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FISHERIES COMMITTEE

FISHERIES TRENDS - A BACKGROUND REPORT

The attached paper, "Fisheries Trends - a background report", is distributed for COMMENTS to the Committee for Fisheries. The paper has been drafted by consultants to the OECD Environment Directorate for its work on the Environmental Outlook Report.

Comments should be sent to Carla BERTUZZI (E-mail: Carla.BERTUZZI@oecd.org)

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Fisheries Trends

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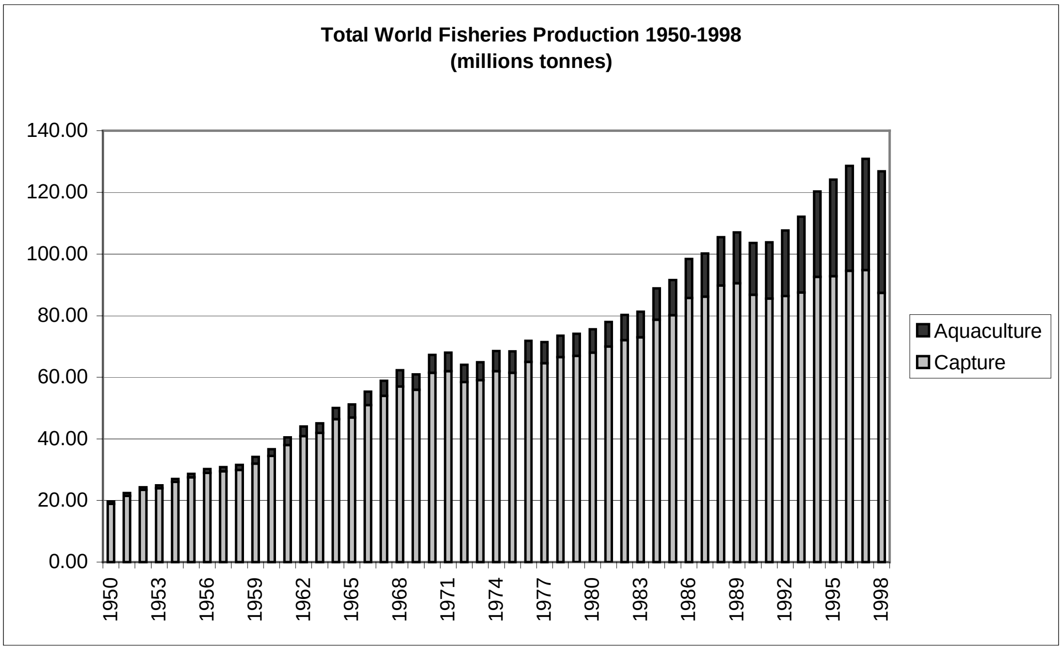
1. Introduction

Among the natural resource sectors, fisheries continue to play a major role in the world economy. First sale revenues from fishery products are estimated to be approximately U.S. $95 billion per annum (National Research Council [NRC], 1999), while world annual exports of fish and fish products are estimated to be in excess of U.S. $52.6 billion (FAO of the UN, 1999a). With respect to employment, the fishing industries of the world are estimated to provide direct employment to in excess of 28 million people, and to many more indirectly (FAO, 2000a).

As a source of food, fishery products account for approximately 20 per cent of all animal protein consumed by human beings. In Asia, the percentage may be as high as 30 per cent (NRC, 1999). Indeed in Japan, the leading fish producing member of the OECD, fishery products constitute the single most important source of protein for the population (OECD, 1997a).

The fisheries sector, with respect to harvesting, is divided within the OECD and the world at large into two broad sub-sectors, capture fisheries and aquaculture. Capture fisheries involves the hunting and gathering of fish in the wild. Aquaculture, or “fish farming,” involves the raising of fish under controlled circumstances. Figure 1 shows total world fisheries production, 1950-1998, broken down into capture fisheries and aquaculture.

Figure 1



Source: FAO, 1999a; 2000b.

It is obvious from Figure 1 that capture fisheries remains the dominant sub-sector. Indeed in 1998, just under 72 per cent of total fisheries production of 127 million tonnes[1], in volume terms, was accounted for by capture fisheries production (FAO, 2000b). Having said this, however, it will be argued that growth in fisheries production up to 2020, and beyond, will be accounted for largely by aquaculture.

While there are unquestionably links between capture fisheries and aquaculture, the distinction between them, particularly when assessing the future prospects of the fisheries sector, is fundamental. In recognition of this fact, the discussion to follow will consider each sub-sector in turn. In so doing, each sub-sector will be considered from both an OECD and world perspective. The discussion will focus on the harvesting segments of the sub-sector, on the grounds that their futures are primarily resource driven. There will at a later point, however, be a discussion, albeit a brief one, on developments in the post-harvest segments of the fisheries sector.

We commence with the capture fisheries sub-sector.

2. The Capture Fisheries Sub-Sector

2.1 An Overview

Table 1 sets forth the capture fishery production levels of OECD members (based upon the most recent five year annual average) along with those of key non-OECD countries and entities. What is striking from Table 1 is the dominant positions, within the OECD, of Japan, the United States and the E.U. On a world basis, Japan and the United States do, as individual countries, rank fourth and fifth respectively for the period 1994–1998. Combined they account for over 40 per cent of the OECD total, while together with the E.U., they account for just under two thirds of the OECD total.

Table 1

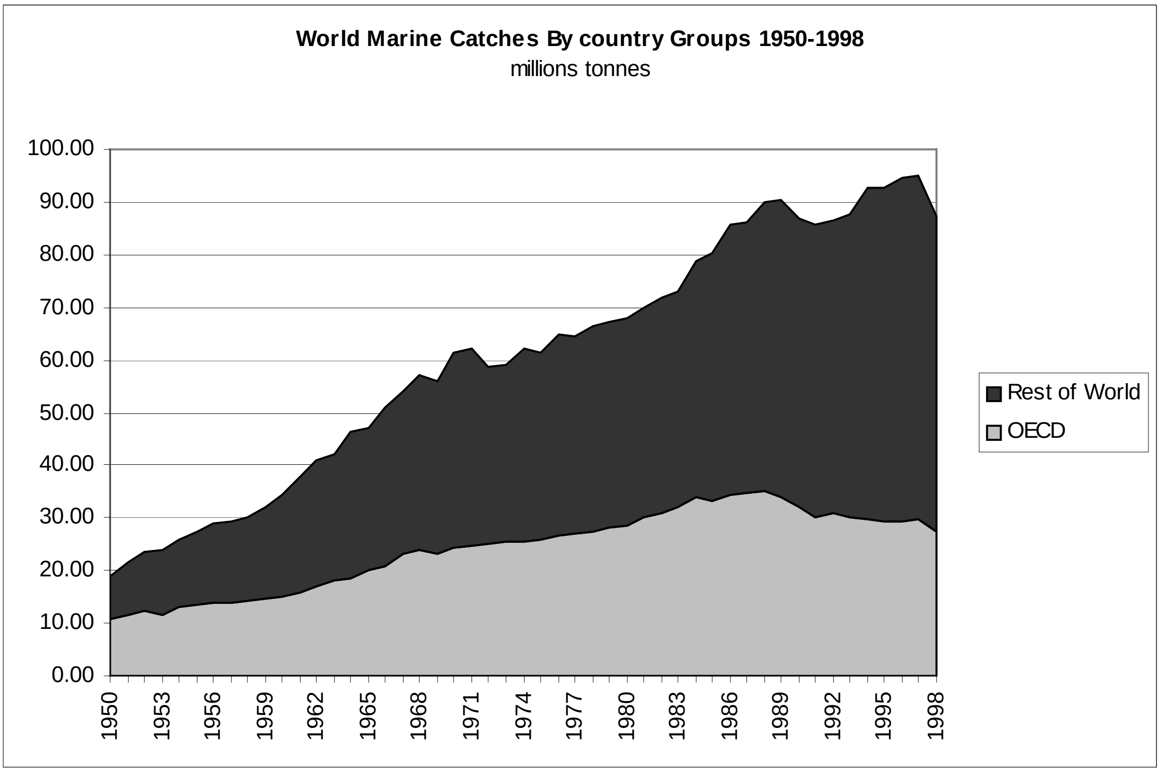
Average Annual Capture Fishery Harvests of
OECD Members and the Rest of the World, 1994-1998
(millions of tonnes)

OECD Members	Harvests			
Western Europe				
E.U.:				
Denmark	1.8			
Spain	1.1			
Other E.U. Members	4.0			
Total EU		6.9		
Norway		2.8		
Iceland		1.9		
Switzerland		<0.1		
Total Western Europe			11.6	
Non-EU, Central and Eastern Europe				
Turkey		0.5		
Poland		0.4		
Czech Republic		<0.1		
Hungary		<0.1		
Total Non-EU Central and Eastern Europe			0.9	
North America				
Canada		1.0		
United States		5.2		
Mexico		1.3		
Total North America			7.5	
East Asia				
Japan		6.1		
Republic of Korea		2.3		
Total East Asia			8.4	
Australasia				
Australia		0.2		
New Zealand		0.5		
Total Australasia			0.7	
Total OECD				**29.1**

Rest of the World	Harvests		
Russia	4.4		
China	14.3		
Chinese Taipei	1.1		
India	3.0		
Indonesia	3.6		
Chile	6.4		
Peru	8.5		
Other	22.1		
Total Rest of the World		63.4	
World Total			**92.5**
OECD as a percentage of World Total			**31.5**

Source: FAO, 2000b.

Figure 2



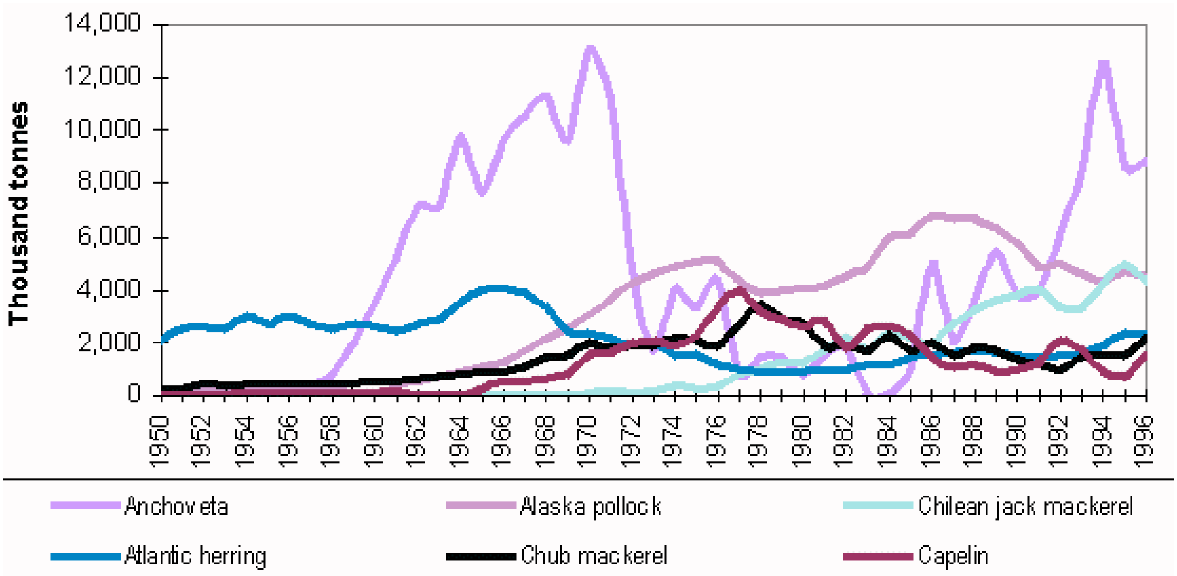
Source: OECD, 1997a; 2000b.

Next consider Figures 2 and 3 which show: (a) the harvests from marine capture fisheries of OECD and non-OECD countries (entities) from the 1950s to the late 1990s,[2] and (b) harvest trends in selected major marine capture fisheries, over much the same period.

There are apparently three immediate conclusions which one can draw from Figure 2. The first is that, over the four decades, 1950 to 1990, capture fisheries experienced an impressive rate of growth. It is indeed true that over the period the average annual rate of growth of harvests was approximately 4 per cent (FAO, 1999a; Garcia and Newton, 1997). The second is that there appears to have been some leveling off of capture fishery harvests after 1990. In fact between 1990 and 1998 (the latest year for which data are available), the average annual rate of growth was just slightly less than 1 per cent, while between 1994 and 1998, the growth rate was slightly negative (FAO, 2000b).

Figure 3

Trends in Catches of Selected Species, 1950-1996



Source: Grainger, 1999.

The third immediate conclusion is that the share of world capture fishery harvests accounted for by OECD countries has been declining inexorably. This is, in part, a reflection of two facts, namely: i) the OECD fishing nations are predominately developed; ii) there has, over the past four decades, been a shift in relative importance in capture fisheries, away from developed fishing nations in favour of developing ones (Garcia and Newton, 1997). The three leading nations involved in capture fisheries (based on the aforementioned five year average) are developing nations, as are six of the leading ten (FAO, 2000b).[3]

What Figure 2 does not reveal is that there is no assurance whatsoever that the levelling of capture fishery harvests is a temporary phenomenon. On the contrary, there is reason to believe that capture fishery harvests have approached, or are approaching an upper limit.

There are two central facts or conditions, pertaining to capture fisheries which must be recognized at the outset. The first is that the ocean and fresh water supply of nutrients supporting capture fish populations is finite. Consequently, there exists an upper limit, or bound, to capture fishery resources and a concomitant upper bound to sustainable capture fishery harvests (NRC, 1999).

Secondly, capture fishery resources have, throughout the world, proven to be notoriously difficult to manage in both biological and economic terms. The consequence of the ubiquitous difficulties in resource management is that many capture fishery resources have suffered from overexploitation and are producing well below their potential.

Both of these central facts have a direct bearing on the question of the outlook for capture fisheries production up to 2020 in the OECD, and the world at large. In the first instance, the prospects for growth in capture fisheries will depend upon how close the OECD regions, and the world, are to the ceiling imposed by nature.

Secondly, if the ceiling have been, or are being approached, there may still be some modest scope for growth of production by correcting the inadequate resource management of the past. Recall the observation that inadequate management has resulted in some fisheries not yielding their potential.

On the other hand, if the aforementioned ceilings have been approached, and if nothing is done to correct the resource management inadequacies of the past, then we may be confronted with an unpalatable prospect. The growth of capture fisheries production from 2000 to 2020 could prove to be negative.

In order, therefore, to assess the growth prospects of capture fishery production in the OECD, and the world, to 2020, it is necessary to examine first the extent to which the aforementioned ceilings have been approached, and the evidence of resource degradation due to overexploitation and due to pollution. It is then necessary to examine the causes of the capture fishery resource management problem and to consider alternative means of alleviating the problem.

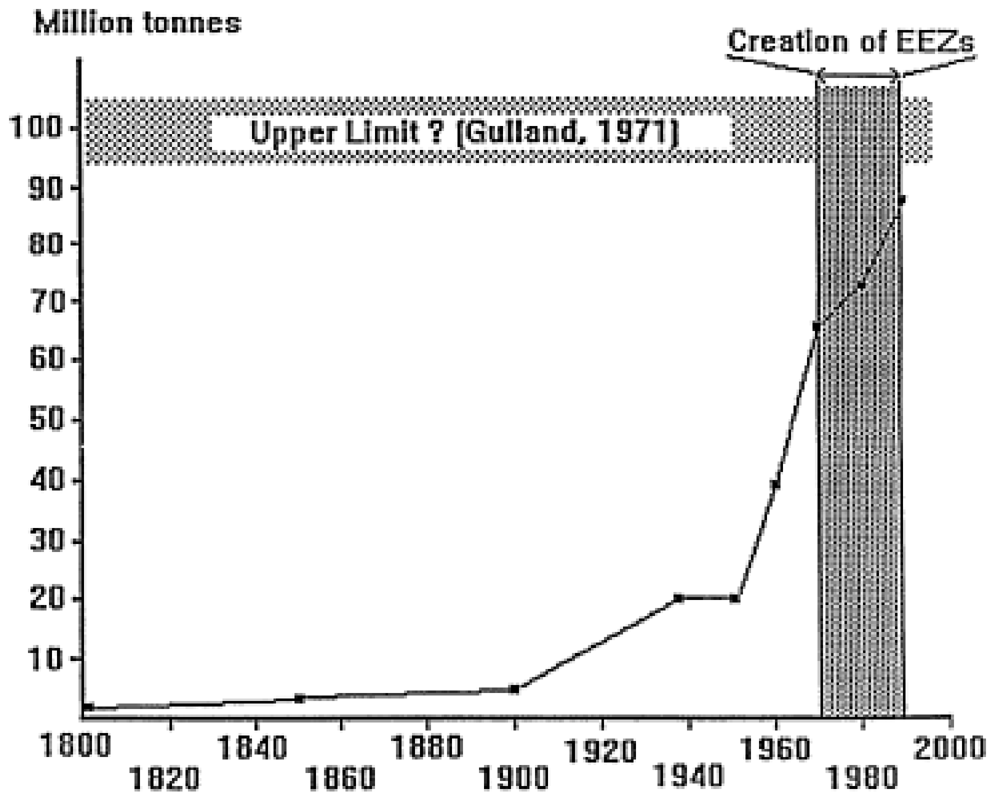
2.2 Natural Production Ceilings and Resource Degradation

In turning first to natural production limits and overexploitation, it is to be noted that several attempts have been made to estimate the upper bound to sustainable capture fishery harvests. The most authoritative, and widely cited, analysis of the state of marine capture fishery resources is that prepared by Serge Garcia and Christopher Newton (1997), both of whom were FAO officials, at the time of writing.[4] Their starting point is a 1971 FAO volume edited by the then prominent marine biologist, John Gulland (1971). In this volume, it is estimated that the theoretical maximum sustainable world harvests from marine capture fishery resources is 100 million tonnes per annum, with the practical maximum being in the order of 80 million tonnes (cited in Garcia and Newton, *ibid*.). Over the past several years, total marine capture fishery harvests have hovered around 85 million tonnes (FAO, 1999a), just above the Gulland "practical maximum."

Figure 4

Growth of World Harvest of Fish: Marine Fisheries

1800-1990



Source: Garcia and Newton (1997)

Figure 4, which is taken from the Garcia and Newton paper, places the growth of marine capture fishery harvests in a broad historical perspective.

The post 1950 rate of growth of capture fishery harvests was indeed spectacular by historical standards. Figure 4 implies that the level of marine capture fishery harvests is approaching the Gulland ceiling. In the text of the Garcia and Newton paper itself, the authors express the view that the total harvest potential of traditional species has probably been reached (Garcia and Newton, 1997). The FAO was subsequently to modify the Gulland upper bound to suggest that, with good management, the theoretical upper bound might be raised as high as 126 million tonnes (Garcia and Grainger, 1997). Nonetheless, the point remains.

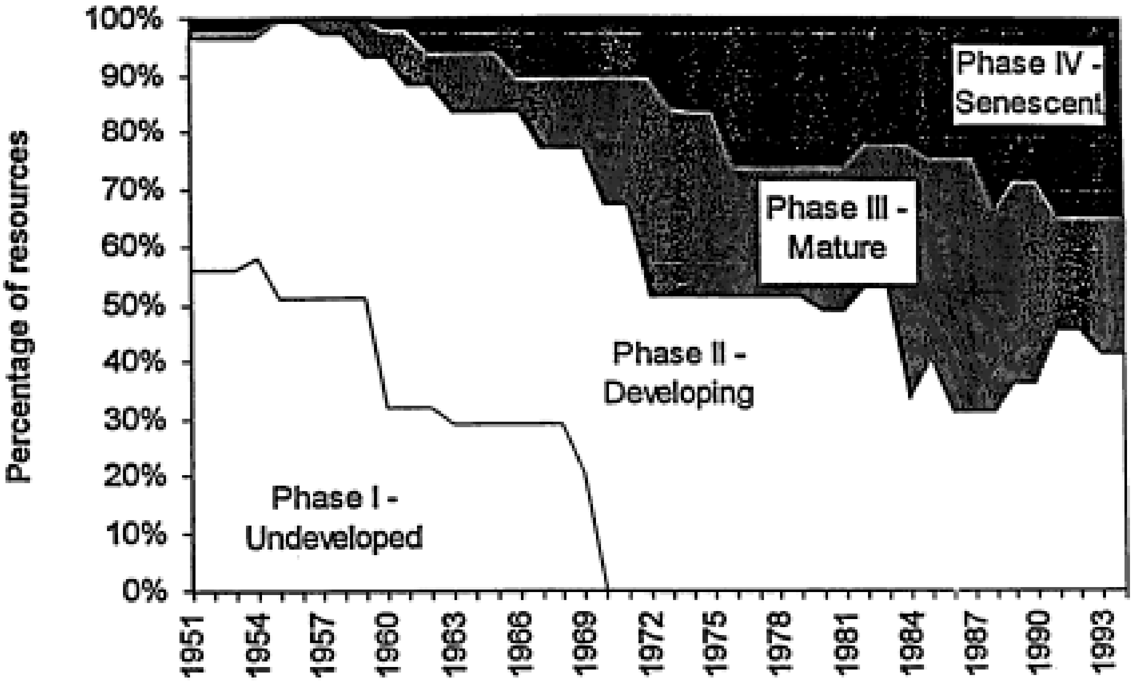
The growth of world capture fisheries towards the Gulland ceiling did not occur uniformly across the world's oceans. Rather the growth was sequential, a fact which helps to explain the relative decline in the collective importance of OECD members in capture fisheries.

If we return to Table 1 and note the relative contributions of OECD members to capture fishery harvests, it can be argued that ocean areas of prime importance to the OECD are the North Atlantic and the North Pacific.[5] According to Garcia and Grainger (1997), the expansion in world capture fisheries in the 1950s was focussed on the North Sea, while that of the 1960s was focussed on the remainder of the North Atlantic. The expansion of the 1980s, in turn, was focussed on the North Pacific (Garcia and Grainger, *ibid.*). Thus, on a sequential basis, the ocean areas of primary importance to the OECD were, over time, pushed steadily towards their productive upper limits (Garcia and Grainger, *ibid.*).

To return to the general overview of Garcia and Newton, the authors address, head on as it were, the issue of overexploitation. The authors categorize capture fishery resources as: I) underdeveloped; ii) developing; iii) mature; and iv) senescent. Mature fishery resources are defined as those which are being harvested at the maximum average long term yield. Senescent fishery resources are defined as those fishery resources, which have been exploited beyond that limit, and which could, from the biologist's perspective, at least, be regarded as unquestionably overexploited. Figure 5, based upon the Garcia and Newton analysis, depicts the evolution of world capture fisheries since 1950, in terms of these four categories.

Figure 5

Percentage of Major Marine Fish Resources in
Various Phases of Fishery Development



Source: FAO, 1997a

During the writing of the first draft of their paper, Garcia and Newton estimated that just under 70 per cent of the world's marine capture fishery resources fell into the mature plus senescent categories (Garcia and Newton, 1997). "Mature," they concede, does not mean "senescent," i.e. overexploited. They warn, however, that "mature" resources "are obvious (and likely) candidates for 'senescent' status in the near future … ." (Garcia and Newton, *ibid.*, p. 14).

The authors also stress that the "senescent" (and soon to be "senescent") categories do not represent a uniform cross section of species. On the contrary, these categories are crowded with high value species, such as several temperate zone demersal (i.e. groundfish, or whitefish) The Garcia and Newton position was subsequently strengthened by a , now widely cited, article appearing in *Science* in 1998 by Pauly, Christensen, Dalsgaard, Froese and Torres. The article, "Fishing Down Marine Food Webs" argues that there has been in capture fisheries a steady, almost inexorable, decline in the trophic levels being exploited. The authors warn that "continuation of present trends will lead to widespread fisheries collapses … (Pauly, Christenson, Dalsgaard, Froese and Torres, 1998, p. 863).

The evolution of capture fishery exploitation, as set forth by Garcia and Newton (1997) and by Pauly et al. (1998) is obviously far from a picture of sustainable resource exploitation. Rather it bears the hallmark of an economics textbook description of a mining operation, in which one commences with the exploitation of the highest grade ore, and as that becomes exhausted, moves on to successively lower grades of ore, until the day that the mining operation ceases to be profitable. Technological developments may postpone that day, but not indefinitely.

2.2.1 Natural Production Limits and Resource Overexploitation: An OECD Perspective

To this point the status, and future prospects, of capture fishery resources have been reviewed in broad, general terms. The FAO does, however, enable us to examine the status of world marine capture fishery resources on a sub-regional basis, at least up until the mid-1990s (FAO, 1997a). Table 2 lists the sub-regions of prime importance to OECD members, but lists as well other sub-regions, including those in which there are no OECD members (e.g. Eastern Indian Ocean). This is done in recognition of the fact that several OECD members have distant water fishing interests (e.g. France, Japan, Poland, Portugal, Republic of Korea, Spain, United States).

Table 2

Marine Capture Fishery Resources by Sub-Region

Sub-Region	Average Annual Harvest 1994-1998 (millions of tonnes)	Year Potential Sustainable Harvests Achieved	Status* of Sub-Regional Fish Stocks
Sub-Regions of Primary Importance to OECD Members			
Northeast Atlantic	11.3	1983	O
Northwest Atlantic	2.0	1971	O
Northeast Pacific	2.9	1990	O
Northwest Pacific	23.3	1998	I
Sub-Total	**39.5**		
Sub-Regions of Secondary Importance to OECD Members			
Mediterranean and Black Sea	1.6	?	F
East Central Atlantic	3.4	1984	O
Southeast Atlantic	1.2	1978	O
West Central Atlantic	1.8	1987	O
Southwest Atlantic	2.4	1997	I
East Central Pacific	1.6	1988	O
Southeast Pacific	15.5	2001	I
West Central Pacific	9.1	2003	I
Southwest Pacific	0.7	1991	O
East Indian Ocean	3.8	2037	I

West Indian Ocean	4.1	2051	I
Sub-Total	**45.2**		
Grand Total	**84.7**		

Source: FAO, 1997a; 2000b

* O – Overfished
F – Fully Fished
I – Increasing

Included in the table are:

i) the average annual harvest, 1994 -- 1998, by sub-region[6]

ii) the FAO's estimates of when each individual sub-region's potential was, or will be, achieved.

iii) the FAO's judgements on the current status of fish stocks in the individual sub-regions.

Of the four sub-regions which, in our judgement, are of prime importance to the OECD, three fall into the category of "overfished." The remaining region should, if the FAO estimates were correct (as of 1997) have already achieved its potential. The sub-regions are reviewed briefly.

The Northeast Atlantic (FAO Statistical Area 27) consists of the sub-region covered by the International Commission for the Exploration of the Seas (ICES). It ranges from the Arctic Ocean to the Straits of Gibraltar and extends west to the eastern part of Greenland. With a few exceptions, the fisheries of the region present an almost textbook example of overexploitation. The FAO observes that "most of the traditional fishery resources of the Northeast Atlantic are fully or overexploited, with several stocks in a depleted condition" (FAO, 1997a, p. 21). The FAO notes further that the economic consequences of the overexploitation is not adequately reflected by the level of harvests. The share of harvests made up of relatively high valued species, such as cod, herring, and haddock has steadily fallen, while the share accounted for by low valued species (e.g. sandeels and blue whiting) has steadily increased. FAO expresses particular concern about the state of fishery resources in EU waters (FAO, *ibid*.).

The Northwest Atlantic (FAO Statistical Area 21), which extends from western Greenland down to the Carolinas of the United States, encompasses the area that was governed by the International Commission for the Northwest Atlantic (ICNAF) (1949 -- 1976). While some valuable invertebrate fisheries have prospered (e.g. lobster), the status of many, if not most, of the demersal and pelagic fisheries is best described as depressing (FAO, *ibid.*). The sub-region has the distinction of being the site of a major resource management disaster, focussed on the Northern Cod resource off Labrador and Newfoundland (NRC, 1999).

The Northeast Pacific (FAO Statistical Area 67) ranges from the Bering Sea to Northern California. The species of primary commercial importance in the region are Alaska Pollock and Pacific Salmon. The FAO deems Alaska Pollock to be fully fished (FAO, *ibid*.). Pacific Salmon stocks have been weak off Washington, Oregon, and southern British Columbia, but strong off Alaska, partly due to climatic factors (Munro, McDorman and McKelvey, 1998). Nonetheless, the FAO gives the sub-region an overall O (overfished) rating (see Table 2).

The Northwest Pacific (FAO Statistical Area 61) ranges from China to the mid-Bering Sea. It does, as has been noted, encompass Japan and the Republic of Korea. In terms of tonnage of harvest, both actual and potential, it is obviously the dominant primary sub-region. While the FAO gives the sub-region an I (increasing) rating, it also expresses concern. The largest fishery in the sub-region, in volume terms, is the Alaska Pollock fishery. The FAO comments that "the overexploited state of this fishery [Alaska Pollock] is becoming more and more apparent …"

(FAO, 1997a, p. 77). Indeed, one is left with the impression from the FAO document that, if present trends continue unabated, the sub-region's rating will shift in fairly rapid succession from I to F (fully fished) to O.

The FAO analysis of the sub-regions of prime importance to the OECD is supported by Pauly et al. (1998). In both the Northeast *and* Northwest Pacific the mean trophic level of harvests peaked in the early 1970s and has declined steadily, and rapidly, since that time. The mean trophic level of harvests in the Northwest and Northeast Atlantic have declined steeply since the 1970s (Pauly, et al., 1998).

With regards to what we have deemed to be sub-regions of secondary importance to the OECD, we shall comment on only four: i) Mediterranean and Black Sea; ii) Southeast Pacific, iii) Western Indian Ocean, and iv) Eastern Indian Ocean. The Mediterranean and Black Sea sub-region is something of an anomaly. Given the intensity of fishing pressure in the Mediterranean and Black Sea, one would have expected that the sub-region would have been awarded a rating of O, rather than F. The explanation offered by the FAO lies in terms of nutrients flowing into the Mediterranean and Black Sea from the many rivers in the sub-region. The nutrients have served to sustain the fishery resources – positive pollution, if you will.

The Southeast Pacific (FAO Statistical Area 87) extends from Colombia to Chile. Historically, the fisheries have been dominated by small pelagics, the most prominent of which is Peruvian anchoveta. These resources are subject to violent fluctuations. The FAO showed considerable optimism about this area, after several years of steady increases in harvests up to 1994, and suggested that harvests could almost double. The FAO did, however, readily concede that its estimates were not particularly reliable. It is worth noting that the level of harvests in the sub-region has steadily declined since 1994 (FAO, 1999b).

The Western and Eastern Indian Ocean sub-regions combined (FAO Statistical Areas 51 and 57) constitute the one area where the FAO appears to see significant potential for long term growth in marine capture fishery harvests. The FAO estimates that the combined harvests could more than treble over time (FAO, 1997a, p. 8). The FAO agrees, however, that its estimates of both the potential harvests of the two sub-regions, and the times at which the potentials are likely to be achieved, must be regarded as unreliable (FAO, 1997a, Table A2.1).

2.2.2 Capture Fishery Resource Degradation and Pollution from Land-based and Offshore Sources.

According to GESAMP (1992), the open sea is still relatively clean but the coastal zone is under serious threat of pollution. Degradation of the marine environment can impact upon fisheries habitats and fish stocks, especially since many fish species spend part of their life cycle in the coastal zone. Impacts include changes in water quality, hydrological characteristics, nutrient concentrations, habitat availability and food supply. Establishing conclusively that an impact or change in fisheries stock is the result of pollution is extremely difficult, however (Parrett, 1998). Biological factors and variation in sex, age and reproductive characteristics as well as the mobility of fish species further complicate this (*op. cit*).

Land-based sources contribute about 70% of marine pollution, while maritime transport and marine dumping activities (such as disposal of dredgings) contribute 10% each (UN, 1992). Activities on land that are important sources of pollution in the coastal zone include urban settlements, construction of coastal infrastructure and discharges once in operation (e.g. from sewage treatment plants, stormwater runoff from roads), agro-chemicals run-off from farmland, tourism and industrial development (*op. cit*.). As the report goes on to note, many of the polluting substances originating from land-based sources exhibit simultaneously characteristics of toxicity, persistence, and bioaccumulation in the food chain.

Algal blooms and red tides also impact on fisheries potential. The principal causes appear to be increased nutrient loading of coastal waters (from the run-off of agricultural fertilizers) and high temperatures. Coastal waters in Japan, Sweden, and Denmark have been subject to these phenomena in recent years.

Shipping and sea-based activities also contribute to marine pollution. Approximately 500,000 tons of oil enter the oceans annually as a result of routine shipping operations, accidents, and illegal discharges. Offshore oil and gas exploration and production activities account for a very small proportion of marine pollution (UN, 1992).

In 1995, a Global Program of Action for the Protection of the Marine Environment from Land-Based Activities was adopted. The Program aims to facilitate action by states to prevent, reduce, control, and/or eliminate degradation of the marine environment, as well as to support its recovery from the impacts of land-based activities. Recommended approaches by source category of activity are set out in the Programme; these cover, *inter alia,* sewage, persistent organic pollutants, heavy metals, nutrients, and litter.

2.2.2.1 Hormonal Disrupting Chemicals

The potential threat to humans and wildlife of hormone disrupting chemicals in the environment is an emerging issue. In the case of marine life, for example, reproductive problems in Baltic and North Sea seals have been linked to high levels of industrial chemicals in their diets; effects of sex hormone disruption have been attributed to tributyltin (TBT) used in antifoulant paints on boats (WWF, 1997a). Concern has also been expressed about the effects of polyaromatic hydrocarbons (PAHs) resulting from combustion activities, particularly on egg production in fish (WWF, 1997b). PAHs can concentrate in the surface microlayer, with implications for biota that reside there. Eggs and larvae of fish and crustaceans, which are especially sensitive to the effects of pollution, may be at risk from multiple pollutants (e.g. copper, lead, organotins, and PAHs) that concentrate in the surface microlayer (*op cit.*). Localised inputs of PAHs to the marine environment can also be important in elevating the risk of exposure. In the North Sea, sources of PAHs include waterborne industrial effluents (especially from the metal and oil industries), discharges of oil from ships and emissions and flaring operations by the offshore oil and gas industry (in WWF's estimation, the UK contributes about 70% of the total 272 tonnes of PAHs released from offshore oil and gas operations in the North Sea) (WWF, 1997b).

The 1995 Ministerial Declaration on the Protection of the North Sea underlined the importance of hormone disrupting chemicals by inviting the Oslo and Paris Commissions and the European Commission to investigate and/or assess by the year 2000 the risk of substances suspected of having endocrine or hormone-like effects and to "adopt necessary measures" (WWF, 1997a). The Declaration also invited these two commissions to "take further action for a substantial reduction of the order of 50 per cent or more between 1985 and 2000 of the discharges, emissions and losses of PAHs of concern to the marine environment" (WWF, 1997b). In addition, Ministers reaffirmed their support for the precautionary principle, as set out in the 1992 Rio Declaration on Environment and Development. UNEP is presently facilitating negotiations on a convention to phase out persistent organic pollutants (POPs) including some endocrine disruptors (many endocrine disruptors are not POPs), to be concluded by the year 2000.

2.3 Overexploitation of Capture Fishery Stocks

The previous section confirmed that world capture fishery resources, not least in the sub-regions of primary importance to the OECD, have been subject to extensive overexploitation. Indeed, it has been seen that the *economic* consequences of overexploitation are in fact more severe than physical levels of harvest would suggest. The current list of overexploited capture fishery resources is heavily weighted in favour of high value species. Moreover, in this section, the point will be made that inadequate fisheries management can result in economic loss even if the resource managers succeed in preventing undue exploitation of the resources.

2.3.1 Fundamental Causes of Capture Fishery Resource Overexploitation and Degradation

To commence, capture fishery resources are difficult to manage on strict biological grounds. Most capture fish resources are mobile and are not readily visible prior to capture. Biologists' estimates of resource size, of the growth parameters of the fish, let alone interaction of fish with other species and the ecosystem at large, are subject to a high degree of uncertainty (NRC, 1999). The United Nations has formally acknowledged this fact in its call for the adoption of the Precautionary Approach to resource management (U.N., 1995, Articles 5 and 6).

The inescapable biological difficulties of resource management, however, are gravely aggravated by the "common pool" aspect of capture fisheries. It will be argued that the "common pool" aspect of capture fishery resources is central to resource overexploitation.

It will be further maintained that the problem arising from the "common pool" aspect of capture fisheries is compounded by the fact that there are, in many fisheries, captures of multiple species, giving rise to the issue "by catch and discards." It will also be seen that there is a further compounding of the problem due to the inescapable international nature of many capture fisheries, the nature of which will be considered under the heading of the international governance of fisheries.

Finally, it must be acknowledged that the discussion to follow will draw heavily upon the recent OECD publication: *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine resources* (OECD, 1997b).

2.3.1.1 The "Common Pool," or Open Access, Characteristic of Capture Fisheries

It is now standard practice for economists to regard fishery resources, along with other natural resources, as forms of "natural" capital, since the resources are capable of yielding a stream of economic benefits to society through time (OECD, 1997b). Since the resources are renewable, i.e. subject to growth, one can "invest," in a given resource by taking a harvest that is less than the natural growth of the resource.[7] "Disinvestment" in the resource results when the harvest taken exceeds the aforementioned natural growth.

Positive investment in "natural" capital, like positive investment in human made, or "conventional," capital involves a current sacrifice, or cost, which is undertaken in the hope of future gain. This is exemplified by the OECD Committee for Fisheries recently issued "Statement on the Study on the Transition to Responsible Fisheries," (OECD, 2000a). The Statement discusses the importance of restoring hitherto overexploited fishery resources. The Statement maintains that "... it is likely that costs will be incurred in the short run if the decision is made to restore fish stocks (OECD, 2000a, p. 3). While the Statement does not use the term "investment" explicitly, it is, in fact, discussing a program of positive investment in "natural" capital, designed to offset the excessive "disinvestment" in capture fishery resource "natural" capital, which occurred in the past.

Optimal economic management of a given capture fishery resource does, in the first instance, involve establishing a resource "investment/disinvestment" programme that will, given the appropriate social rate of discount, yield the maximum economic returns from the resource to society through time (OECD, 1997b). One must be concerned, not only with the investment goal, e.g. the extent to which a resource should be restored, but also with the nature of the investment program through time. For example, should one opt for a high, as opposed to low or intermediate, rate of investment? The highest rate of resource investment , (positive) can presumably be achieved by declaring an outright harvest moratorium. Such a high rate may come, however, at the cost of severe industry and community disruption.

Capture fishery resources are characterized in most cases, by being "common pool" resources, the property rights to which are ill-defined, or are simply non-existent. The mobility of fishery resources and their lack of visibility prior to capture, which makes the biological aspect of fishery resource management inherently difficult, have, in turn, made it difficult, in the past, to assign effectively property rights to these resources (Bjorndal and Munro, 1998). As economists have explicitly recognized since the mid-1950s (Gordon, 1954), the existence of the ill-defined property rights results in a system of incentives confronting the fishers which are perverse from society's point of view (NRC, 1999). If a fisher refrains from harvesting with the objective of "investing" in the resource, he/she is likely to do no more than increase his/her competitors' harvests. Thus, the rational fisher is given every incentive to discount very heavily any future returns from the resources. One can be assured that the rate at which the fishers will discount such future returns will far exceed any reasonable social rate of discount. Indeed, it can be argued that the rate at which the fishers will discount future returns, when the property rights to the resource are non-existent, will, in fact, approach infinity (Clark, 1990).

From an economic standpoint, "overexploitation" of a fishery resource can be deemed to occur whenever the resource, the "natural" capital, is reduced below the level which would assure the maximum economic benefits to society through time. In light of the fact that fishers have the incentive to discount heavily[8] future returns from the fishery, the following can be readily predicted. If a capture fishery is wholly unregulated and open to all – what we shall refer to hereafter as a Pure Open Access Fishery[9] – "excessive"[10] disinvestment in the "natural" capital, i.e. "overexploitation" of the resource, is all but guaranteed. One could also predict that, globally, there would be, as we have indicated, a tendency towards successive "mining" of the capture fishery resources, commencing with the most valuable.

Governments in many countries throughout the world have responded to the consequences of Pure Open Access by intervening in fisheries to control global harvests (e.g. by establishing season by season Total Allowable Catches) in order to conserve the resources. If the governments, as resource managers, do not at the same time exercise control over the size and nature of the fleet taking the allowed harvest, then, at a minimum, much, if not all, of the economic benefits derived from the fishery will be dissipated. Let this situation be referred to as: Regulated Open Access.[11]

In a Regulated Open Access fishery, the limited, season by season, harvest becomes the "common pool." Fishers then have the incentive to compete for shares of the harvest, which leads inevitably, in turn, to fleets well in excess of that required to capture the allowed harvests.[12] The consequences are straightforward: (i) dissipation of the economic benefits from the fishery; (ii) undermining of the power of the resource managers to control the harvests.

As the OECD (1997b) points out, the economic consequences of Regulated Open Access can easily extend beyond the harvesting sector into the post-harvest (processing and distribution) sector. A normal consequence of Regulated Open Access is that the fishing season becomes progressively shorter and shorter as harvesting capacity grows. Processing plants find themselves confronted with short periods of glut, followed by lengthy periods of famine, which does, in turn, lead to higher than necessary processing costs and possibly diminished quality of product (OECD, 1997b).

To this point, the focus has solely upon what are essentially supply conditions. Demand conditions, however, also feed into the system of perverse incentives, under pure, or regulated, open access. If there is an increase in demand for the output from a particular fishery leading to an increase in the price of harvested fish, then it is easy to demonstrate that the rise in price will lead to an intensification of the overexploitation of the resource under pure open access, and to an aggravation of the excess fleet capacity problem under regulated open access (Bjorndal and Munro, 1998).

In any event, it is difficult to dispute the statement made in the aforementioned OECD volume that:

> The open access nature [ill defined property rights] of marine fisheries is the fundamental cause of poor economic performance and … overexploitation[13]

It need only be added that the statement, which is directed towards marine capture fisheries, applies with equal force to inland capture fisheries.

2.3.1.2 Bycatch and Discards

In many, if not most capture fisheries, the target species intermingle with other species. The nature of the gear employed often ensures that non-target species are harvested – bycatch – as well as the targeted species. While some of the bycatch is kept, most is discarded.[14] The National Research Council (1999) estimates that marine discards may amount to 27 million tonnes per year, equal in turn to almost one-third of the total reported marine capture fishery harvests.

Since most discards are unreported, the consequence is to exacerbate the difficulty of managing the resources. The resource managers are left uncertain about the true levels of fishing mortality. Resource managers can easily overestimate the true size and health of the resource stocks, until it is too late (NRC, *ibid*.).

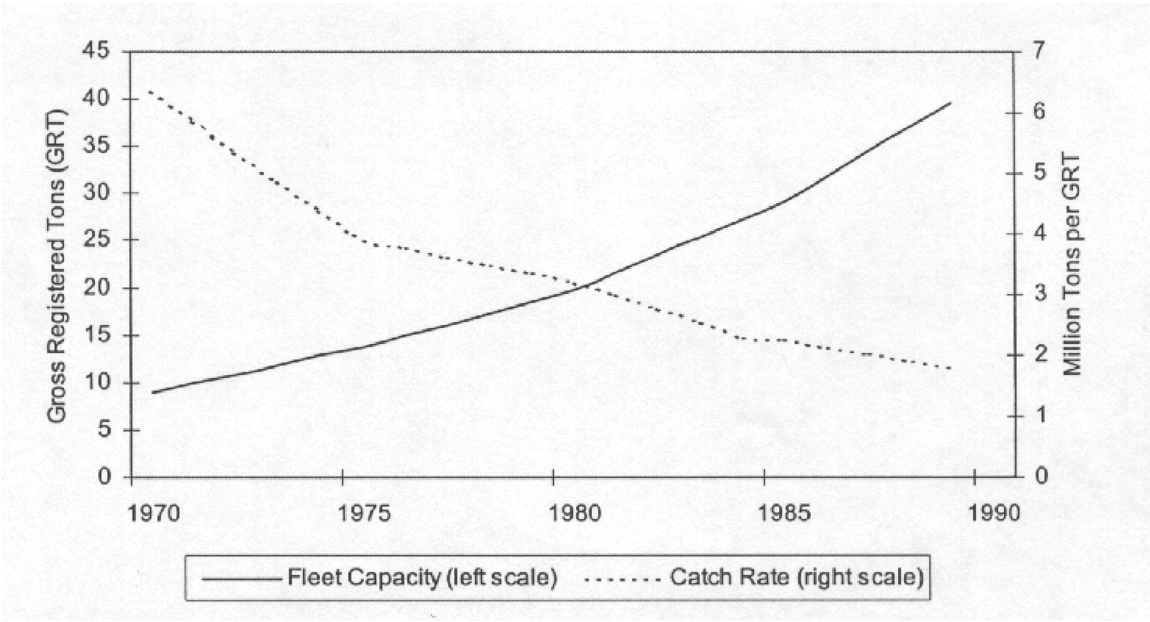
The relationship between bycatch/discards and the aforementioned "common pool" problem is straightforward. If the incentive structure is such that fishers care little about the future of targeted stocks, they will care even less about the future state of untargeted stocks.

2.3.1.3 The Impact of Excess Fleet Capacity and the Issue of Government Financial Transfers

In February 1999, the FAO Committee on Fisheries adopted "The International Plan of Action or the Management of Fishing Capacity" (FAO, 1999c). In the Introduction to the plan, it was stated that "… excessive fishing capacity is a problem that … contributes substantially to overfishing … and significant economic waste" (FAO, *ibid*.). An indication of the magnitude of the problem is provided by Figure 6 which shows the rapid growth in fleet tonnage accompanied by the equally rapid decline in catch rates.

Figure 6

Global Fleet Capacity and Catch Rate, 1970-1989



Source: McGinn, 1998

The question of the contribution of "excess" fleet capacity to the overexploitation of fishery resources cannot be fully addressed until the international aspects of capture fisheries are considered. We can, nonetheless, discuss in this section some important aspects of the questions. In so doing, we commence by digressing briefly to introduce some economic jargon now finding its way into FAO reports.[15] The jargon consist of two terms: "malleable" vessel capital, and "non-malleable" vessel capital. The term "malleable" capital refers to capital which can be quickly and easily removed from a particular activity, without risk of capital loss. The term is directly analogous to the concept of "liquid" assets in finance. "Non-malleable" capital is thus capital which cannot so be removed (see FAO, 1998a). With regards to a specific fishery, one would think of vessel capital used in the fishery as being "malleable" if the vessels can be easily and costlessly diverted to other fisheries. By way of contrast, if the vessels were highly fishery specific and had no value outside of the fishery, the capital embodied in the vessels would be decidedly non-malleable. It can be demonstrated that fleet overcapacity has no real economic meaning if the vessel capital is perfectly malleable (Gréboval and Munro, 1999).

Perfectly malleable fleet capital is very much the exception. Vessel capital, which may be highly malleable with respect to a single fishery, is still likely to exhibit some degree of non-malleability with respect to fisheries at large, i.e. the vessel capital may have very limited use outside of fisheries.

With the digression in hand, return first to the discussion of Regulated Open Access fisheries. Here the problem of excess capacity can be dealt with in a reasonably straightforward manner. The problem of excess capacity in this form has long been recognized by economists (OECD, 1997b).

To repeat our earlier discussion, under Regulated Open Access, the authorities regulate the global harvest in the fishery, with the objective of stabilizing the resource at a target *level*. The limited harvest then becomes the "common pool" and, if the fleet size is not effectively controlled, excess fleet capacity will emerge as fishers compete for shares of the limited harvest.

The FAO has now provided us with a measure of excess capacity which is directly applicable to the case described (FAO, 2000c). Let current, actual, fishing capacity be defined as "... the maximum amount of fish over a period of time (year, season) that can be produced by a fishing fleet if fully utilized, given biomass and age structure of the fish stock and the present technology" (FAO, 2000c, p. 6). Denote current fishing capacity by $Y_{c.}$ Define target capacity as "... the maximum amount of fish over a period of time (year, season) that can be produced by a fleet if fully utilized while satisfying fishery management objectives ... " (FAO, *ibid*.). Denote target capacity as $Y_{T\,.}$ The FAO then introduces the concept of *Relative Capacity*, which can be expressed as

$$\text{Relative Capacity} = \frac{Y_c}{Y_T}$$

If the ratio Y_c/Y_T exceeds 1, then excess capacity can be deemed to exist. Suppose, for example, that the annual TAC for a fishery is set at 10,000 tonnes, but that Y_c is estimated to equal 15,000 tonnes. Then, using this simple measure, excess fleet capacity would be deemed to exist[16] (FAO, *ibid*.).

When we turn to the case in which the exploitation of the resource is not effectively controlled, then the detection and recognition of excess fleet capacity becomes a much less certain and agreed upon matter. One does, in the first instance, have to avoid confusing symptoms with the cause of the disease. Consider the following.

It can be shown that, in many fisheries, the size of the fleet required to harvest the resource on a sustainable basis increases as the resource (biomass) diminishes (Clark, Clarke and Munro, 1979; Gréboval and Munro, 1999). Now suppose that a particular fishery is characterized by Pure Open Access and that the fishery achieves an equilibrium in the sense that it is unprofitable for the fleet to deplete the resource further, what economists term "Bionomic Equilibrium" (Gordon, 1954).

After Bionomic Equilibrium is achieved, resource managers intervene with the objective of subjecting this hitherto unregulated fishery to thoroughgoing management. The resource managers quickly conclude, that from their perspective, the resource has been grossly overexploited. A resource, or biomass, target level, substantially above the existing level, is established. Calculations are made of the size of fleet to harvest the resource on a sustainable basis at the target level. It is observed that the desired fleet is significantly smaller than the current fleet. The resource managers conclude – post hoc, ergo propter hoc – that the root cause of the resource "overexploitation" was excessive investment in fleet capacity. The root cause of the "overexploitation" was in fact the aforementioned perverse incentive structure, which arises under conditions of pure open access. The investment in fleet capacity was the inevitable consequence of the fishers responding to the perverse incentives.

Having said this, however, the following point must be made. The existence of meaningful fleet capacity (i.e., when the vessel capital is other than perfectly malleable) under conditions of unregulated open access does, in fact, add dimensions to the resource exploitation problem that have not been adequately captured in the standard economic models of the fishery (e.g. Clark and Munro, 1982).[17] The single most important dimension arises through what the FAO has come to refer to as the "spillover" effect (FAO, 1998a). A proper understanding of this further dimension will have to await the review, in the next section, of the evolution of the international governance of marine fisheries.

The question of excess fleet capacity often becomes linked with that of government financial transfers (GFTs) to the fishing sector. It has now been recognized that the level of fleet capacity, and indeed the level of fishing effort, has been magnified by world GFTs. There are numerous estimates. One of the more conservative, and well researched, estimates places the amount at U.S. $14-20 billion per annum (Milazzo, 1998). A recent OECD study estimates that the level of GFTs is in the order of U.S. $6 billion per annum for OECD countries (OECD, 2000b).

It has, however, been pointed out that a significant portion of the GFTs fall under the heading of expenditures on general services, e.g. fisheries research, enforcement (OECD, 2000b). It can be argued that the impact of these GFTs is neutral, or indeed even positive (OECD, *ibid*.; Flaaten and Wallis, 2000).

Furthermore, a substantial component of GFTs is used for explicitly for capacity reduction, i.e. decommissioning of vessels – "buybacks." *Prima facie*, these GFTs would obviously appear to be beneficial. Whether these GFTs, designed for capacity reduction, are in fact as beneficial as they would appear is a question which we shall address in the section on Approaches to Resource Management (2.3.2).

One final comment on GFTs and excess capacity is in order. A casual reading of the literature pertaining to subsidies in fisheries can lead one to come away with the impression that the *sole* cause of excess fleet capacity is to be found in GFTs. The impression is quite simply wrong. Given the existence of the aforementioned perverse incentive structure, excess fleet capacity would emerge, even if GFTs to the fisheries sector equalled zero.

We turn now to the evolution of the governance of marine fisheries.

2.3.1.4 The International Governance of Marine Fisheries and Resource Overexploitation

The governance of marine fisheries has been revolutionized by the United Nations Third Conference on the Law of the Sea, and the resultant United Nations Convention on the Law of the Sea (UN, 1982)[18] The Convention has been supplemented, or buttressed, by the Agreement arising from the subsequent United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, 1993 – 1995 (UN, 1995).[19]

Prior to the U.N. Third Conference on the Law of the Sea, it was unusual for a coastal state to have jurisdiction over its fishery resources out to as much as 12 miles from shore. Under the U.N. Convention on the Law of the Sea, coastal states were enabled to establish Exclusive Economic Zones, with outward boundaries 200 nautical miles from shore (UN, 1982). To all intents and purposes, individual coastal states were granted property rights to fishery resources encompassed by their EEZs (McRae and Munro, 1989).

The status of vast amounts of marine renewable resource wealth was thus changed from international common property to that of coastal state property. The economic rationale underlying the EEZ regime was clearly that of mitigating the “common pool” problem associated with marine capture fishery resources (Eckert, 1979).

The EEZ regime has had only limited success in mitigating the aforementioned “common pool” problem. Many coastal states have found the problem re-emerging within the EEZ, either because they could not vest property rights to the resources among individual fishers or companies and/or because the coastal states, as states, were unwilling, or unable, to exercise full property rights to the resources (FAO, 1992).

In addition, there have been two interconnected resource management problems, which emerged as the EEZ regime became established The first involves fishing capacity and the “spillover” effect.

In the discussion of fishing capacity, focus was placed on the concept of non-malleability of capital. If non-malleable vessel capital is removed from a particular fishery, one cannot assume that it will simply disappear. The distinct possibility exists that vessels will “spillover” into another fishery. Such a “spillover” is not necessarily damaging. If the recipient fisheries are ineffectively managed, however, the effect can indeed be damaging (Clark and Munro, 1999). In any event, the existence of “spillover” effect means that linkages exist between and among fisheries with the consequence that ineffective resource management in one fishery can have repercussions in other fisheries.

With the advent of the EEZ regime, many coastal states did, over time, reduce significantly, if not eliminate entirely, distant water fishing fleets from their newly established EEZs. The evicted distant water fishing fleets were then, more often than not, replaced by additions to the coastal states’ domestic fleets. It was not unknown for coastal state governments to subsidize the construction of the new additions to the coastal state fleets (Newton, 1999).

While some of the evicted distant water fishing vessels were scrapped, most were not. Many continue to operate up to the present time (Newton, 1999). Newton observes that, during the period 1980 to 1984 the industrial fleet (which Newton defines as being equal to, or greater than, 100 gross registered tons, or 24 metres in length) actually increased by 14 per cent.

The owners of the evicted distant water fishing vessels were faced with the options of laying up the vessels, scrapping them, or seeking out other fisheries in which to employ the vessels. Given the capital intensity of these vessels, and thus relatively large fixed costs, the first option was unattractive. The second option would have been preferable only if the scrap value exceeded the present value of the expected *operating* profits to be gained in exploiting other fisheries.[20]

The evidence provided by Newton (1999) makes it apparent that most of the vessel owners preferred the third option. The fact that these vessels were, by definition, mobile, enhanced the attractiveness of the third option. In any event, since coastal states were replacing evicted distant water fishing vessels within their own EEZs, and the bulk of the distant water fleet did not disappear, total world fleet capacity increased.

Thus, evicted distant water fishing vessels “spilled over” into other fisheries. In some instances, the vessel owners (or their governments) negotiated access to fisheries in other EEZs, with, or without, the aid of GFTs from their home governments (Newton, 1999). Importantly, the vessel owners turned their attention to fisheries in the remaining high seas, which had seemed unattractive in the pre-EEZ era. It is no coincidence that the FAO began to perceive “excess” fishing capacity as a major problem in the late 1980s (FAO, 1999c). Nor is it a coincidence that the high seas fisheries resources were by the mid, to late, 1980s, seen to be in a state of crisis. The crisis was to result in the convening, in 1992, of the U.N. Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, to which reference has already been made.

At the time of writing, the FAO has a major initiative underway directed at the problem of excess capacity.[21] Solutions to various aspects of the problem, e.g. the "spillover" effect, have yet to be determined.

The U.N. Conference, 1993 – 1995, points to a second, and interconnecting, resource management problem, which arose under the EEZ regime, namely that of transboundary fishery resources. While transboundary fishery resources had certainly existed before 1982, the resource management issue was greatly magnified by the EEZ regime.

Given the mobility of most capture fishery resources, it was inevitable that, when EEZs were established, coastal states would find that some of the fishery resources encompassed thereby would cross the EEZ boundary. It is now common to place such transboundary fishery resources in the two decidedly non-mutually exclusive categories: (a) resources which cross the EEZ boundary into the EEZ(s) of a neighbouring coastal state, or states, which are thus "shared;" and (b) resources which cross the EEZ boundary into the adjacent high seas. The latter are referred to as highly migratory fish stocks (tuna species to all intents and purposes) and "straddling" fish stocks.

The economics of the management of transboundary fishery resources of both categories, which draws upon the theory of games, demonstrates that, if the countries, or entities, jointly exploiting such a resource refuse, or are unable, to cooperate in the management of the resource, the results can be highly destructive, leading to results which are similar to those to be found in pure open access fisheries (Clark, 1980; Kaitala and Munro, 1997; OECD, 1997b).

The management of "shared" fishery resources, since 1982, has provided examples of both success and failure. The cooperative management of Barent Sea groundfish resources between Norway and the Soviet Union/Russia must be counted as a success (Armstrong and Flaaten, 1991). The co-management of Pacific salmon in the Northeast Pacific, by two OECD members, Canada and the United States, has had periods of success, but has also provided a dramatic example of the damaging consequences of a breakdown in cooperation (Munro, McDorman and McKelvey, 1998).

The cooperative management of "shared" fishery resources is difficult, but it is far less difficult than the management of the other class of transboundary fishery resources – straddling/highly migratory fish stocks. The state property rights to "shared" fishery resources are reasonably well defined (McRae and Munro, 1989). The property rights to the high seas portions of straddling/highly migratory fish stocks – which are exploited by both coastal states and distant water fishing nations – were exceedingly ill defined by the U.N. Convention on the Law of the Sea (Munro, 1999). Hence non-cooperative management of the resources was all but assured. The high seas enclave in the Bering Sea, the Donut Hole, and the high seas segments of the Grand Bank of Newfoundland provide two, of many, examples of the severe consequences of non-cooperative management of such resources (Munro, 1999).

At an earlier point, we referred to the interconnection of the two post EEZ regime fisheries management problems. It is here that the interconnection occurs. There is convincing evidence that displaced distant water fishing nation capacity did, inter alia, "spillover" into the high seas portions of straddling/highly migratory fisheries.[22]

In any event, the overexploitation of straddling/highly migratory fish stocks became so serious that the United Nations felt compelled to convene the aforementioned Conference of 1993 – 1995. The Agreement, arising from the Conference, called for the resources to be managed on a region by region basis through Regional Fisheries Management Organizations (RFMOs), which are to have distant water fishing nations, as well as coastal states, as members.

The Agreement has yet to come into force, so that it is far too early to predict whether the RFMO regime will prove to be successful. The Agreement can, however, claim at least one success to date, one which involves OECD members. Historically, one of the larger fishery resources of the North Atlantic has been the Norwegian Spring Spawning Herring stock.[23] In the late 1960s, the fishery provided a clear example of a pure open access fishery. The resource collapsed. In the early to mid-1990s, the resource revived and is now exploited by Norway, Russia, the Faroe Islands, Iceland, and the EU. Since the resource, when in a healthy state, migrates through a high seas enclave, the Ocean Loop, it is to be regarded as a "straddling," as well as "shared," stock. The five countries/entities exploiting the resource have used the U.N. Agreement as a framework within which they have established a cooperative management regime. To date, the regime has proved to be very successful, and could come to serve as a model for the management of straddling/highly migratory fish stocks throughout the world (Munro, 1999).

2.3.1.5 Impacts on International Trade

The concern about the state of marine capture fishery resources has begun to feed into international trade. It first appears as part of the general debate on environment and trade, namely over the issue of whether ineffective resource management justifies the implementation of trade barriers directly, or indirectly through so called eco-labelling (see, for example, Brander and Taylor, 1998; Tsamenyi and McIlgorm, 1999).

There is now being expressed the fear on the part of fishing nations, which pride themselves on good resource management, that their export markets may be adversely affected by resource mismanagement elsewhere. The implementation of fisheries trade barriers on environmental grounds could come to be used indiscriminately, thereby damaging those fish exporting nations whose fishery resource management is sound. One OECD fishing nation member, in which this fear has been expressed explicitly, is New Zealand (PECC, 1997). We return to trade issues at a later point (see: Section 5).

2.3.2 Approaches to Resource Management

The alarming state of world capture fishery resources has led to increasingly intensive discussions on optimal approaches to capture fishery resource management (NRC, 1999). Nonetheless, there are, at the time of writing, no universally accepted solutions to the resource management problems.

Consider first the inherent, and inescapable, biological uncertainty surrounding resource management, which can easily lead to management error. Outside of admonitions to resource managers to recognize uncertainty in their planning, the one significant proposal for addressing uncertainty is the establishment of large Marine Protected Areas (MPAs), in which fishing would be banned (NRC, 1999; Pauly et al., 1998). The MPAs, if large enough, it is argued, could serve as buffers against management error, arising from uncertainty and other factors.

In economic terms, the argument for maintaining such reserves is similar to the argument for risk averse holders of financial wealth maintaining a set of highly liquid, low yielding, assets in their financial portfolios (NRC, 1999; Lauck, Clark, Mangel and Munro, 1999). The *expected* yield, or return, on the portfolio will be reduced by maintaining this set of highly liquid assets, but the portfolio holders are compensated by enjoying a greater degree of safety. Thus, the portfolio holders are faced with an ongoing trade off between expected yield on the portfolio and safety. In the context of fisheries, the establishment of a large MPA in a fishery could well reduce the expected sustainable harvest through time,[24] but the MPA would at the same time provide protection against resource catastrophes (NRC, *ibid*.). Be that as it may, work on MPAs, and their applicability must be described as being at an exploratory stage.

With respect to the “common pool” problem, resulting in perverse incentives confronting fishers (and countries), the FAO has (e.g. FAO, 1998a), appropriately, come to place approaches to capture fishery resource management into two broad categories:

A. Incentive Blocking Approaches

B. Incentive Adjusting Approaches

Incentive blocking approaches are the obvious approaches to management. If fishers are responding to perverse incentives, then measures should be taken to prevent them from responding to those incentives. An example is provided by the setting of Total Allowable Catches (TACs), combined with programs to limit entry to specific fisheries, and vessel decommissioning schemes. While there is no question that these approaches have had some success in curbing resource overexploitation, the successes have been limited (NRC, 1999).

The success of these approaches in curbing the emergence of redundant capacity has been open to very serious question. In limited entry schemes, the resource managers have never been able to control all inputs. Fishers, naturally, substitute, where possible, uncontrolled for controlled inputs. The effectiveness of accompanying decommissioning schemes has also been questioned and is currently the focus of an intense debate (Gréboval and Munro, 1999). At this point, it is appropriate to return to the issue of GFTs to the fisheries sector.

It would seem to be obvious that GFTs designed to reduce harvesting capacity should be seen as being “positive” in nature, both in terms of resource conservation and in terms of elimination of economic waste (Milazzo, 1998, p. 65). Yet, if the underlying perverse incentives remain in place, the “positive” nature of these GFTs then becomes open to serious question, for at least two reasons. The first is that the GFTs may, in the long run, prove to be ineffective. Harvesting capacity, it is argued, will seep back into the fisheries. The number of fishing vessels may be reduced, but the catching power of the remaining vessels will be increased through co called “capital stuffing” (Holland, Gudmundsson and Gates, 1999; Holland, 1999).

The second reason is that, if decommissioning schemes and their accompanying GFTs should come to be anticipated by the industry, the anticipated GFTs will enhance the incentive to invest in fleet capacity It is easy to demonstrate that such anticipated GFTs will act as the equivalent of cost reducing GFTs, and thus will prove to be decidedly “negative” in character (Clark and Munro, 1999). The argument thus advanced is no more than an application of the concept of “rational expectations,” so prevalent in the field of macro-economics (e.g. Sargent, 1986).

The disappointment with the efficacy of incentive blocking approaches has led to increasing attention being given to incentive adjusting approaches. Under these approaches, attempts are made to change the incentive structure itself to make the incentives compatible with social goals. Such approaches would include taxes, community based fisheries management schemes, and individual harvest quotas (Gréboval and Munro, 1999; OECD, 1997b). The first, taxes, is the economist's classic prescription for altering incentives. This instrument appears to have been little used in developed fishing nations, for reasons having less to do with logic and efficacy, and more to do with political considerations. The latter two cn be seen as an attempt to create quasi-property rights to the limited harvest, although not to the resource itself.[25] It can be argued, nonetheless, that the two approaches are evolving in such a manner as to lead to property rights to the resource itself (Munro, Bingham, Pikitch, 1999).

One OECD member, Japan, has had a long experience with community based fisheries management schemes. They are to be found in the Netherlands as well (OECD, 1997). The use of individual harvest quotas, particularly in transferable form – ITQs – is becoming increasingly popular in developed countries, although it remains controversial. Two OECD members, Iceland and New Zealand, have extensive and highly developed ITQ schemes. ITQ schemes are also employed by other OECD members such as Australia, Canada, the Netherlands, Norway, and the United States (OECD, 1997b).

It must be conceded that community based fisheries management schemes appear to have limited applicability, and that ITQ schemes are nothing, if not controversial. Having made this concession, however, one must go on to point out that there are less elaborate incentive adjusting schemes which mimic, at least in part, one, or both, of the two aforementioned schemes. Thus, for example, the deleterious effects of excess fleet capacity in the Bering Sea-Aleutian Islands pollock fishery have been addressed by establishing harvester cooperatives (Pollock Conservation Cooperative and High Seas Catchers' Cooperative, 2000). A second example is provided by an even simpler pooling arrangement among vessels operating in the British Columbia roe herring fishery (Clark and Munro, 1999).

While the Incentive Adjusting approaches to resource management hold promise, issues pertaining to the extent of their applicability are far from being resolved at the time of writing. For example, the FAO, in cooperation with the Government of Western Australia, held a major conference on the use of property rights in fisheries – Fish Rights 99 – in November, 1999.[26] While some selected papers are available, the proceedings of the Conference are not.

It is also worth noting that the question of the impact of incentive adjusting approaches on fleet capacity remains an unresolved issue calling for extensive further research and investigation. To take but one example, the incentive adjustment approaches, unless applied universally (a truly utopian prospect), do not resolve the "spillover" effect, discussed previously.

2.4 Projections of Future Capture Fishery Harvests Up to 2020

We must now attempt to draw together the discussion of the preceding two sub-sections. The fundamental fact of life which must be faced in capture fisheries production is that nature imposes an upper bound upon sustainable harvests. Future growth in harvests will obviously be possible in particular fisheries or regions, if the upper bounds have not yet been approached. These fisheries would fall into Garcia and Newton (1997) categories of Underdeveloped or Developing.

If the upper bound has been approached, some future growth in harvests is possible, if the fisheries' potential had in the past been partially dissipated through ineffective management. This is what might be termed growth through correcting one's past resource management errors. Such fisheries would fall in the Garcia and Newton category of Senescent.

The review of the state of the world capture fishery resources clearly indicate that the regions of primary importance to the OECD, the North Atlantic and North Pacific, contain fisheries that are largely in the Garcia and Newton Mature and Senescent categories. The upper bound has indeed been approached. There is clear evidence of overexploitation in many of these fisheries, hence there is some modest scope for growth through "correcting one's past errors." At the same time, however, the harvest growth potential offered through resource management is a two edged sword. If resource management continues to be inadequate, the aforementioned growth could be negative.

The review of the fundamental causes of overexploitation and fleet overcapacity, and management approaches to addressing the causes, indicates that while progress has been made in resource management, a great deal remains to be done. There are no universally accepted approaches to resource management; several major issues remain unresolved. A example is provided by the key issue of fleet overcapitalization. The FAO, as has been noted, has underway a major initiative concerning this issue. Recently, the FAO convened a Technical Consultation on the Measurement of Fishing Capacity (FAO, 2000).[27] Measurement of capacity, while obviously important, is only the beginning. The all important question of the *management* (and reduction) of fishing capacity awaits some future technical consultation.

In 1997 the FAO published projections of total capture fishery production for the world at large out to 2010. Under its optimistic scenario, it projected an average annual rate of growth of 0.96 per cent per annum up to that time. It was assumed that most of this growth would come from improved management (FAO, 1998).

The average annual production of OECD capture fisheries, 1994–1998, was estimated to be 29.1 million tonnes. If the OECD harvest grew at the aforementioned rate of 0.96 per cent per annum out to 2020, total OECD harvests would be rougly in the order of 35–37 million tonnes. This could be viewed as a *highly* optimistic projection. First, the FAO projection out to 2010 includes fisheries having truly unutilized potential, which the primary OECD regions most assuredly do not have. Secondly, if the OECD were to experience steady, unbroken progress in improved resource management, the growth in harvests through improved management would be temporary and could well be exhausted before 2020.

A much more probable projection is that total capture fishery production for the OECD would be largely the same as it was at the end of the 1990s. Even this "probable" estimate assumes significant improvement in resource management.

Table 3

OECD Capture Fishery Productions to 2020

(millions of tonnes)

Actual: 1994–1998 Annual Average*	Projections to 2020	
	Highly Optimistic	Probable
29.1	37	30

*Source: FAO 2000b.

With regards to the world at large, total capture fisheries production has, in the past been in the order of 90+ million tonnes (see: Table 1). The FAO projected that under its optimistic scenario world output would grow to 105 million tonnes by 2010. Under its pessimistic scenario it projected a fall in output to 80 million tonnes (FAO, 1998).

Projections beyond 2010 made by those outside of the FAO would have to be labelled as wild guesses. Be that as it may, if total harvests were to continue to grow at the same rate between 2020 and 2020 (0.96 per cent per annum), as they were projected to grow up to 2010 under the FAO's optimistic scenario they would achieve approximately 115 million tonnes by 2020. This we would regard as only slightly less highly optimistic than our comparable projection for the OECD. A projection of 105 million tonnes to 2020 could be characterized as a moderately optimistic "wild guess."

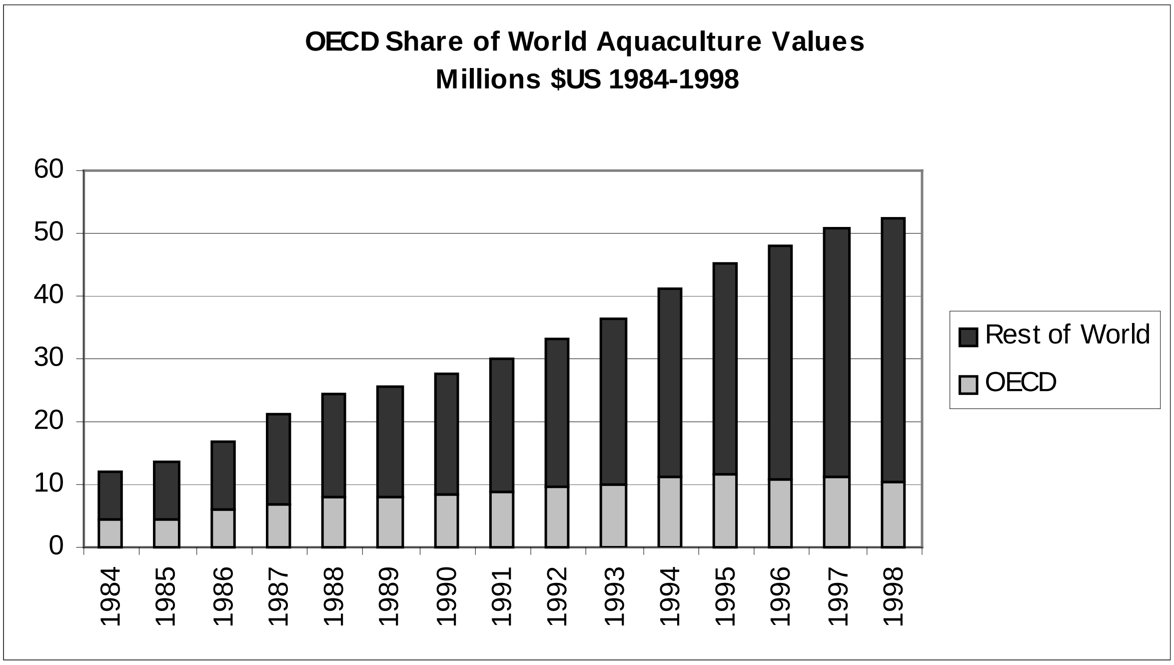
3. The Aquaculture Sub-Sector

3.1 Levels of Production and Past Rates of Growth

As was observed in the introduction, the aquaculture sub-sector is currently the junior partner of the capture fisheries sub-sector in terms of total production. In 1998, according to the FAO, aquaculture accounted for approximately 28 per cent of the total world production of fish (FAO, 2000b). On the other hand, there appears to be widespread agreement that future expansion in world production of fish rests primarily with aquaculture. The FAO states categorically that most of the future increase in fish production for human consumption will come from aquaculture (FAO, 1999d).

Aquaculture production, in contrast to that of capture fisheries, has enjoyed, over the past decade and a half, a very rapid rate of growth. Obviously the rate of growth may reflect aquaculture's modest position in the past. In any event, between 1984 and 1998, the average annual rate of growth of aquaculture was 11.2 per cent in value terms, and 10.2 per cent in volume terms (FAO, 2000b). Modest beginnings or not, the FAO maintains that aquaculture is one of the most rapidly growing food production activities in the world (FAO, 1997b). Consider Figure 7.

Figure 7



Source: FAO, 2000b

The rapid rate of growth of aquaculture production can be ascribed in part to the fact that aquaculture does not face the natural constraints affecting capture fishery production, although a significant qualification will have to be introduced at a later point. Secondly, aquaculture production, almost by definition, does not face the resource management problems confronting capture fisheries, which arise from ill defined property rights. The basic incentives confronting aquaculture producers are sound, although once again qualifications will have to be introduced.

As an example of “sound” incentives, the producers have incentives, common in other private industries in which property rights are clearly stated and enforced, to improve productivity. A case in point is provided by Norway, the most important non-Asian OECD aquaculture producer. Norwegian aquaculture production is focussed on Atlantic salmon. Over the period 1985 – 1997, average cost of production, in real terms, of Norwegian salmon aquaculture production fell by almost two-thirds (Bjorndal and Tveteraas, 1999).

We next observe that, although over 250 cultured species or species groups are reported to the FAO (FAO, 1997c), the leading 10 species (including aquatic plants) account for over 50 per cent of the production in value terms. The current narrow base of aquaculture has implications for future growth. The leading 10 species (species groups) are as follows:

Table 4

Average Annual Production of the Ten Leading Aquaculture Species: 1994–1998

($ millions)

Species	Value of Production Average 1993–1997	Value of Production as Percentage of Value of Total Aquaculture Production
Giant Tiger Prawn	3,988.9	8.13
Pacific Cupped Oyster	3,167.0	6.46
Kelp	2,805.3	5.72
Silver Carp	2,687.4	5.48
Common Carp	2,485.6	5.07
Grass Carp	2,181.0	4.45
Atlantic Salmon	1,920.2	3.92
Yesso Scallop	1,528.1	3.12
Japanese Carpet Shell	1,600.9	3.26
Laver	1,305.2	2.66
Total	23,670.0.0	48.27

Source: FAO, 2000b.

Within the group of 10, one notices the predominance of carp. Aquaculture, in turn, accounts for approximately 90 per cent of the world's supply of carp (FAO, 1999a).

Consider now Table 5, which shows the aquaculture production of OECD countries (in value terms), along with that of major non-OECD producers.

Table 5

Average Annual Aquaculture Production of
OECD Members and the rest of the World 1994 – 1998
(millions of U.S. Dollars)

OECD Members	**Production**		
Western Europe			
EU:			
France	631.1		
Italy	420.4		
United Kingdom	356.2		
Spain	247.3		
Other EU members	758.8		
Total EU		2,413.8	
Norway		1,010.7	
Iceland		14.9	
Switzerland		13.1	
Total Western Europe			3,452.5
Non-EU, Central and Eastern Europe			
Turkey		182.7	
Czech Republic		48.6	
Poland		60.0	
Hungary		17.7	
Total Non-EU Central and Eastern Europe			309.0
North America			
United States		743.8	
Canada		284.4	
Mexico		102.8	
Total North America			1,131.0

East Asia				
Japan	5,050.6			
Republic of Korea	981.2			
Total East Asia		6,031.8		
Australasia				
Australia	150.7			
New Zealand	48.4			
Total Australasia		199.1		
Total OECD			**11,123.4**	
Rest of the World				
Bangladesh		1,192.2		
China		20,986.7		
Chinese Taipei		1,119.0		
India		2,134.5		
Indonesia		2,035.3		
Philippines		1,098.0		
Thailand		1,867.6		
Others		5,960.5		
Total Rest of the World			**36,393.8**	
World Total				**47,517.2**
OECD as a Percentage of World Total				**23.4**

Source: FAO, 2000b

The single most striking feature of Table 5 is the predominant position of China, which, over the period in question, accounted for approximately 44 per cent of total world production in value terms. Its output was almost 90 per cent greater than that of the entire OECD. Within the OECD itself, the predominance of Japan is obvious. Indeed, it is the only OECD country to exceed the output of the five leading non-OECD countries, excluding China.

Table 5 and Figure 7 combined indicate that, as in capture fisheries, the OECD's relative position within aquaculture has steadily declined. The developing countries are now predominate in aquaculture (FAO, 1999a). Having said this, however, one must also note that, over the period 1984–1998, OECD aquaculture production (in value terms) grew at a respectable average annual rate of growth of 7.7 per cent.

The concentration of aquaculture production in a narrow range of species is even more marked within the OECD than it is within the world at large. This fact is illustrated in Table 6, which shows output of the five major species as a percentage of total aquaculture output (in value terms) for each of the 10 leading OECD aquaculture producers. The 10 leading producers account for just slightly less than 90 per cent of total OECD output. They are listed in the table in order of importance.

Table 6

Value of Production of Five Major Species

as A Percentage of Total Country Aquaculture Production:

Ten Leading Aquaculture Producers of the OECD

Country	Species	Value of Production by Species as a Percentage of Total Country Aquaculture Production (1994–1998 Average)
Japan	Amberjack	23.8
	Laver	20.5
	Seabream	13.4
	River Eels (n.e.i.)	8.9
	Pacific Cupped Oyster	7.1
	Total 5 species	**73.7**
Republic of Korea	Laver	22.4
	Bastard Halibut	17.6
	Pacific Cupped Oyster	12.9
	Inflated Ark	10.0
	Wakame	4.6
	Total 5 Species	**67.5**
Norway	Atlantic Salmon	91.7
	Rainbow Trout	7.9
	Finfishes n.i.e.	0.1
	Atlantic Cod	0.1
	Chars (n.e.i.)	0.1
	Total 5 Species	**99.9**
U.S.A.	Catfish	49.0
	Golden Shiner	9.1
	Atlantic Salmon	8.9
	Rainbow Trout	7.5
	American Cupped Oyster	5.7
	Total 5 Species	**80.2**
France	Pacific Cupped Oyster	43.5
	Rainbow Trout	23.6
	Blue Mussel	11.3
	European Seabass	3.6
	Mediterranean Mussel	2.5
	Total 5 Species	**84.5**

Italy	Rainbow Trout Carpet Shells n.i.e. Mediterranean Mussel European Seabass European Eels **Total 5 Species**	26.5 26.4 16.0 8.6 7.5 **85.0**
U.K.	Atlantic Salmon Rainbow Trout Blue Mussel Sea Trout Pacific Cupped Oyster **Total 5 Species**	75.4 18.6 3.7 1.0 0.6 **99.3**
Spain	Blue Mussel Rainbow Trout Grooved Carpet Shell Gilthead Seabream Pullet Carpet Shell **Total 5 Species**	25.6 21.8 10.9 10.1 7.7 **76.1**
Turkey	Trouts n.e.i Seabream Seabasses n.e.i Mediterranean Mussel Atlantic Salmon **Total 5 Species**	41.0 30.1 25.2 2.6 1.0 **99.9**
Canada	Atlantic Salmon Chinook Rainbow Trout Coho Blue Mussel **Total 5 Species**	68.4 14.0 7.1 3.8 2.6 **95.9**

Source: FAO, 2000b

3.2 Issues and Problems Confronting Aquaculture

Aquaculture, as has now been repeatedly emphasized, has experienced an extraordinarily high rate of growth. Future high rates of growth are not assured, however. Several constraints and issues will have to be addressed if even a moderately high rate of growth is to be maintained. These constraints and issues are examined in detail in a recent article by Michael New, formerly with the FAO (New, 1999). They are:

A) Reduction of the reliance of aquaculture on marine capture fisheries

Several forms of aquaculture, e.g. raising of Atlantic salmon, rely heavily on fish meal and fish oil produced by capture fisheries. It is estimated that, by 2010, aquaculture will account for the consumption of 25 per cent of total fish meal and 80 per cent of total fish oil produced (New, 1999; Naylor et al., 2000). The implication is that the constraints confronting the capture fishing industry could impinge upon the aquaculture industry. If the constraint becomes binding, it will be reflected in steadily increasing prices for fish meal and oil, which could, for obvious reasons, curb the growth of the aforementioned forms of aquaculture. On the other hand, the rising prices will, of course, intensify the incentive to develop alternative sources of feed.

B) Pollution and the development of new production technologies

Aquaculture (not unlike agriculture) has been subject to attack on the grounds that it is a major source of pollution, and that in particular, it results in degradation of coastal zone areas (e.g. destruction of mangroves). It is also argued that aquaculture leads to the spread of disease to wild stocks of fish. The consequence for the aquaculture industry, if it does not successfully address these charges, is that its growth will be curbed by increasing sets of regulations.

The solution to the problem, argues New, lies through technological research. He cites two examples: aquaculture in recirculation systems and the development of offshore sites for aquaculture (New, *ibid*).

C)The use of genetically modified organisms and introduced species

New points out that aquaculture has done far less than agriculture to use genetics to increase growth rates, enhance resistance to disease, and create new products, although he does admit that the situation is changing rapidly (New, *ibid*.). He also acknowledges, however, that agriculture has been subject to serious attack over genetically modified plants and animals (New, *ibid*.).

D) Diversification into new species

The discussion to this point has emphasized the narrow species base of current aquaculture. The OECD provides some striking cases in point, as is evidenced by Table 6. Thus, for example, it is seen that 95 to 100 per cent of the aquaculture production of Norway, the U.K. and Canada is accounted for by salmonids. An obvious means of enhancing aquaculture growth is through the development of new aquaculture species. Research is proceeding and has produced some encouraging results (New, *ibid*.). New, however, raises serious questions about the wisdom of developing new species. He maintains that, as in the raising of terrestrial livestock, it may make more sense to concentrate research on a few species, thereby improving their growth, survival, and feed efficiency (New, *ibid*.).

3.3 Growth Projections to 2020

As before, one is almost wholly reliant upon the FAO, or near FAO (e.g., Michael New), sources for growth projections. Several difficulties immediately arise. First, FAO projections are confined entirely to quantities, rather than values. Examining the world aquaculture in quantity terms seriously understates the OECD's contribution, because of the predominance of higher valued species in the OECD production, as compared with, say, China. This affects not only the reported level of production but also the rate of growth of production. OECD's average annual rate of growth of aquaculture production, in quantity terms, over the period 1984 to 1998, was a modest 3.2 per cent, in contrast with an average annual rate of growth of over 7 per cent in value terms (FAO, 2000b). The rate of growth of world aquaculture production in quantity terms over the period, it will be recalled, was in excess of 10 per cent per annum.

Secondly, world aquaculture production statistics are inevitably skewed by China, which New (1999) argues should probably be placed in a category by itself. Thirdly, several of the FAO projections are production targets, rather than true projections. Presumably, however, the production targets are tempered with realism.

One additional point needs to be made. An increasingly significant proportion of total world aquaculture production is accounted for by plants. On the basis of the most recent data available, one is forced to conclude that the fraction of the OECD's aquaculture production accounted for by plants is trivial (less than one per cent in either quantity or value terms) (FAO, 2000b). Consequently, attention has to be focussed on the FAO's growth projections pertaining to aquaculture excluding plant production.

In 1997, the FAO published a set of projected world aquaculture production growth figures (quantities) out to 2010, with a highly speculative projection out to 2050 (FAO, 1997c). Michael New subsequently criticized the growth projections, which varied from 2.4 per cent per annum for the very long term to just under 4 per cent per annum to just under 6 per cent for the short term, as being too conservative for the near future, and too optimistic for the long term (New, 1999). Be that as it may, we have no superior alternatives.

Taking all of the aforementioned factors into account, we put forward the following projections. They are to be seen as no more than educated guesses. For this fact, we offer no apologies.

Table 7

OECD Aquaculture Output in Quantity Terms: 2020

Actual Level of Production Average: 1994-1998* (millions of tonnes)	Expected Average Annual Rate of Growth	Anticipated Level of Output: 2020 (millions of tonnes)
4.7	Conservative – 2 per cent	7
	Optimistic – 3.5 per cent	10

*Source: FAO, 2000b

For the world at large, one would expect a much more rapid rate of growth of aquaculture, giving the growing dominance of developing country producers, China in particular. The FAO projections up to 2010 (which New criticized as somewhat conservative) adopted an assumed rate of growth of aquaculture production, with and without, plant production, of approximately 5 per cent per annum (FAO, 1997c). Let us therefore adopt as our very optimistic assumption that world aquaculture production would have an average annual rate of growth from 1995 to 2020 of 5 per cent per annum; and adopt as our conservative assumption that the average annual rate of growth over that period will be a much more modest 3 per cent. Our "educated" guesses for aquaculture production would look as follows:

Table 8

Projections of World Aquaculture Production to 2020

(millions of tonnes)

Class of Aquaculture Production	Current Production (Average 1994-1998)*	Anticipated Level of Production – 3 per cent annual rate of growth	Anticipated Level of Production – 5 per cent annual rate of growth
Plants Excluded	26.4	54	85
Plants Included	33.7	68	109

*Source: FAO, 2000b

The wide range of estimates reflects the high degree of uncertainty.[28] A reading of the New article (New, 1999), suggests that he would criticize the lower estimates as too conservative, and would argue that the constraints to development which he discussed (e.g., dependence upon capture fisheries for feed supplies) could well become binding, well before the very optimistic projections were achieved.

A final comment about Table 7 is in order. We have no sound basis for estimating the growth of OECD aquaculture production in value terms. This will depend, inter alia, upon the mix of new species appearing. One can hazard the guess – and it is no more than that – that the growth in value terms would be 3+ per cent per annum.

We now address three issues which are relevant to both the capture fisheries and aquaculture sub-sectors: The Post Harvest Segment; Trade in Fish and Fish Products and Demand Considerations.

4. The Post Harvest Segment of the Industry

The post-harvest sector is defined as "those activities and structures that transform and distribute harvested fish from the harvester to the consumer" (OECD, 1998, p. 4). It begins the moment the fish is killed and includes the chain linking harvesters, processors, distributors, retailers and consumers.

Several trends can be discerned concerning the post-harvest sector. First, although data is scarce, the contribution of the sector in terms of turnover, value added and jobs appears to be of growing importance. Data from the US, for example, indicates that the value added of commercial marine fishery products totalled US$21 billion in 1996 (OECD, 1999). Of this total, almost US$18.6 billion (90%) was created in the post-harvesting sector, i.e. processing and retailing (op. cit.). In the UK, total sales in 1995 by primary and secondary processors totalled £1.5 billion based on a raw material supply worth £738 million, creating a value added of about £762 million (op. cit.).

Second, falling transport costs have encouraged the relocation of processing industries seeking cheap labour (Le Sann, 1998). This can have both social and economic implications. In rural communities, fish processing and canning plants can account for a large share of local employment opportunities. Some regions within a country also derive considerable direct and indirect revenue from the presence of fish processing facilities.

Third, production, processing and marketing of fish and fish products is increasingly dominated by multinational corporations (Le Sann, 1998), with some vertical integration within the industry evident. Unilever, Kraft Foods and Nestlé have large stakes in the fishing industry; Starkist, a large US tuna fishing company, controls a significant share of global tuna production capacity; the Spanish fishing company Pescanova is one of the five largest in the world in its industry, accounting for half the market share of frozen seafood in Spain, handling 20 per cent of global hake production and owning a fleet of more than 140 boats (mostly freezer trawlers), seven factories and 25,000 retail outlets (op. cit.). Le Sann notes that Pescanova plays an important role in several developing country economies (e.g. Mozambique and Namibia), where it has established local production facilities. In Namibia, for example, the company has built a hake filleting factory with a 21,000 tonne capacity; 90 per cent of this factory's total production is exported to Spain.

To better understand how the benefits derived from the post-harvest utilisation of fish might be maximised, the OECD Fisheries Committee launched a study on the implications of responsible post-harvesting practices on responsible fishing (see OECD, 1998 and 1999).

The following draws heavily upon the results of the study to date. Reciprocities between the harvest and the post-harvest sectors can be important. For example, some retailers now demand the supply of fish sizes that fit portion-sized packaging requirements. For some fish species, this has meant that the sale of smaller sized immature fish fetch higher prices than fish sizes that would require cutting. The influence of this demand-side practice on the landings by fishers has implications for addressing the by-catch problem. Another example is consumer demand, as reflected in willingness to pay, for fish that has not been caught from over-fished stocks or caught in an environmentally safe manner. Conversely, a poorly performing harvest sector will result in reduced supply of fish available to the post-harvest sector.

A further linkage between the harvest and post-harvest sectors concerns sales and price relationships. Price setting in fisheries takes numerous forms. In some countries, auctions are the main approach while in others sales are based on contracts between harvesters and processors; in a few countries a high degree of vertical integration between the two sectors exists. In most OECD Member countries, a mixture of all three types of approaches co-exist. The increasing globalisation of fisheries and the trend towards increased vertical integration in food processing and distribution are likely to make auction systems less important in the future.

Ensuring food safety is a key element underlying seafood inspection and quality control programmes. The Hazard Analysis and Critical Control Points (HACCP)[29] approach is being increasingly used as a common standard; most OECD countries now use it and several have, or will shortly introduce, mandatory HACCP programmes. For example, use of HACCP-based systems is mandatory in Australia, Canada, New Zealand, Iceland and the member states of the European Union irrespective of whether the seafood is intended for domestic consumption or export; in Japan and Korea the use of such systems is voluntary for domestically-consumed products and mandatory for exports.

National sanitary and phyto-sanitary requirements often form part of the set of fish buyers specifications, setting minimum standards to be met. Some large post-harvest operators, such as supermarkets and processors, have established their own specifications that exceed the relevant national standards (see also the discussion of eco-labelling in Section 5).

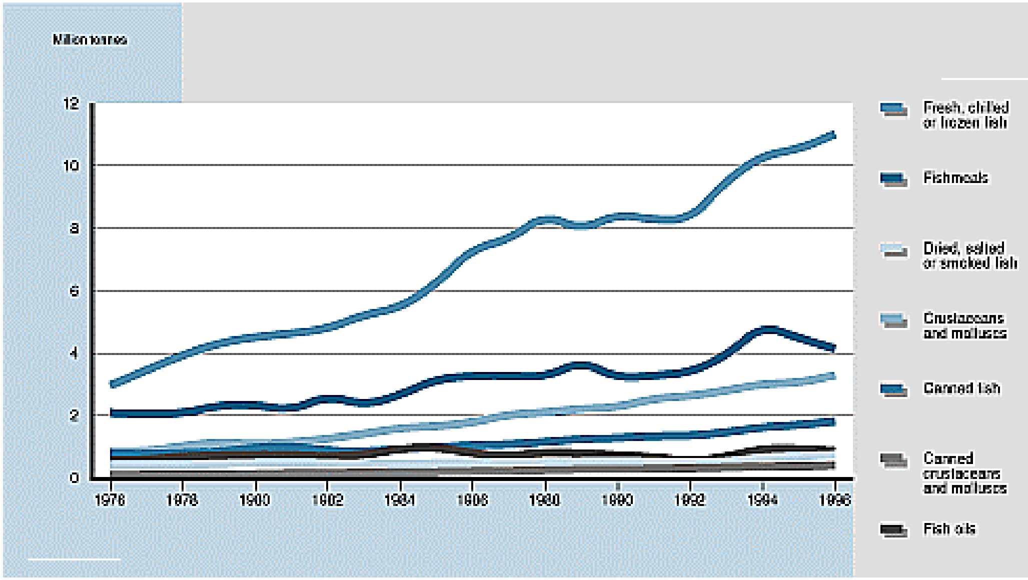
5.Trade in Fish and Fishery Products, Once Again

Concomitant with the upward trend in world fisheries production, trade in fish and fishery products has increased over time. Indicators of the growing importance of fish trade include:

- between 35%-40% of fisheries production is traded internationally;
- export volumes reached 122 million tonnes in 1996, or nearly three times the volume traded in 1976;
- in 1996, 195 countries exported part of their fish production and 180 countries imported varying amounts of fish and fishery products;
- the value of fish exports increased from US$11 billion in 1970 to US$52.5 billion in 1997 (McGinn, 1998; FAO, 1998b, 1999a).

Figure 8

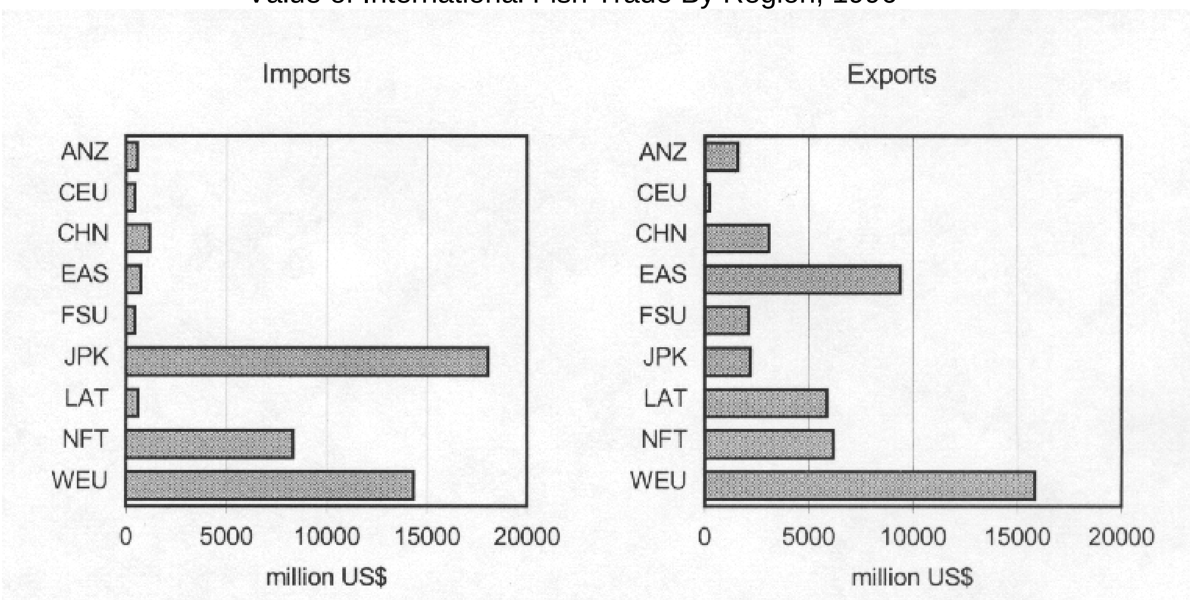
World Fishery Exports by Major Commodity Groups



Source: FAO, 1998b; 1999a.

Figure 9

Value of International Fish Trade By Region, 1996



Source: FAO, 2000b

Figure 8 shows the trend in fishery exports by major commodity types for the period 1976-1996 while the value of international fish trade by region in 1996 is shown in Figure 9.

In value terms, developing economies account for more than 50 per cent of the fish traded internationally, with imports largely into OECD countries (FAO, 1998). There are, however, important fish trade linkages among developing/emerging economies. India, Indonesia, Malaysia, the Philippines and Thailand import fishmeal from Chile and Peru for their shrimp farming operations; processing plants and canneries in Thailand and the Philippines import sardines and mackerel from Latin America and frozen tuna from the US, with the end product usually sold in developed country markets (McGinn, 1998).

5.1 Linkages Between Trade and Environment

International trade in fish and fisheries products can have both positive and negative environmental effects (Tsamenyi and McIlgorm, 1999). Positive effects include opportunities for the transfer of "best practices" in fishing techniques and post-harvest management and the use of more selective gear. On the other hand, where fish stocks are not adequately valued and managed trade can exacerbate pressures on the unmanaged fishery, e.g. in many developing countries demand from overseas markets can stimulate producers to overfish in an open access fishery (op. cit.). As these authors state, the "problem is the lack of fishery management in the face of the trade stimulus to producers." (Tsamenyi and McIlgorm, 1999, p. 34). They note that the resource management issue is at the centre of the fish trade and environment debate and that governments must manage their marine fish resources.

Trade measures have an influence on consumption patterns and feedback to decisions made by the harvesting sector (OECD, 1999). The OECD report gives the example of high import tariffs on canned tuna, which in some markets is a substitute for canned mackerel. In such cases, a re-direction of consumer demand towards canned mackerel can occur and fishing pressure could increase on mackerel stocks.

Eco-labelling has emerged as a response to consumer demand for greater information that fish and fishery products have been harvested and processed in an environmentally responsible manner. Spain has introduced an "appelation d'origine' label that is used mainly for farmed fish and fish products although there is interest in extending the scheme to cover fish from other origins. In addition, the Nordic Council, the European Commission and the FAO have each been holding on-going discussions on eco-labelling schemes for fish and fishery products. Some privately sponsored labelling or information programmes have also emerged, including those of the Global Aquaculture Alliance and the US National Fisheries Institute (OECD, 1999). An interesting initiative concerns the Marine Stewardship Council, initially set up as a partnership by Unilever and WWF in 1997 and now an independent NGO. The Council has established a process for third party certification of a fishery or fish stock as well as the fishing method and practice. It is anticipated that soon it will be possible for retailers and consumers to purchase fish bearing the Council's logo, indicating that it comes from well managed sources. Tsamenyi and McIlgorm (1999) suggest that the scheme should help promote environmentally sound production in countries where government management of fisheries has been poor. (And also in countries where fisheries management is more advanced.)

Several high profile cases concerning fisheries trade and the environment have been taken to the GATT/WTO for resolution:

- the tuna-dolphin issue in which the US imposed trade embargoes on the importation of tuna and tuna products from tuna fishing nations and intermediary nations under the Marine Mammals Protection Act and other related US legislation because of a large by-catch of dolphins (Mexico-US dispute, 1991) (Tsamenyi and McIlgorm, 1999). The GATT panel declared the US measures to be incompatible with GATT rules (op. cit.).

- prohibition of imported shrimp. In 1996 a complaint was lodged by India, Malaysia, Pakistan and Thailand against a US ban on the importation of shrimp and shrimp products from these countries as a result of US legislation that prohibited shrimps being caught without acceptable turtle excluder devices (Tsamenyi and McIlgorm, 1999). The WTO Appellate Body found in favour of the complainants.

Trade measures included within the Convention on International Trade in Endangered Species (CITES), and some other conventions, are relevant to the fisheries sector (OECD, 1999). In particular, by reinforcing domestically applied signals to the market place about fisheries production, e.g. no shrimp catch without a turtle excluder device installed, observers on tuna vessels, etc. (op. cit.). The OECD report notes that two multilateral fisheries conservation agreements provide for the use of trade measures against non-contracting parties. First, the 1992 Convention for the Conservation of Antarctic Marine Living Resources provides for the possibility to prohibit landings and transhipment of fish from non-contracting vessels found to be in contravention of the Convention. Second, the International Convention for the Conservation of Atlantic Tunas, which focuses on bluefin tuna and swordfish, provides for parties to use non-discriminatory trade measures against non-contracting parties who are in violation of the Convention.

6. Demand Factors

There is a limited amount that one can safely say about future demand for fish and fish products. Nonetheless, a particularly useful source, has been provided in the form of a paper that was prepared by Lena Westlund for the 1995 Kyoto International Conference on Sustainable Contribution of Fisheries to Food Security (Westlund, 1995).

Westlund reports that the FAO projected that the demand for fish in 2010 would be in the order of 140–150 million tonnes. This is roughly equal to the FAO's optimistic projection of fish available for human consumption in 2010 (FAO, 1997b).

Westlund (*ibid*.) cites the factors that can be expected to influence future demand:

(a) population growth

(b) growth of per capita income

(c) shifts in consumer preferences.

Of perhaps equal importance, but only alluded to by Westlund, is:

(d) substitutes for fish products.

With regards to (d), the FAO, in its most recent assessment in demand and supply considerations in the world fisheries, emphasize the point that, in many parts of the world, poultry and pork are close substitutes for fish (FAO, 1999a). Hence, supply conditions in the poultry and pork industries will obviously have an impact upon the demand for fish products. The FAO cites one example. A proposed modification in the EU's Common Agriculture Policy will, among other things, have the consequence of reducing grain prices, to the cost benefit of EU poultry producers. This in turn can be expected to have a negative impact on the demand for fish (FAO, *ibid*.).

It is difficult to escape the conclusion that numerous demand for fish projections are based upon the assumption of constant per capita consumption of fish (e.g., see New, 1999). Demand for fish thus becomes a simple function of population, an approach which is clearly inadequate. Items (b) and (d) indicate that it is essential to take into account income elasticities of demand for fish, on a product by product, and region by region basis, and that it is equally important to take into account price elasticities ("own" price elasticities, and cross price elasticities) when assessing demand for fish now, and in the future. Item (c) indicates that one must be prepared to allow for shifts in demand for fish due to changing consumer preferences.[30]

One should next ask what the consequences are for the two sub-sectors of shifts in demand. It is to be anticipated that the aquaculture sub-sector would respond like any normal industry. Increases in demand, and resultant increases in prices, should stimulate increased production. The threat of a fall in demand, due to improved supply conditions in competing industries should, in turn, stimulate the search for means of increasing productivity and thereby reducing costs.

In the capture fisheries sub-sector, by way of contrast, there are obviously limits to which increases in demand can increase sustainable output. Furthermore, if resource management inadequacies are not addressed, increases in demand could worsen both overexploitation and overcapitalization problems and lead to eventual declines in output. This is but another manifestation of the perverse outcomes arising from the "common pool" problem.

7. "Drivers" of Change and Options for Policy

In this section, we attempt to draw together some of the conclusions emerging from the discussion up to this point. In so doing, we attempt to list the "drivers" of change in the two sub-sectors of the fishing industry. This is followed by a listing of the policy options which emerge.

A) Population and per capital income growth. This "driver" influences obviously both sub-sectors through demand for fish and fish products. In terms of output such growth should work in a positive fashion for the aquaculture sub-sector, but quite possibly in a negative fashion in the capture fisheries sub-sector.

B) Technological advances. This is another obvious "driver." Once again, the impact almost certainly positive for the aquaculture sub-sector; but quite possibly negative in the capture sub-sector. If technological advances lead to reduction in harvest costs, for example, the consequences would be the same for Pure Open Access and Regulated Open Access fisheries, as an increase in price of harvested fish – i.e., an intensification of resource overexploitation and fleet overcapitalization.

C) Resource constraints. The capture fisheries sub-sector, as has now been emphasized many times, faces an upper bound on sustainable harvests due to the finite capacity of the relevant water bodies. It was for this reason the sub-sector was described as resource driven. The evidence indicates that the upper bound has been, or is close to being, achieved. The aquaculture sub-sector does not face this constraint, although it could face a comparable constraint in time if rapid growth continues.

D) Property rights and environmental degradation. Capture fisheries throughout the world face chronic resource management problems, which manifest themselves in resource overexploitation, degradation of the surrounding eco-system. This state of affairs we referred to as the "common pool" problem, which in turn could be traced to the fact that property rights to the resources are ill-defined, or non-existent. Aquaculture, fish farming does not face this problem, at least to the same degree. Property rights to aquaculture operations are normally well specified. Having said this, however, property rights to the environment surrounding aquaculture operations are often not well specified. This, in turn, can lead to pollution problems, including, one might add, the spread of disease to wild stocks. It should also be added that some aquaculture operations are heavily reliant upon wild stocks for feed. Thus the growth of aquaculture can lead to the intensification of overexploitation of wild stocks, if the latter are subject to ineffective management.

With regards to policy options, they are surely straightforward in the case of capture fisheries. In light of the overwhelming importance of the "common pool" problem of capture fisheries management, policies must be directed to addressing the problem. The likely cost of not so doing will be negative growth in capture fisheries harvests.

Specifically this implies giving full support to FAO initiatives such as:

I. The management and control of fishing capacity

II. Investigation of means of developing incentive adjusting management instruments – as exemplified by the Fish Rights 99 Conference of November 1999.

It involves as well supporting the ratification and effective implementation of the U.N. Fish Agreement, governing straddling and highly migratory fish stocks. The point was made that the existence of transboundary fishery resources exacerbates the "common pool" problem.

Finally, policies should be directed towards addressing the resource management problem that would arise even in the absence of "common pool" considerations by virtue of the inherent uncertainties in capture fishery resource management. This means adopting the Precautionary Approach by investigating the use of instruments such as Marine Protected Areas.

With respect to aquaculture, it is difficult to do better than adopt the policies implied by Michael New's "challenges for the 21st century" (New, 1999). Aquaculture does have the possibility of rapid growth, but the growth may be hindered by:

1) heavy dependence upon capture fishery resources for feed
2) generation of pollution and degrading of surrounding environment
3) competition from non-fish substitutes
4) current dependence upon a narrow species base.

The basic implication of the New list is that policies be directed towards encouraging research and technological developments designed to surmount these barriers, such as offshore aquaculture production. The reader is referred back to the New article for detailed recommendations.

8. Summary and Conclusions

The fisheries sector continues to play a significant role in the world economy. International trade in fish and fish products is in excess of U.S. $50 billion per annum. The sector provides direct employment for almost 30 million persons.

In the survey, a sharp distinction was made between capture fisheries and aquaculture. Capture fisheries production, to which the OECD countries contribute one third in quantity terms, currently accounts for between 75 and 80 per cent of total world fish production in volume terms. The capture fisheries sub-sector'' position of dominance is, however, being steadily eroded.

Two factors dominate capture fisheries, which must be taken in to account when attempting to assess future growth prospects of harvests based upon these resources. The first is that sustainable capture fisheries production faces an upper limit imposed by nature, given the finite nutrient capacity of the oceans and the relevant fresh water bodies. The existing evidence strongly suggests that world capture fisheries, particularly those in the oceans of primary importance to the OECD, are pressing against that ceiling.

Secondly, capture fisheries are plagued by resource management problems, which arise, in the first instance, from the irreducible level of uncertainty faced by managers of capture fishery resources, and by the "common pool" nature of many of the fisheries. The problems manifest themselves in terms of overexploitation of fishery resources and overexpansion of the fishing fleets. The resource management problems are exacerbated by the fact that many capture fisheries are international in nature, in spite of the implementation of the EEZ regime.

The aforementioned resource management problems have meant that numerous capture fisheries are not realizing their full potential. This, in turn, holds out the prospect of a modest growth of capture fishery production through improved resource management. There is an accompanying threat, however, namely that, if resource management is not significantly improved, capture fishery production may experience negative growth over the ensuing two decades

While much work has been done in recent years through the OECD and FAO to improve the biological and economic management of capture fisheries, there are no universally accepted solutions to, for example, the joint problems of resource overexploitation and fleet overcapitalization. The policy implications are obvious. Effort must be devoted towards the search for improved methods of management by, for example, supporting FAO initiatives pertaining to the management and control of fishing capacity. The consequences of not pursuing such policies is that total capture fishery output in the OECD, and other parts of the world, will decline during the following two decades.

In what was termed a highly optimistic view of the future, OECD capture fishery harvests were projected to increase by roughly 15 per cent up to 2020. What was termed a more probably view of the future saw OECD capture fishery harvests remaining roughly constant over the next two decades. Even this conservative estimate assumes some improvement in resource management. Very modest increases in total world capture harvests up to 2020 were also anticipated.

Aquaculture production, of which the OECD accounts for approximately 25 per cent in value terms, constitutes the one significant hope for future growth in the fisheries sector. The sub-sector, which has enjoyed a spectacular rate of growth over the past two decades, does not face the same resource constraints of capture fisheries, nor does it face the intractable management problems of capture fisheries.

A very optimistic assessment of OECD aquaculture production (in volume terms) would see total aquaculture production increasing by over 125 per cent over the period 1995-2020. This, combined with the optimistic projection of OECD capture fishery harvests, would see total OECD fish production increasing by 35 per cent over the same period.[31]

Aquaculture production in the non-OECD world is expected to grow much more rapidly than in the OECD. In large measure, this is a reflection of the almost overwhelming dominance of China in aquaculture production. Optimistic projections of world aquaculture production could see it result in total world fish production increasing by more than 50 per cent over the period, 1995-2020 in spite of the modest expectations of future capture fishery harvests.

While the growth of aquaculture production has been spectacular, and while aquaculture does not yet face the same natural constraints confronting capture fisheries, aquaculture does face barriers which, if not surmounted, could result in aquaculture growth falling far short of expectations. Examples are provided by aquaculture as a major source of pollution and the heavy dependence of some components of aquaculture upon capture fisheries for feed. Once again, the appropriate policy is straightforward, namely to foster research and technological development designed to surmount the aforementioned problems.

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Notes

[1] These figures include finfish, shellfish and marine mammals, but exclude aquatic plants (e.g. seaweed). Aquatic plants constitute a small, but increasingly significant, component of aquaculture production, as shall be noted at a later point.

[2] Capture fisheries includes harvests from freshwater (inland) sources as well, e.g. the Great Lakes of North America. Marine capture fishery harvests normally account for about 90 per cent of total capture fishery production. Consequently Figure 1 provides a reasonable representation of long term trends.

[3] The leading country is China, with an average annual production (1994—1998) of 12.5 million tonnes, which exceeds that of Japan and the United States combined (FAO, 2000b). See Table 1.

[4] Once again, while the analysis is that of marine capture fishery resources, the analysis applies, with appropriate modification, to inland capture fishery resources.
Christopher Newton has retired from the FAO, while Serge Garcia continues with the FAO.

[5] The FAO definition of the Northwest Pacific (FAO Statistical Area 61) encompasses the domestic waters of both Japan and the Republic of Korea (FAO, 1997a).

[6] It should be borne in mind that Table 2 is concerned with harvests from marine capture fisheries only. Hence the total harvests are lower than those reported in Table 1.

[7] In the case of some fishery resources, “investment” is also possible through enhancement projects.

[8] I.e. apply a rate of discount well in excess of the social rate of discount.

[9] This term, and the term to follow: Regulated Open Access, was originally coined by James Wilen (1987). See as well Homans and Wilen (1997).

[10] “excessive,” from the point of view of society.

[11] See: n.9.

[12] This remains true even if one allows for harvest fluctuations through time.

[13] OECD, 1997b, p. 61.

[14] For example, vessels trawling for shrimp on the Gulf of Mexico catch substantial amounts of red snapper. The bycatch stands as a threat to the red snapper resource .

[15] e.g. FAO, 1998.

[16] This simple rule obviously has to be modified for resource fluctuations.
[17] See Clark and Munro, 1999.

[18] The Convention achieved the status of international treaty law in November 1984.

[19] The Agreement: "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks," has yet to come into force. Since the Agreement has received 25 out of the required 30 ratifications, its coming into force is just a matter of time.

[20] Once the investment has been made in non-malleable, the costs which count thereafter are operating costs alone (Clark, Clarke and Munro, 1979; Clark and Munro, 1999).

[21] For example, the FAO recently convened a Technical Consultation on the Measurement of Fishing Capacity, November 29 – December 3, 1999.

[22] The evidence is particularly convincing in the case of the Donut Hole fisheries (Munro, 1999).

[23] Also referred to as the Atlanto-Scandian Herring stock.

[24] This is not to say that MPAs must necessarily reduce the expected sustainable harvest. If the use of MPAs is compared with other alternative conservative resource management techniques, e.g., the use of conservative TACs, the expected sustainable harvests, when employing MPAs, may actually be significantly greater than those associated with other conservative management regimes. This point is examined in detail in Lauck et al. (1999).

[25] For a detailed examination of both incentive blocking and incentive approaches see: OECD 1999b.

[26] See: http://www.fao.fisbrights99.conf.au/

[27] See as well: http://www.fao.org/fi/meetings/mmt/default.asp

[28] Unquestionably, the "optimistic" projections for aquaculture production to 2020 appear to border on the outlandish. The fact of the matter, however, is that we simply do not know. FAO projections of aquaculture production, thus far, have, more often than not, been overtaken by events. Thus, for example, in 1997, the FAO made optimistic and pessimistic projections of world aquaculture production (excluding plants) to 2010. The projections were 39 million tonnes and 27 million tonnes, respectively. In 1997, actual aquaculture production exceeded the pessimistic projection for 2010 by almost 2 million tonnes. Aquaculture production will have to increase by less that 2.5 per cent per annum, if the "optimistic" projection for 2010 is not to be exceeded well before that year.

Of course, the now repeatedly discussed constraints may well become binding long before the "optimistic" projections for 2020 are achieved. The constraints, or barriers, are, however, not immutable and insurmountable, unlike the natural constraints confronting capture fisheries. Moreover, there seems to be little question that the industry is faced with incentives that will drive it to seek out means of surmounting the barriers. If, over the next twenty years, the barriers are successfully surmounted, the "optimistic" projections may not appear to be so outlandish after all.

Finally, it is worth noting that the Minister of Fisheries of Norway, the leading non-Asian OECD aquaculture producer, has confidently predicted that his country's aquaculture production will double, not over the next twenty years, but over the next decade (*IntraFish*, 1999).

[29] The aim is to provide greater assurance of product safety without relying on finished product inspection of domestically produced or imported goods. In this way, trade in fish products should be facilitated and sanitary and phyto-sanitary requirements to be satisfied made more transparent.

[30] It should be emphasized that the FAO makes it very clear that it does not take a simple minded approach to demand for fish projections (FAO, 1999a).

[31] By way of contrast, if conservative projections were combined, total OECD production of fish would be seen as growing by a modest 7 per cent over the period.