SUSTAINABLE DEVELOPMENT

Global Marine Fisheries Resources: Status and Prospects

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AUGUST 2002 · ISSUE BRIEF 02–17

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Introduction

Most of the protein in the world's food supply is derived from either grain or animal sources, each of which provides roughly half the supply. Fish resources generally account for about 16% of the protein attributed to the animal group. So, while by no means the dominant source of the world's protein, fisheries resources are nevertheless important in several ways. First, fish and crustaceans are important and high quality sources of amino acids, which are nutritionally important types of protein found only in small amounts in cereals and grains. This turns out to be important for global nutrition and particularly important to some food deficient, low-income countries. Second, fisheries are locally important sources of food, trade, and income in many developed and developing coastal nations. Trade in fisheries products is an important source of foreign exchange for some countries, and has been of growing importance as global markets for both food fish and fish meal have grown. Finally, according to Bell (1978, see Further Readings), fisheries provide employment and income earning opportunities for considerable numbers of people, particularly in less developed coastal countries.

As we enter the 21st century, population and income growth—and the unequal distribution of both—will place increasing stresses on all global resources, including fisheries resources. The bad news is that there are daunting institutional impediments to attaining and maintaining sustainable use of the world's fisheries. The good news is that, if these can be solved individually and cooperatively by resource users, marine resources will be able to contribute their full potential to global well-being. In this paper, we discuss the status of the world's fisheries and their prospects, paying particular attention to these institutional impediments. In the next section, we review events since the close of World War II that have influenced exploitation trends that lie behind the current status of global fisheries stocks. In the third section, we discuss the impact of the important Law of the Sea Convention of the mid 1970s. We then assess the biological and economic status of the world's fisheries, followed by a look at the manner in which fisheries management institutions have evolved. In the final section, we discusses some visions of the future.

Global Trends in Exploitation

In order to understand the status of the world's global fisheries resources, one has to look back only as far as the end of World War II. In 1945, total world fisheries production was about 14 million metric tonnes (MT). Of that amount, about one-third was allocated to production of fish meal and fish oil, which were used as a protein supplement for animal feeds. There was very little aquaculture produced, and only a modest amount of trade in fishery products. Most fish stocks were healthy biologically, partly as a result of low prior exploitation and partly as a result of the near moratorium indirectly imposed by war-time use of the sea. Many biologists viewed the oceans as capable of producing as much fish as available technology could profitably yield, and few saw any limits in the foreseeable future, if ever, as reported by the United Nations Food and Agriculture Organization (FAO) (1993, see Further Readings).

The 1950s saw a post-war ship-building boom that expanded global fishing capacity several fold. An important engine of this growth was the drive by centrally planned economies including countries of the former Soviet bloc to capture protein for planned dietary goals of their citizens. Ships from Soviet bloc countries like Poland, together with ships from coastal nations such as

Japan, China, the Philippines, and Thailand, quickly came to dominate global marine production by the late 1960s. This period also saw the development of so-called factory ships—vessels capable of catching huge volumes in weather and seas of all conditions; these ships were able to process the catch on board, freeze it into blocks, and then store the processed raw product until return to port, a trip that often took many months.

The 1950s also saw the first hints of potential limits of marine capture fisheries, as fishery scientists began to develop and test new theories of exploited populations, as well as understand symptoms of overfishing that were just beginning to reveal themselves. Some of the important intellectual foundations of fisheries science, such as the concept of maximum sustainable yield (MSY), were developed during this period, as were techniques of monitoring and recording the impacts of growing effort on the world's fish populations.

During the postwar period of rapid expansion of fishing fleets throughout the world, most coastal nations claimed jurisdictions extending 12 nautical miles from shore, an area that encompassed only a fraction of the ocean's most productive upwelling and continental coastal shelf areas. The post-war global fleet expansion thus brought a huge increase in fishing effort to the near-shore waters of all coastal nations, increasing fisheries production in proportion.

By the 1970s, says Christy (1997, see Further Readings), global marine harvests had quadrupled from the 1945 levels of 14 million MT to 60 million MT, about a third of which was consumed by Soviet bloc countries. The expansion of fishing capacity coupled with increasing demand for seafood products naturally led to increases in conflicts between domestic fleets fishing operating within their territorial waters and foreign fleets operating just outside. These conflicts led to several international confrontations, exemplified, for example, by the "cod wars" between Iceland and Great Britain.

In 1976, an immensely important institutional change occurred as coastal nations simultaneously extended their jurisdictions from 12 to 200 miles. The United Nations Law of the Sea Convention negotiations that culminated in the jurisdiction extension concluded several years of intense debate waged primarily over establishing new rules to exploit seabed minerals. While seabed minerals were the impetus for the jurisdiction extension, the new institutional governance structure had critical importance for the world's fisheries as well.

Since most of the world's fisheries are found in the upwelling zones and continental shelf areas close to coastal borders, this territorial change effectively brought the bulk of the world's fisheries under the control of coastal nations. Some of these fisheries came under control of single nations, others came under joint control (shared or straddling stocks). A small number of fisheries for highly migratory species (such as tuna) that spend most of their life in the high seas beyond 200 miles were unaffected by this significant institutional change.

It is difficult to overemphasize just how important the 1976 jurisdiction extension was to the world's fisheries. Most importantly, the change converted what was largely a global commons into a system that effectively gave coastal nations the immediate ability, if not necessarily the legislative and regulatory means and political will, to manage fisheries rationally. Prior to 1976, few nations found it in their national interest to manage their own domestic fleets on stocks that straddled 12-mile limits, even in the face of evidence of overexploitation. This was the so-called tragedy of the commons at work, in that any harvesting curtailment designed to maintain stocks at sustainable yield levels would ultimately and inevitably be dissipated by foreign fleets attracted by the very success of such actions. Under these conditions, it should not be surprising that the

growth in yields during the 25 years following World War II came about largely through chaotic and unplanned capacity growth rather than careful and rational management of the world's fisheries.

Impacts of the Jurisdiction Extension

What was the impact of the conversion of the world's commons into this new system of coastally "owned" fisheries? First, there was a shuffling of production and changes in the patterns of world trade as a number of the world's fishing nations found themselves shut out of coastal waters they once exploited. Some nations, like China, turned to aquaculture and inland-produced fish to supplement diets. Others turned to trade to procure what was lost as domestic fleets were shunted into the still-open high seas. Japan, for example, rose to dominate world trade in fisheries in the past two decades, currently providing a market for more than a third of the world's imports. Still other nations, like the U.S.S.R., formed joint ventures with domestic fleets, purchasing fish from local fishers that were (prior to the 200 mile territorial extension) caught by global open seas fleets. Second, the new global configuration set off a series of national experiments as nations undertook to learn how to manage the new fisheries suddenly under their control. The legacy of fisheries management shows a wide spectrum of response, from plans that barely changed conditions of operations to radically new rights-based systems.

Most nations' first order of business was to replace foreign fishing capacity with domestic capacity. In many instances, this was accomplished via vessel construction subsidies and loans that allowed the domestic fishing fleets to expand rapidly to fill the void left by the exclusion of the foreign fishing fleets. Consequently, the problems associated with too many foreign fishing vessels that occurred under the global commons regime was simply supplanted by domestic overcapacity under new management institutions. This resulted in continued growth in harvesting power embodying new fish finding technologies, improvements in gear, and large-scale handling and processing operations. In parallel, and often in conflict, most coastal nations established scientific and bureaucratic institutions to begin assessing fisheries potential, estimating sustainable yields, and enforcing total allowable catches (TACs) and other regulations designed to manage harvests.

The overall legacy of the new domestic fisheries management institutions implemented after 1976 is clearly mixed and quite controversial according to FAO (1993, see Further Readings). While the extension of jurisdiction provided conditions for more rational management, the follow-up by individual countries was varied for many reasons. First, the extension of jurisdiction did not "privatize" all of the world's valuable fisheries and leave them under undisputed claim by single nations. Fish stocks do not honor political boundaries, and circumstances range from nations with large continuous coastlines encompassing some fisheries completely within territorial waters to densely packed countries sharing resources that overlap many different political boundaries. But even under the most favorable conditions (countries with contained fisheries) we have not seen universal success in bringing rationality to management.

Some of the poorer and less developed countries have seen corrupt leaders invite foreign vessels in to "mine" out the resources in unsustainable ways. Other countries have developed sophisticated, scientifically based management targets, only to abandon the scientific advice in the face of local political pressures to permit higher exploitation rates. Still other nations have scram-

bled to develop and innovate new methods of assessing, forecasting, enforcing, and monitoring, all in the face of steadily growing domestic fleets.

While having stocks contained within single jurisdictions is an ideal precondition for success, most fisheries are shared by two or more nations, necessitating complicated and protracted negotiations between neighbors over migrating and straddling stocks. For the most part, agreeing on TACs that limit total catch to sustainable levels has been inextricably tied up with negotiations over how to share a resource among joint claimants. This has frequently led to delays in the process of establishing conditions for sustainable management, coupled with further expansions of subsidized capacity-building in order to establish bargaining stances in discussions over relative shares. Negotiations over straddling and shared stocks have been slow to resolve, taking most of the rest of the 20th century to conclude in many cases.

Assessment: Biological and Economic Status of Global Fisheries Resources

Any assessment of the success of global fisheries management during the 25 years since the jurisdiction extension depends upon whom one asks and what criterion one is using to judge success. One commonly used measure is the status of existing stocks of fish or, more specifically, their ability to continue producing sustainable yields.

FAO reports group fisheries into "status" categories including: under-exploited, fully-exploited, and over-exploited or depleted as described by FAO (2001, see Further Readings). Most recent data suggests that about half of the world's fisheries fall into the fully-exploited category, one quarter in the under-exploited category, and a final quarter in the over-exploited or depleted category. Those who view the legacy positively point out that, ideally, we would want all of the world's fisheries in the fully exploited category and hence a record with three quarters of the world's stocks either fully- or under-exploited seems reasonably successful at this stage of fisheries development. Those who view this legacy as unsuccessful often use the same data with a different spin, summarizing by concluding with alarm that "three quarters of the world's fisheries are fully- or over-exploited." Many environmental groups decry lack of progress in management, citing important and highly visible management failures, such as the collapse of the Atlantic cod, Peruvian anchovetta, and New England groundfish fisheries. Some prominent scientists have extrapolated these cases, concluding that these kinds of failures are inevitable and a result of the inherent unpredictability of fisheries coupled with political pressure to continually expand TACs.

Our judgement is that the regulatory legacy should be viewed more charitably. In the first place, the relevant comparison should be what might have been without the important extension of jurisdiction. Most would agree that, by the 1970s, a large fraction of the world's most important fisheries was badly overexploited and severely overcapitalized. This trend would have surely continued, driving even more species into overexploitation and perhaps extinction. The past 25 years have seen an arrest of the decline of many fisheries, gradual and dramatic rebuilding of stocks in some cases, and a general move toward establishing responsible institutions charged with rational management. None of these developments would have been likely if the open access conditions of the global commons were allowed to continue.

In the second place, the period during which one ought to assess the regulatory record is comparatively short, effectively only 25 years. While some might view this progress as too slow, an alternative view would acknowledge that there has been a tremendous institutional evolution dur-

ing the past two decades. A more optimistic interpretation would also acknowledge the difficulties of setting up management institutions, establishing requisite scientific monitoring and stock assessment, and agreeing on goals and TACs that reflect not only the science of population assessment but also complex socio-economic tradeoffs. In the final analysis, most of the world's most valuable fisheries now have regulatory institutions that are charged with long-term goals of sustainable fisheries. These institutions are staffed with individuals who take the job of conservation seriously and are not naive about the difficulties inherent in the task.

There are other objectives by which one might judge the success of the past 25 years of regulatory activity. One important measure is whether the world's fisheries resources are providing any economic return. On this score, even the most charitable interpretations lead to less favorable assessments. One heavily cited FAO report estimated that, in 1990, the world's marine capture fisheries resources yielded output worth about 70 billion U.S. dollars in market value as seen in Grainger and Garcia and Christy (1996 and 1997, respectively, see Further Readings). But the same report estimated that the actual out-of-pocket operating costs of producing this output were on the order of $92 billion. Hence, the conclusion was an extremely dismal one, namely that the world's fisheries were not only failing to return a profit, but they were actually draining income from other, potentially more productive uses.

How could this be? First, it was estimated that a huge fraction of fisheries income ($30 billion) was going to vessel capital maintenance. This is most likely due to the dramatic fleet buildup that occurred under global open access conditions during the 1950–76 period, and probably the continued growth in capital that occurred even after jurisdiction extension. Another factor explaining outright operating losses is the considerable subsidization granted the fishing industry in many countries. As recently as the early nineties, many countries were subsidizing fishing investment in the face of global overcapacity, generally in order to increase catch histories as means to gain bargaining advantages in contested shared stock negotiations.

While perhaps surprising enough on the face of it, the finding that the world's fisheries are operating at net losses actually understates how poor the economic record for global marine capture fisheries is. This is because these resources ought to not only earn enough to cover operating expenses but they also should be earning enough to cover the valuable resource productivity inherently responsible for fisheries yields in the first place. This important fact can be explained by thinking about farming and the value of land.

In sustainable privatized farming systems, the value of output produced earns not only enough to cover labor, capital maintenance, fertilizer, and other variable inputs, but it also earns something to contribute to what economist's refer to as land rent. A tenant farmer or share cropper who uses land owned by someone else must pay rent, which is a payment to the inherent productive capability of the land itself. More productive land generally generates higher rents. Moreover, even a farmer who owns his own land must earn enough after expenses to cover what he is giving up by not renting or leasing his land out to someone else.

The analogue with fisheries resources carries directly over and helps explain why we don't see the world's fisheries generating any returns on the productive capacity of the resources themselves. If the world's fisheries could be divided up and privatized like farmland, the "owners" could charge rental fees to the fishing industry for the privilege of using the ocean's productivity. Under these circumstances, the fishing industry would compete for access, reduce costs and rationalize inputs, and seek out higher-valued uses for fish in order to generate the most value from

the access rights. Given the right circumstances, we would then see fisheries covering basic (and reduced) operating costs plus a return paid to owners of the resource and its productivity.

Evolution of Fisheries Management Institutions

Unfortunately, the past 25 years have not seen a wholesale move toward policies that mimic or otherwise approach what we might see under a hypothetically privatized regime of ocean governance. What we now know in hindsight is that fisheries management regimes seem to evolve through several stages as the resource continues to become more valuable in the face of demand growth. The first stage is pure open access in which there is no regulation of access possible, much as we witnessed during the global fleet build-up between World War II and 1976. Within this stage, the most likely outcome is severe overcapacity coupled with dramatic overexploitation. The end result is generally one in which the target population is driven to a low level, the extent of which is governed by costs and markets. With highly valued products caught with technologies that produce at low costs, these fisheries may be driven close to, or beyond, levels that ultimately lead to extinction.

A second stage in the evolution of fisheries management is conversion to what might be called regulated open access, as described by Homans and Wilen (1997, see Further Readings). In this regime, access is still open to any entrants, but participants abide by certain regulations, generally aimed at holding aggregate harvests at sustainable levels or at maintaining a certain spawning biomass. For fisheries to progress from open access to regulated open access, there must be some mechanism enforcing compliance of the rules of the regime. For resources shared by a few nations exclusively, this may take the form of a treaty, like the North Pacific Halibut Treaty of 1930.

The regulated open access stage is significant because it is the stage that most coastal nations quickly evolved into after the jurisdiction extension in 1976, and it also is the stage that a large number of the world's fisheries find themselves in presently. In contrast to pure open access, which often drives biomass to low levels, under regulated open access, conventional effort control measures, such as closed seasons and mesh size and gear restrictions, are used to achieve some targeted TAC. This is why we see the current paradox in global capture fisheries of having a significant number of fisheries at or below maximum sustainable exploitation, but without any returns being generated. Under regulated open access, entrants are driven to build more vessels, with more capacity, under increasingly frantic conditions (the so-called "derby fisheries") in order to capture a larger share of a biologically determined TAC. This "race to harvest" leads to the allowable harvest being caught with too many inputs to generate any return. Moreover, there are other well-known symptoms manifested in poor quality raw product, excessive by-catch and discarding, non-selective gear adoption, and low-valued end products, all of which waste the ultimate income earning potential of renewable resources.

The next stage in the evolution of fisheries management institutions that has been observed is the conversion from regulated open access to regulated restricted access. This differs only in that some form of limited entry is adopted so that subsequent competition is among a closed group of participants. What Wilen's experience (1988, see Further Readings) has shown is that fisheries will begin to generate some returns under this regime, even though the fundamental incentives to race for the fish still exist. In particular, if numbers in the closed group are low, and if the form

of limited entry restricts critical dimensions of capacity expansion (for example, gross tonnage, engine size, and hold capacity) then, fishers will be unable to work around these restrictions to such an extent as to dissipate all potential returns. It should be emphasized, however, that regulated restricted access systems are still fundamentally driven by perverse incentives operating between participants to maximize their shares of the fixed TAC. Any innovation that improves fish catching power, for example, will be quickly adopted by everyone, even when there is no gain to the group as a whole because total output is fixed.

The last stage of institutional innovation that we have seen over the past 25 years is the development of so-called rights-based fishing systems, as demonstrated by Neher et. al. (1989, see Further Readings). These are radically different in that fishers hold shares in the TAC and they may harvest in whatever ways they choose. Hence, instead of racing to harvest larger quantities before competitors get it, individuals will be driven to focus on maximizing the value of the shares of the TAC they hold. The kinds of institutions that have developed under the rights based rubric include individual transferable quotas (ITQs), territorial use right fisheries (TURFs), cooperatively managed fisheries, and community development quotas (CDQs).

From the experience accumulated thus far, rights-based systems generate radically different incentives compared with systems that retain full or vestige open access incentives. Most early entrants were skeptical of the benefits of these systems, but most current participants are virtually unanimously in favor of them. The kinds of changes in both the techniques of fishing as well as in downstream value-added activities has far outstripped most early expectations, as in Casey et al. (1995, see Further Readings). Large resource rental values have been generated in virtually all fisheries rationalized with ITQs and similar rights-based systems, and a few anticipated problems such as high grading and black market sales have not materialized. Most knowledgeable observers give rights-based systems a vote of confidence, both in the incentives to generate economic return and in the incentives toward stewardship that they typically induce. It is widely believed and supported by anecdotal evidence that once fishers have a financial stake in the returns from sensible investment in sustainable practices, they are more easily convinced to make sacrifices required to rebuild and sustain fisheries at high levels of economic and biological productivity.

The Future Potential of World Capture Fisheries

As discussed above, after 25 years of institutional evolution following jurisdiction extension, the report card on global capture fisheries remains mixed. For the most part, institutions have been implemented to replace the wasteful pure open access regime that existed before the jurisdiction extension was implemented. Not all of these institutions have been able to overcome the internal political pressures brought to bear on the process by participants, however, and this has manifested itself in the failure to rebuild and sustain fisheries and the failure to generate economic returns. Our view is that the next 25 years will see continued evolution of management institutions away from the regulated open access scenarios toward more restricted-access regimes and rights-based systems. As this happens, fisheries plagued by overcapacity and in the depleted status categories will recover and move into the fully-exploited categories. At the same time, under-utilized fisheries and some yet to be exploited will likely experience market-driven value increases until they, too, become fully utilized. The key to attaining both sustainable physical yields and

economic returns seems to be in realigning fishers' incentives, away from those generated under derby (race for fish) conditions, toward those generated by circumstances experienced under rights-based systems. While the later have their detractors, the successes are hard to ignore and we know much more about how to tailor programs to address various anticipated deficiencies.

How much potential is there in the world's marine capture fisheries? At a current level of 90 million to 95 million MT, it is not difficult to believe that, within the next 25 years, we might witness levels in excess of 100 million MT. This ought to materialize out of recovering stocks, growth in under- and un-exploited commercially feasible stocks, improved forecasting and fine tuning of harvest targets, reduced catch and discard waste, and some increased harvests of krill and other species at the extensive margin of feasibility. Perhaps more importantly, however, is the possibility of generating economic returns.

A back-of-the envelope computation of what is feasible is instructive. If we begin with the 1990 estimate of world revenues of $70 billion, it is not difficult to imagine a doubling of this from several sources. First, the real demand for fish protein will likely continue to grow at some positive rate as incomes and world population grow. A 1.7% growth in real demand would increase revenues by about 50% after 25 years. Second, to the extent that fisheries are rationalized with rights-based systems, new incentives to add value in the marketplace will emerge. Past cases show that revenues can increase by 50% very soon after implementing management systems that generate high value in the market. At the same time, rationalization will reduce inputs and costs, including the costly overhang of excess capital and variable input costs now witnessed under regulated open access. Again, evidence in several rights-based ITQ fisheries shows that rents often rise to levels approaching 60% to 70% of gross revenues. If we take, for the sake of argument, a figure of 66% of the (doubled) $140 billion in revenues, we can conclude that fisheries might generate more than $90 billion in returns per year, instead of the current losses being experienced yearly. This is a significant sum and a measure of how much the world has foregone as a result of the legacy of inefficient and wasteful open access conditions.

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