Lines of Death:
Longlining and bycatch

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Executive Summary

Longlining is a fishing practice implemented worldwide in a wide array of fisheries from artisanal operations to modern industrial enterprises. The gear usually involves very long stretches of line set with thousands of baited hooks. An estimated 10 billion longline hooks are deployed globally every year[3], but the catch rates for target species are generally as low as one or a few fish for every hundred hooks set[2]. Theoretically, longline fisheries focus on one or a few target species. However, longlines do not discriminate between species or size, and they end up hooking large numbers of animals unintentionally (bycatch). The gear is responsible for the unintended deaths of other fish and animals, such as seabirds, sea turtles, and marine mammals. Bycatch also includes fish that may be of the target species but are too small to be taken legally. These fish thus die before having had the chance to reproduce.

Fishing pressure has risen dramatically over the past few decades, as increasingly high-tech fishing fleets are kept afloat through heavy subsidization. UN Food and Agriculture Organization scientists have estimated that the world's fishing fleet could be reduced by 53% and still maintain the same catch levels[8]. According to the FAO's 2000 report on the state of world fisheries and aquaculture[9], between 71% and 78% of the world's major fish stocks are either depleted, overexploited, or fully exploited. Longlining has contributed—sometimes solely—to the overfishing of fish stocks around the globe. Ninety-eight percent of the swordfish caught in the North Atlantic are caught on longlines, and lower levels of the swordfish population in the North Atlantic have never been recorded[11]. Populations of other large pelagic fish such as bluefin tuna, blue and white marlin, sailfish, and sharks are being heavily overfished.

Some shark populations have been diminished by as much as 90%[10]. It is thought that mortality on longlines is the primary threat to many species of seabirds[17.] Longlines also catch an estimated 40,000 sea turtles yearly[3]. In the Pacific Ocean, the leatherback turtle is reportedly "on the verge of extinction" [21], and their decline is strongly associated with mortality in longline fisheries[21].

Longlining boats such as this Costa Rican vessel can drop miles of line in one day. Credit: Randall Arauz

Considering these experiences, a proposal to open up small-scale artisanal longlining in the Galapagos Islands Marine Reserve should be viewed with great concern. A longline fishery there would very likely result in high bycatch of many species of sharks, seabirds, turtles, sea lions, and fur seals--all of which are important elements of the Galapagos marine ecosystem. Many of these are rare species and some are found nowhere else on the globe. Proposals to open the fishery have included no economic viability assessments. Though the fishery may be initiated on a relatively small scale, it would be almost certain to expand, as these operations proved to be uneconomical. Following the trend of fisheries worldwide, there would be a tendency for overcapitalization followed by political pressure to maintain or expand the fishery to unsustainable levels accompanied by high bycatch. In the Galapagos sea cucumber fishery, some fishermen were prepared to riot and vandalize to protect their unsustainable catches.

There are more traditional and less intensive fishing methods that could serve as alternatives including trolling, rod and reel, and handline fishing. The methods are more selective and produce considerably lower levels of bycatch. Furthermore, any bycatch is more likely to be released alive. At a global level, reductions of bycatch in longlining will likely be achieved only via large-scale modifications, including prohibition of longlining in certain critical areas. Unless critical policy changes are put forth and strictly enforced, these problems will persist and will likely worsen worldwide.

Preface

The fishing practice of "longlining" probably originated in the Mediterranean region during the 1500s[1]. However, it was not until the latter part of the 19th century, when industrial production made metal hooks widely available at affordable prices, that longlining began developing on a large scale. There are historical records of foreign fishermen using longlines in Norwegian cod fisheries in the 18th century. The introduction of this erstwhile new fishing method led to conflict as the longlines were condemned by locals for being too effective[1].

Longlining was as highly effective a method of fishing then as it is today. The equipment, involving long stretches of line set with thousands of baited hooks, was conceived to catch many fish at a time. However, it does so indiscriminately, catching both targeted and untargeted fish species, as well as hooking other forms of marine life such as seabirds, sea lions and sea turtles.

The experience from 18th century Norway proved to be a harbinger of things to come. The historical account inadvertently heralds some of the problematic aspects of modern-day longlining and its effectiveness in catching astounding numbers of marine animals--fish or otherwise. Longlining has been implicated in the overfishing of fish stocks around the globe. Many species caught unintentionally have also been drastically and dangerously reduced in numbers by longlines. This is part of a problem termed bycatch, and it is a grave matter inherent, albeit not exclusive, to longline fisheries.

Methods of Longlining

Longlining is a prevalent fishing practice utilized worldwide in fisheries that vary from small-scale artisanal operations to large and highly modernized industrial enterprises. An estimated 10 billion longline hooks are deployed globally every year[3]. Longlining is considered a passive fishing method because the capture of a fish depends on the animal's own movement toward the gear. This is in contrast to active fishing methods such as trawling in which fish are sought and captured by mobile gear.

There are two fundamental types of longline fisheries:

Demersal longline fisheries target fish that live on or just above the sea floor. It is usually carried out in very deep waters and among the species typically targeted are halibut, hake, Chilean seabass (also known as Patagonian toothfish), and cod. It is not uncommon for demersal longliners to deploy as many as 40,000 hooks in a single day[1].

Longlining equipment involves long stretches of line set with thousands of baited hooks. Credit: New Zealand Seafood Industry Council

Pelagic longline fisheries utilize lines that are suspended from floats and drift in the water column behind the fishing vessel in order to catch fish typically at depths of around 3 – 186 meters. These fisheries primarily go after species with high market value such as swordfish and many species of large tuna. Pelagic fisheries have received most of the attention focused on the issue of bycatch, the incidental catch of non-target fish or other marine animals.

Longlining Equipment and Deployment

Longline equipment and use varies depending on physical oceanographic conditions and the species targeted. Essentially a multifilament or monofilament mainline that varies in length from a few kilometers to 130 km^2 (81 miles) or more is deployed from the fishing boat. Attached to the mainline are branch lines that bear baited hooks, up to around 3,000 in total. Originally, longlining started by using short, handheld lines. But, industrial longlining has benefited greatly from modern technological developments that increase fishing power. The use of sophisticated navigational equipment and on-board computers that utilize remote sensing software, color depth sounders and oceanographic instruments that record and display temperature profiles has become widespread. Vessels also have easy access to charts that provide real-time information on surface currents and sea temperatures. These instruments combine to increase the fishermen's ability to locate areas where fish are likely to be caught.

In pelagic longlining, the mainline is suspended from floating buoys that drift on the sea surface and are spaced at intervals along the mainline. Radio buoys and long metal poles, known as hiflyers, reflect radar and aid in the retrieval of the longline. These are attached to floaters spaced at larger intervals along the mainline. A radio buoy or hiflyer is attached to the end of the mainline and thrown overboard. The vessel then advances along a specific course while the mainline is spooled out from the ship's stern. As the mainline is being fed out, crewmen bait hooks at the end of branch lines and clip these on to the mainline while other crewmen attach buoy lines on to the mainline. Both buoy and branch lines are attached at predetermined space intervals along the mainline until all of the line is out. Boat and longline then drift for 1–24 hours allowing the lines to fish until the mainline is hauled back on board. As the mainline is being retrieved and a fish is encountered on a branch line, crewmen gaff and pull it onboard if it is of a desired size or species. Otherwise, the fish, or other marine animal, is discarded, usually injured or already dead. The fish brought on board are immediately cleaned and packed in ice. Large longline vessels can have freezers with enormous capacity and commonly remain at sea for many months[1].

Principal fisheries

Longline fisheries focus, in theory, on one or a few target species of fish. However, the catch rates for target species are generally as low as one or a few fish of for every hundred hooks set[2]. From an industry perspective, these very low catch rates virtually dictate that individual fish caught need to be large and carry a high market value if longlining is to be economically feasible. As a result, the principal targets are big and high-priced fish such as bluefin tuna or swordfish. In demersal longline fisheries, some typical target species are cod and Patagonian toothfish.

However, the past decade has seen many populations of primary target species like swordfish decline significantly. Consequently, longline fisheries have taken on a more opportunistic approach, seeking profits from species caught in greater abundance. New markets for species previously considered undesirable have arisen, and longliners have been given incentive to keep fish they would have previously discarded. Notable examples include the appearance of a U.S. domestic market in the 1980s for marlin and the opening of a very profitable Asian market for shark fin. More incentive for catching sharks was provided in the 1980s when the U.S. government proclaimed sharks as "under-utilized species" [2]. Other tuna species and dolphin-fish have also been increasingly targeted in pelagic longline fisheries. The general trend has been that of a marked increase in the number of species landed in longline fisheries.

In Galapagos waters, sea lions will inevitably be caught on longlines.
Credit: Sea Turtle Restoration Project

Overfishing as a Result of Longlining

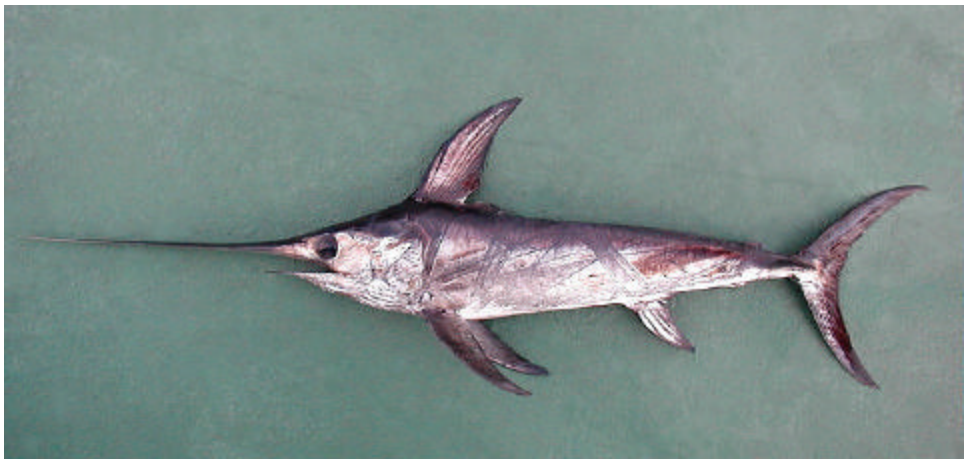
The dramatic worldwide declines in populations of marine life due to overfishing have been widely documented and discussed [4, 5, 6, 7]. The astonishing collapse of the 500-year-old cod fishery in the Grand Banks off of Canada and New England in the early 1990s is but one remarkable example. Fishing pressure has risen dramatically over the past few decades, as increasingly high-tech and irrationally large fishing fleets are kept afloat through heavy subsidization. UN Food and Agriculture Organization (FAO) scientists have estimated that the world's fishing fleet could be reduced by 53% and still maintain the same catch levels[8]. Increased technological capability and fishing intensity notwithstanding, according to the FAO's 2000 report on the state of world fisheries and aquaculture[9], between 71% and 78% of the world's major fish stocks are either depleted, overexploited, or fully exploited. In the words of "Jaws" author of Peter Benchley, "There are too many fishermen with too much sophisticated gear chasing too few fish." [10]

Until recently, the notion of humanity bringing individual stocks of fish to frighteningly low levels, or even pushing entire species into extinction, was considered the hyperbole of environmentalists. But a report published by the American Fisheries Society in November 2000 gave credence to the possibility[10]. In July 2001, a paper that framed overfishing in a historical context was published *Science*. The article stated explicitly that "[e]cological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems, including pollution, degradation of water quality, and anthropogenic climate change"[4]. The same article proclaimed that "even seemingly gloomy estimates of the global percentage of fish stocks that are overfished are almost certainly far too low." Overfishing may not be a new phenomenon, but the scale of overfishing witnessed in the 20th century is surely unprecedented.

The North Atlantic Swordfish

Longlining fleets have been conspicuously implicated in overfishing scenarios worldwide. The most glaring such example is that of the demise of swordfish in the North Atlantic. Ninety-eight percent of the swordfish caught in the North Atlantic are caught on longlines. These swordfish are heavily overfished. In fact, never have lower levels of the swordfish population in the North Atlantic been recorded[11].

Catch rates for the fish have declined consistently. The average size of a caught swordfish has also plunged dramatically from 260 pounds in 1960 to only 90 pounds in 1995[2]. Longlines do not discriminate between big and small fish, and large amounts of swordfish that are caught are not big enough to be landed legally. These are juveniles not yet of reproductive age, and they are simply discarded by fishermen. The majority of the swordfish caught in the North Atlantic are in fact juveniles. Adult fish make up about one third of the population[2] and, under pressure from longlining, they seem to be simply too few to replenish the North Atlantic swordfish's numbers.



Longlining fleets have been implicated in overfishing scenarios worldwide. The most glaring such example is that of the demise of swordfish in the North Atlantic.
Credit: Pedro Niny Duarte©ImagDOP

Other Large Pelagic Fish

- Populations of other large pelagic fish such as bluefin tuna, blue and white marlin, sailfish, and sharks are being heavily overfished. This is occurring both as a result of directed longline fisheries and of fish dying as bycatch. The problem is not confined to a particular region of the globe; longlining is practiced in all the world's oceans.

- The Bluefin tuna is the most heavily overfished large pelagic fish in the Western Atlantic[2]. In the Southern hemisphere, the (southern) bluefin population has been reduced to 2-5% of its original levels, according to some estimates[12]. The

(southern) bluefin tuna has been categorized as “critically endangered” by the International Union for the Conservation of Nature (IUCN).

- Similarly, stocks of blue marlin and white marlin in the Atlantic have recently declined to levels of ‘overexploitation’ and ‘severe overexploitation’, respectively[2]. Stock assessments conducted in 1993 by the International Commission for the Conservation of Atlantic Tuna (ICCAT) suggest that sailfish populations in the Western Atlantic are either fully- or over-exploited. The reductions of these billfish populations have come predominantly as the result of longline bycatch. In the U.S., the greatest source of billfish (marlins, sailfish, and spearfish) mortality comes as bycatch on commercial tuna and swordfish longlines. Between 1993 and1996, 975 metric tons of marlin and sailfish were discarded already dead by longliners targeting tuna and swordfish in the Atlantic[2.]

A blue shark is finned on a Costa Rican longliner. Often fisherman will cut the fins off while the shark is still alive and discard the dead or dying animal back into the ocean. Credit: Roberto Vargas/Sea Turtle Restoration Project

Sharks

A similar fate has befallen many populations of sharks worldwide. Sharks are especially susceptible to overfishing because they take long to mature sexually, reproduce slowly, and produce few young. Many fisheries targeting sharks have arisen in response to Asian demand for shark fin soup, an expensive fare increasing in both price and popularity. But sharks have always represented a large proportion of the bycatch in longline fisheries. About half of the global shark catch is in the form of bycatch, and longline fisheries, more than any other fishing method, are accountable for that catch[10].

Depending on the species, some shark populations have been diminished by 90%[10]. In the U.S. between 1997-1998, 24,000 metric tons of sharks were taken as target species or discarded as bycatch. The National Marine Fisheries Service (NMFS) has estimated that large coastal and pelagic sharks (e.g., blue, shortfin mako, tiger, and bull sharks) have been reduced in numbers by 50-70% since the early 1970s[2]. A 1997 study showed that the Hawaiian longlining fleet catches more than 100,000 sharks every year[13]. In New Zealand, the tuna longline fishery took 450,000 blue sharks alone between 1988-1998[14]. Longlining by both domestic and foreign fleets is overwhelming shark populations in waters off of Africa, Asia, Latin America, and elsewhere[10].

The Galapagos Islands are famous for their shark populations, which make them one of the top three dive sites in the world supporting a growing dive industry. Any longlining activity in the Galapagos would seem destined to bring about high bycatch of sharks. These sharks, even if successfully released alive, would carry the hooks with them. For divers this would be like visiting Africa on safari and seeing lions with snares on their legs or nooses around their necks. This clearly contradicts the image of pristine wilderness that is the lure of the Galapagos tourism industry.

Seabirds

Worldwide, 180,000 seabirds are estimated to die on longlines each year[3]. Seabird mortality in longline fisheries occurs as the result of birds being attracted to and seizing the baited hooks on longlines near the sea's surface. The seabirds get pulled underwater and drown as the lines sink. Incidental bycatch of seabirds is known to occur in the longline fisheries for tuna and swordfish in several parts of the oceans; halibut, Pacific cod, black cod, Greenland halibut, haddock, tusk, and ling in the northern Oceans, and Patagonian toothfish in the Southern oceans[15].

Wandering albatross downed on a longline.
Credit: Graham Robertson

The principal seabird species killed in longline fisheries in the southern Oceans are albatrosses and petrels. In the North Pacific, albatrosses, sea gulls, and fulmars are most frequently killed. The same is true for northern fulmars in the North Atlantic[16]. As with sharks, seabirds such as albatrosses sexually mature late in life and have few young in a slow reproductive cycle. It is thought that mortality on longlines is the main threat to these seabirds[17] and one of the most serious threats to ocean-going seabirds in general[18].

For albatrosses, longline mortality is highest in the Patagonian toothfish fishery in the Southern Oceans and the tuna fishery in the Indian Ocean where there are large albatross populations. The problem is most severe in the illegal fishery for Patagonian toothfish where vessels certainly don't carry international observers and are highly unlikely to take measures to reduce seabird bycatch[19]. The numbers of albatrosses and petrels being killed worldwide on longlines each year is somewhere in the thousands[12].

For the blackfooted albatross, with a total population of 300,000 birds, some estimates indicate that more than 10,000 of these birds are killed per year on tuna and swordfish longlines alone[20]. But reliable information is hard to come by. Of the seven major longlining fleets that fish within the distribution range of North Pacific albatrosses, data on seabird bycatch from international observers is only available for some U.S. fisheries[20]. This would appear to indicate that estimates of seabird mortality on longlines are, if anything, understated.

In February 1999, good news for seabird populations came in the form of the FAO's approval of an International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries[15]. The plan called on states to assess their respective longline fishery and upon determining that a problem exists, adopt and begin implementing a National Plan of Action to mitigate incidental seabird mortality by February of 2001. The Plan also provides technical suggestions on how to do so. But, the FAO plan is voluntary in nature and few nations have adopted National Plans of Actions while fewer still are implementing such plans.

Sea Turtles

Like seabirds, turtles die as bycatch in disturbingly high numbers on longlines each year. Under the U.S. Endangered Species Act, all seven species of sea turtles are listed as endangered, threatened, or vulnerable. Longlines catch an estimated 40,000 sea turtles yearly[3]. The turtles are caught either by swallowing the bait on longlines or by getting ensnared in the lines' hooks.

The scenario is especially grave for the leatherback turtle. Numbers of adult female leatherbacks worldwide have declined dramatically from an estimated population of 115,000 in 1982 to 34,500 in 1996[21]. An article In *Nature* (2000), concludes that in the Pacific Ocean, the leatherback is "on the verge of extinction" [21]. And their decline is strongly associated with mortality in longline fisheries[21]. The leatherback population in the eastern Pacific, which nests along the shores of Costa Rica, Nicaragua, Panama, and Mexico declined from an estimated 91,000 adult females in 1980 to only 1,690 in 1999[21].

In Terranganu, Malaysia, the number of leatherback females nesting annually has plummeted from 3,103 in 1968 to just 2 in 1994[22]. Nor are leatherbacks the only turtles to be taken in longline fisheries, all sea turtle species are in fact susceptible. Loggerhead, green, and olive ridley turtles are frequently hooked in longlines in the western Pacific[23] and elsewhere in the world's oceans. According to a recent scientific study, loggerhead turtles in the central north Pacific naturally travel along oceanic fronts that lie within the grounds of the Hawaiian longline fishery[24]. This would help explain the incidence of loggerhead turtles taken as bycatch in the fishery.

A number of lawsuits have resulted from concern over the effects of the pelagic longlining fishery on sea turtle populations. In Hawaii, the locally based swordfish longlining fleet was closed down, and the tuna longlining fleet was ordered to reduce fishing. This came in April 2001 as a federal district court judge handed down an order with the intent of mitigating the impact of longline fisheries on populations of endangered and threatened sea turtles[25]. Following the same rationale, the same judge had previously ordered the closing of millions of miles of Pacific Ocean to Hawaiian longliners. In response, the longline vessels simply relocated their operations to Californian waters in order to evade the restrictions in Hawaii. The move resulted in a lawsuit on behalf of several U.S. non-profit groups against the NMFS to protect leatherbacks in California. The same groups filed another lawsuit in October 2001 against the NMFS for continuing to allow the deaths of the critically endangered leatherback in Hawaii[26].

A scuba diver trys to untangle a sea turtle from a longline.
Credit: WildAid

Marine Mammals

Although dolphins appear to generally avoid longlines, sea lions and fur seals, especially juveniles, are susceptible. These animals feed on squid, a bait commonly used in longlining. Sea Turtle Restoration Project observers on Costa Rican vessels fishing in Galapagos waters before the expansion of the Marine Reserve filmed baby fur seals being caught on longlines. It is also reported that baby sea lions are used as bait in current illegal shark fishing in the Galapagos.

Longlining in the Galapagos Islands Marine Reserve: a disaster waiting to happen

In 1998 a landmark law (known as the Special Law) established the conservation and management principles for the world-renowned Galapagos Islands. It extended the seaward boundaries of the Galapagos Marine Reserve to 40 nautical miles around the Islands. Only "artisanal" fishing is legally allowed within the Reserve, but the question of what qualifies as "artisanal" fishing has been highly contentious. Recent attempts to allow much larger fishing vessels were turned down, for example. The Special Law requires that regulations for the fisheries sector be drawn up, and these regulations would presumably resolve the question. But regulations have been slow in coming, and in their absence local fishermen have been clamoring for the licensing of longlining as an "artisanal" practice inside the reserve. This has become more the case with the disappointing catches of the profitable coastal sea cucumber and lobster fisheries in recent times due to overexploitation and excessive fishing capacity.

As in any other part of the world, the opening up of a longline fishery implies an attendant high level of bycatch and high pressure on fish stocks. In the Galapagos, however, these problems would be particularly worrisome. The Islands have an unusually high proportion of marine species that are endemic to the Galapagos, i.e. found nowhere else in the world.[30] Examples include the waved albatross, the Galapagos sea lion, and the Galapagos fur seal. Also, hammerhead, white-tipped reef, and black-finned reef sharks among others are known to occur in the waters of the Galapagos. And, many species of seabirds are common in and around the Islands. Further, the Pacific green turtle is also found in the Galapagos. Studies in the 1970s and 1980s showed that the Islands represent one of the largest green turtle nesting colonies in the Eastern Pacific[31].

All of these species are highly susceptible to being caught on longlines in the Galapagos. This may be even more likely inside the Reserve where these animals are found in higher concentrations due to the special oceanic conditions that occur near the Islands. Recently, the Ecuadorian National Fisheries Institute carried out experimental longline fishing within the Reserve in order to determine what the resultant catch composition of longlining in this area might be. The experiment clearly showed that high bycatch would be the likely result. Sixty-two percent of the total catch was made up of bycatch (sharks, sea turtles, and manta rays), of which sharks constituted 93%[34]. Sharks, sea turtles, and manta rays alike are protected species within the Reserve.

Though not the typical implements of an artisanal fishery, the longlining gear currently being advocated for use inside the Reserve is relatively small-scale: carrying **a maximum of 170 hooks and utilizing boats of up to 18 meters in length.** But, if implemented, the prospects for the longlines to remain at that level would be very low. The nature of longlining as well as the politics and economics of fishing in general strongly indicate that these 'short' longlines will be forced to expand into fully commercial-scale longlines or not be commercially viable.

The danger is that after new fishing gear and possibly boats and processing plants have been paid for there would be irresistible financial pressure to expand the fishery. In addition, there is already a thriving illegal fishery for sharks in the Galapagos and opening longlining would seem to increase the opportunities for these illegal activities.

The sea cucumber fishery in Galapagos has been subject to widespread abuse. Populations appear to be declining drastically. Credit: Galapagos National Park Service

The low catch rates of target species associated with longlines mean that individual fish of the target species need to be highly valuable. This needn't be the case if the objective of the fishery is only to provide for local subsistence needs; in this case sufficient numbers of a variety of species would meet these needs. However, once the aim becomes commercial, fishermen need to set many hooks in order to catch enough of the high-value fish for the endeavor to be profitable. When catches of the target species decline, fishermen fish harder (use more gear) and/or shift to other target species. And this more closely resembles the scenario that would likely ensue if longlining were to be allowed in the Galapagos Marine Reserve.

Fisheries have a tendency to grow. Entering the longline fishery in the Galapagos requires substantial monetary investments. Larger boats, bigger quantities of fuel, and longline gear would need to be secured, as well as processing and refrigeration facilities. These requirements are beyond the financial reach of the local fishermen[31]. As is common in fisheries worldwide, the increased costs of production mean that local artisanal fishermen often become indebted to external financiers, which represent powerful external political interests[6]. Once initiated, fishing enterprises that are beyond the subsistence level tend to expand. Generally, as fish become scarcer and thus command higher prices, fisheries, instead of relaxing pressure to allow stocks to replenish themselves, invest in larger boats and more gear in order to increase their fishing power. In the case of longlines, this translates into longer lines that carry greater numbers of hooks. In the long term however, this results only in higher levels of fishing effort but not in higher catches of any target species. The cycle has been likened to a "technological treadmill"[6] and the fisheries expansion it describes has more to do with economic and political pressure than science or common sense.

The pattern has been borne out in countless developing small-scale fisheries all over the world[6, 32, 33]. And if their experiences are any indication, commercial pressures will likely drive any purported artisanal longline fishery in the Galapagos Marine Reserve far beyond any level that could be construed as artisanal.

Alternatives to longlining

In comparing longlining to alternative fishing methods, the main issue is that of degree of selectivity. Despite the non-selectivity of longlines, there are fishing methods even less selective. Trawling for example, in which marine animals are engulfed in a net as it is dragged behind a vessel, produces tremendous levels of bycatch. Prior to regulations implemented in 1998, the Gulf of Mexico shrimp trawling fishery took four pounds of various fish species as bycatch for every pound of shrimp caught[27]. Gillnets, often referred to as 'walls of death', are notorious for incidentally killing marine mammals, sharks, and sea turtles as well as many other non-target fish species.

However, there are more traditional, truly "artisanal" and less technologically intensive fishing methods that are more selective than longlines and produce considerably lower levels of bycatch. Harpooning is a remarkably selective method that was once prevalently used to catch swordfish. The harpooner visually targets the individual animal to be caught, and thereby directly selects for the species and size of the animal. A once-prevalent harpooning fishery for swordfish in the North Atlantic has all but disappeared as capital- and technology-intensive fishing gears have replaced the traditional, and swordfish populations have crashed. If swordfish populations were not so depleted, a commercial fishery using harpooning or rod and reel fishing could reasonably be supported[2].

Other methods more prominent in non-industrial level operations and suitable for application in the Galapagos, include trolling (towing single or several fishing lines behind a vessel), rod and reel, and handline fishing. These methods are associated with low levels of bycatch[28]. And, compared to longlines, they can yield lower levels of mortality in non-target animals that are incidentally caught. With these methods, an animal remains hooked for only a short time, so any bycatch is usually released alive. Though these methods are much more labor-intensive than longlines, their adoption would provide employment for more fishermen[29]. These alternative methods are not well suited for widespread use in all fisheries, but for some they may represent viable alternatives. Bluefin tuna, for example, can be caught at commercial levels using harpoons or rods and reels. In 1995, 74% of the U.S. total allowable catch for bluefin was taken on precisely these gears[2].

Conclusions

Overfishing and bycatch associated with longlining are serious and pervasive problems. They threaten the viability of populations of numerous marine species, many of them endangered, in the world's oceans. Short of critical policy changes put forth and strictly enforced by the relevant governments and international commissions, these problems will persist and will likely worsen worldwide.

Gear modifications, protected areas and alternative fishing methods represent part of a possible solution to reducing bycatch. But large-scale reductions in the capture of non-target animals in longlining will likely be achieved only via large-scale modifications in longlining practices. Prohibition of longlining in certain critical areas such as nursery or spawning grounds and areas where high bycatch levels are known to occur would seem the most elemental of such modifications. Yet, closures of these areas to longlining risk being rendered futile without adequate enforcement and monitoring programs to ensure compliance on behalf of fishers.

In the case of the Galapagos Marine Reserve longlining appears to be an extremely bad idea, which has not been properly researched:

1) Longlining is not an artisanal method as described in the Special Law, but an industrial one.
2) Given the high numbers of sharks, rays, turtles, sea birds in the Marine Reserve, it seems inevitable that bycatch will be extremely high and will impact populations of these animals, many of which are threatened or endangered.
3) Longlining is unlikely to be economically viable at a small-scale level, and would soon become industrial and unsustainable.
4) It would require new investment in gear, which would then have to be recouped.
5) The overfishing of sea cucumbers, the illegal shark fisheries, and riots against management in the lobster fishery do not inspire confidence that opening longlining in the Reserve would not be an unmitigated disaster.

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