to the other Parties. The Convention also

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provides that countries with subsistence takes agree to take into account the relevant recommendations of the Consultative Committee and to ensure that such take does not undermine the overall objectives of the Convention.

<sup>34</sup> The elements are: (a) Develop and use gear, devices and techniques to minimize incidental capture of marine turtles in fisheries, such as devices that effectively allow the escape of marine turtles, and spatial and seasonal closures; (b) Develop procedures and training programmes to promote implementation of these measures, such as vessel monitoring systems and inspections at sea, in port and at landing sites, and national on-board observer programmes; (c) Exchange information and, upon request, provide technical assistance to other signatory States to promote these activities; (d) Liaise and coordinate with fisheries industries and fisheries management organizations to develop and implement incidental capture mitigation mechanisms in national waters and on the high seas.

<sup>35</sup> Tradable emission permits are called "allowances." This program was designed to cut acid rain by reducing sulfur dioxide (SO<sub>2</sub>). Allowances can be bought or sold without restriction to cover emissions anywhere in the continental U.S. (Schmalensee *et al.* 1998). Emissions everywhere in the U.S. do not have the same marginal damage, but continent-wide trading helps insure that the allowance market is not too thin, i.e. that there are sufficient number of trades to insure a well-functioning market and price discovery.

<sup>36</sup> This is a key reason they are often ineffective. However, if the trade restriction deters relocation of production or emissions (production leakage), then the countries imposing the sanctions gain by imposing them. This then reinforces the credibility of sanctions.

<sup>37</sup> Costs and benefits of an agreement do not always fall equally on nations and willingness to pay varies by income levels for many environmental goods and services. By adopting technology standards or performance standards, gains to cooperation are created and all parties deserve to receive a share of this gain.

<sup>38</sup> Barrett (2003, p. 15) for example, states, "...the Oslo Protocol ignores the need for side payments. As noted previously, if the winners of acid rain controls do not compensate the losers, the losers will have little incentive to participate or to reduce their emissions by more than they would have absent Oslo."

<sup>39</sup> Side payments redistribute the additional gain from cooperation and help guarantee that all parties are at least as well off as before cooperation. Barrett (2003, p. 351) observes, "...side payments on their own have little effect on international cooperation. Side payments make the recipients more inclined to participate, but lower the payoffs of the donor countries, and so make them less inclined to participate. They do not on their own fundamentally alter the cooperation problem. In particular, they do not make punishments for free-riding any more credible." Barrett (2003, p. 351) later observes about the role of side payments through the Multilateral Fund of the Montreal Protocol, "On their own, trade restrictions might have deterred non-participation by the developing countries, but such an outcome would not have been fair. Side payments not only helped to increase participation. They also legitimized the threat to impose trade restrictions. It is really the combination of carrots and sticks that succeeded in protecting the earth's ozone layer." In addition, side payments to otherwise non-cooperating countries, while increasing the coalition of cooperating countries, may create an incentive for them initially to stay out of cooperation (Hoel and Schneider 1997). In the Kyoto Protocol, the surplus of emission entitlements created by allowing economies in transition to choose an alternative base year to 1990 (that may not be exhausted by economic growth in these countries) allows the economies in transition surplus emissions to trade with Annex I countries and in effect to receive a side payment to foster participation (Barrett 1998, p. 30).