Liquidating deep-sea capital?

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Over the past decade, a mounting body of evidence documents massive fishery declines and their history, potential causes and societal impacts (1-6). Now, scientists report that fishing impacts, particularly impacts of bottom trawling, extend to the deep ocean, a large portion of which has no fisheries management regime. With the collapse of coastal fisheries, fishing effort on deep-sea ecosystems and seamounts has intensified, (7) resulting in irreversible depletion of deep-sea fishes and obliteration of deep-sea habitats.

Public concern and efforts by some national governments, led to adoption of a United National General Assembly resolution in 2004, calling on nations to take "urgent" action to protect deep-sea corals, seamounts and vulnerable marine ecosystems from impacts of bottom trawling (8). In 2006, the General Assembly will review efforts by major fishing nations and regional fisheries management organizations to implement the 2004 resolution, and make recommendations for further action. Currently, almost seventy five

percent of the world's oceans lack a governance regime to protect fish species or habitats from the impacts of trawling.

Long-lived, Slow-growing, Vulnerable Fishes

In the deep ocean, light, nutrients and food are limited. Species inhabiting this environment ultimately live in the slow lane, with low growth rates, late maturity and low fecundity (9). These characteristics, along with aggregative behavior and dependence on structural habitats, increase the vulnerability of deep-sea fishes to overfishing (10-12). Several deep-sea fishes have declined to the point that they are considered endangered (13), regardless of whether they have been a target species or caught as incidental bycatch.

Fishery managers accustomed to dealing with shallow water, shelf-dwelling species have a suite of tools, including closed seasons, effort control, size restrictions and gear limits, to deal with stock declines. The life histories of deep-sea fishes make them less responsive to such measures, and hence more vulnerable to fishing impacts, with recovery times and capacity unknown. Were deep-sea species to be managed under the typical fisheries management strategies, annual yield, or total allowable catch would need to be set extremely low and likely much lower than required to support an economically viable fishery.

Fragile and Diverse Ecosystems

These vulnerable fishes live in ecosystems where habitat structure is provided by delicate species such as long-lived deep-sea corals and glass sponges (14). Deep-water corals and other habitat-forming organisms grow very slowly, with life spans and growth rates an order of magnitude lower than deep-sea fishes. These fragile structures are no match for modern deep-water trawling gear (15); massive steel doors, rollers, cables and nets that can weigh over 15 tonnes can, in a few hours, destroy deep-sea corals and sponge fields that have taken centuries to millennia to grow (Figure 1). Habitat damage from bottom trawling occurs globally (16). In Australia and New Zealand, for example, bottom trawling has stripped individual seamounts of nearly all their natural cover (17). Even if these organisms are capable of regenerating, the habitat they provide will take hundreds or thousands of years to be reestablished.

Deep-sea structural species, and seamounts in particular, are known hotspots of species diversity and endemism, hence destroying these habitats has major implications for marine diversity conservation. Fully one-third of the species surveyed from southwest Pacific seamounts were new to science and possible endemics (18). It is likely that many species not yet known to science are being destroyed, as a tiny fraction of seamounts have been surveyed. Fisheries generally expand to new areas before any scientific exploration has occurred. Consequently, there is often no scientific record of what existed before trawling occurred or what was destroyed in the process. Irreversible destruction of these habitats renders the concept of a sustainable, trawl-based deep-sea fishery somewhat of an oxymoron.

Perverse Economic Incentives

In the event that a sustainable deep-sea fishing regime could be designed, with sustainable catch and protection of habitat, enforcement would be extremely difficult on the high seas. And even if enforcement were effective, current economic incentives for sustainable fisheries on the high seas are non-existent. Rather, they lead to mining the resources of the deep-sea, than sustainable fishing. The boom and bust nature of these fisheries has been evident since the advent of deep-sea trawling in the 1960's. This cycle has characterized the fisheries for grenadiers on the slopes of the North Atlantic and North Pacific, orange roughy, oreos and armorheads of Pacific seamounts, or icefishes on the deep fringe of Antarctica (Figure 2). Following each bust, the fishery moves on from region to region, seamount to seamount and species to species (19).

In the absence of effective regulation, fleets compete to catch as much as they can before others do (20). The tragedy of the commons continues. National subsidies make matters worse by keeping fleets at sea beyond the time when fishing is profitable (21). As the fished populations have little to no chance of recovery during the time of the fishery, there are economic incentives to catch all the fish possible in one area (22), before moving on to exploit the next resource.

Stocks are often depleted before they are known to science and unknown diversity continues to be lost. Society's economic incentives should be to avoid irreversible damage (23), rather than promote it. It would be one thing to ignore societal interests if

these fisheries contributed substantially to national economies or global food security. In fact, they do neither. Economic return from deep-sea trawl fisheries comprises less than 0.5 percent of global fisheries value and the catch is sold almost entirely to the wealthiest nations (24).

International Opportunity

From an ecological perspective, we cannot afford to destroy the deep-sea. From an economic perspective, deep-sea fisheries cannot occur without government subsidies, and current deep-sea fisheries are certainly not sustainable. To ensure that deep-sea fishes and deep sea habitat are not irreversibly harmed, immediate action is needed to limit the adverse impacts of deep-sea bottom trawling. This need is recognized by a growing number of countries. National governments are increasingly designating areas closed to trawling and recently established closures comprise an area of almost 10.4×10^6 km^2 (Figure 3). On the high seas, defined as the area beyond the 200-mile limit, effective regulation can be accomplished through binding international agreements and national commitments to uphold such agreements. To establish or strengthen such agreements is a laudable goal, but will take several years to occur. Marine ecosystems do not have the luxury of time, as the fishing industry is already far ahead of the game.

At its November 2006 meeting, the UN General Assembly should adopt a resolution establishing an interim moratorium on all high seas bottom trawling. Doing so will protect deep-sea ecosystems in the vast areas of the oceans that lie in international waters where trawling is unrestricted. This will provide the protection needed until

comprehensive, accountable and enforceable regimes are established to properly manage deep-sea resources. Scientific evidence and economic arguments exist. With international political will, there is a good chance that this can happen.

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Figure captions

Figure 1. Before and after trawling on a giant carbonate mound, Porcupine Bank, NE Atlantic: (a) Rich coral fauna at 750 m water depth on the sloping side of the mound, (b) Broken corals and lost trawl net.

Figure 2. Landings of the most valuable deep-sea fishes 1965-2004. Roundnose grenadier is from the slopes of the North Atlantic, oreos and orange roughy are from Pacific seamounts, and Patagonian toothfish is from deep waters of the Antarctic.

Figure 3. Number of countries banning trawling and cumulative area closed.