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CURRENT SITUATION, TRENDS AND PROSPECTS IN WORLD CAPTURE FISHERIES[1]

by

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Abstract

Following an earlier analysis provided by FAO (1993), the paper gives an update of the trends and future perspectives of world fisheries. It describes and comments on worldwide trends in landings, trade, prices and fleet size. It illustrates the decrease in landings in the last 3 years, the relationship between landings and prices and the large overcapacity in world fishing fleets. It provides a review of the state of world fishery resources, globally, by region and species groups, as well as a brief account of environmental impacts on fisheries. It presents an economic perspective for world fisheries which underlines further the overcapacity and subsidy issues that characterize modern fisheries. In conclusion, it discusses management issues including the need for fleet reduction policies, the potential combined effect of international trade on resources depletion in developing exporting countries, throwing into question the overall sustainability of the world fishery system.

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[1]Paper presented at the Conference on Fisheries Management. Global trends. Seattle (Washington, USA), 14-16 June 1994

curves = "selected" species (i.e. excluding the 5 main pelagic species).

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CURRENT SITUATION, TRENDS AND PROSPECTS IN WORLD CAPTURE FISHERIES

INTRODUCTION

World fisheries play an important role in development, providing incomes to about 200 million people, directly or indirectly. One third of the world catches is exchanged through international trade, the volume of which has doubled between 1980 and 1990. Fisheries play a significant role in the development of a number of developing countries where, since 1950, more than 85% of the world demographic growth has been concentrated. The coastal fisheries are potentially threatened by the ongoing progressive migration of people towards coastal areas, particularly coastal urban centres, where 60% of the world population already live.

The rapid and continuous increase in fishing intensity during the last half-century has had a tremendous impact on the aquatic ecosystem, the resources and the market. This impact is evident in the depletion of resources, the degradation of the environment and the evolution of supply, demand and prices. It is also reflected in the changes in access and property regimes in the ocean, which are still evolving.

The political changes in Eastern Europe are also leading to an important modification of the role of these countries in world fisheries. Between 1961 and 1990, a large part of the catches of small pelagic species was made by fleets from the former USSR, Germany (GDR), Poland, Bulgaria and Rumania, that specialized in the capture of these abundant low-price species and compensated for natural oscillations in stock abundance by "migrations" between areas of production and by pulse fishing. The economic consequences of these political changes have led to a curtailment of the activities of these fleets (largely subsidized in the past) and to a shift in their area of operation and target species, with a return in their EEZ and waters closer to home, and a greater interest in high value species for the export market. In some developing regions (e.g., in the Gulf of Guinea), which were markets for part of the landings of the Eastern European fleets, the sudden reduction in landings by these foreign fleets has led to shortage in supply and significant increases in prices (for example in Guinea Bissau).

All these important changes have affected fisheries and resources, sometimes positively, often negatively. FAO's perspective view on fisheries trends and their implications have been presented in many documents prepared for, and following, the UN Conference on Environment and Development (UNCED) in 1992 (Garcia, 1992; Garcia and Newton, 1993; FAO, 1992b, 1993). This paper presents an update of this perspective, focusing on trends in fisheries landings, trade, prices and fleet size and describes the state of the world fishery resources (globally, by region and species groups). It provides a global assessment of the world fishery resources as well as a global economic model for world fisheries which underscores the huge overcapacity that characterizes modern fisheries. In conclusion, it discusses management issues, addressing briefly environmental impact.

1. TRENDS IN WORLD FISHERIES PRODUCTION

Total landings

Marine ecosystems produce 85% of the world fish yields. The process of intensification of marine fisheries, which started just before the Second World War, accelerated notably after it, and led to an exponential increase in landings (Figure 1). During the period 1950-1992, marine fishery catches have increased by 300 % from 18.5 to 82.5 million tonnes (Figure 2). The changes in the rate of increase with time, however, indicate that the upper limit of capture fisheries on conventional species has probably been reached (see below and Figure 19).

Figures 1 and 2

From 1950 to 1992, reported landings from marine fisheries increased at an average rate of 6.8% per year in the fifties (18.5 million tonnes in 1950 to 31.2 million tonnes in 1959),7.4% per year in the sixties (to 54.5 million tonnes in 1969), 1.7% only in the seventies (to 63.7 million tonnes in 1979) and 3.6% in the eighties (to 86.4 million tonnes in 1989). In the first three years of the nineties, however, catches decreased at a rate of 1.5% per year (to 82.5 million tonnes in 1992) for the first time in history, with the exception of the two World Wars, despite an increase in the landings of anchoveta of 4.0 million tonnes in 1991 and 5.5 million tonnes in 1992.

The first period of low growth, in the 1970s, corresponds to the collapse of the Peruvian anchoveta resource, possibly aggravated by the first oil price crisis in 1974, which slowed down the activity of long distance fleets. The second period of low growth, in the early 1990s, corresponds to a decrease of Japanese and South American pilchard, as well as overfishing of important demersal resources in the Northwest Atlantic. Between these two periods, the higher growth rate of the 1980s was mainly due to the simultaneous recovery of the Peruvian anchoveta and the Japanese sardine, as well as to the intensification of exploitation of Alaska pollock for the surimi industry.

Species composition

In 1992, the marine catch consisted of 81.3% of fish, 10.4% of molluscs, 5.9% of crustaceans and 2.4% of other species. An analysis of the trends by species groups indicates that most of the increase in marine catches, since the early eighties (Figures 3 and 4), came from five major pelagic or semi-pelagic species (Peruvian anchoveta, Alaska pollock, Chilean jack mackerel, South American pilchard and Japanese pilchard) which accounted for 24% of the total marine production (including aquaculture production) in 1992 against 30% in 1989

(Figure 4)[2]. These species account for about 5% of total value in 1992 against 6% in 1989. From 1970 to 1992, the catch of the 4 major demersal species (silver hake, haddock, Cape hake and Atlantic cod) decreased by about 67% from 5.0 to 1.6 million tonnes. Atlantic cod was the second most important species in 1970 (after anchoveta) with 3.1 million tonnes. It was only the sixth most important species in 1989 (after Alaska pollock, anchoveta, Japanese and South American pilchards and Chilean jack mackerel), with landings of 1.8 million tonnes and the tenth most important species in 1992, falling below capelin, Atlantic herring, skipjack tuna and European pilchard, with landings of 1.2 million tonnes. The world fish supply is increasingly relying on low value species, characterized by large fluctuations in year to year productivity, concealing the slow but steady degradation of the demersal high value resources.

Figures 3 and 4

The evolution of landings of flatfish, tuna and shrimp, between 1970 and 1992, are given in Figure 5. Flatfish appear very stable having produced between 1.1 and 1.4 million tonnes per year since 1970, with an average of 1.2 million tonnes, without trend. Tuna and shrimp landings, on the contrary, reflect the large increase in overall pressure they have endured. Tuna landings have increased at a rate of 7.4% per year, from 1.7 to about 4.4 million tonnes. Total shrimp production increased by 8.3% per year, from 1.1 to 2.9 million tonnes resources but a part of that increase came from shrimp culture, which now represents about 25% of the total production (Figure 5). The expansion of shrimp culture seems, however, to be locally reaching the limits imposed by environmental management and the environmental impacts observed (e.g., in Thailand) and the severe economic losses incurred through diseases (e.g., in China in 1993) are an indication that, in some areas, an environmental limit has been reached that cannot be passed without more costly mothods of production and more stringent management measures.

Figure 5

Economic value

Four species or species groupings make up about half of the value of the world catch (Figure 6). In 1989, and by decreasing order of importance, these were shrimp, redfish, miscellaneous marine fish and tuna. The miscellaneous category occupied the 3rd rank (Figure 6A) when it did not even appear in the first 13 species in 1970 (Figure 6B). It is likely that this reflects the trends in many fisheries towards landing large quantities of unidentified mixtures of small fish with low economic value (the so called "trash fish") as a result of overfishing and reduction in the size of fish. During the same period, redfish moved from the 5th to the 2nd rank (reflecting an increase in fishing pressure). Many high value species decreased in economic importance reflecting their overfishing such as Atlantic cod,

[2]For more details, see FAO (1993).

(from the 3rd to the 12th rank) and hake and haddock (from the 2nd to the 7th rank). Values are not available for 1992 but data on landings confirm the trends, showing that the miscellaneous category which, with 10 million tonnes, has doubled between 1970 and 1992, and now occupies the Ist rank while cod regressed from the 3rd to the 10th rank.

Figures 6 (A and B)

Regional distribution

Information on the regional distribution of fisheries is extensively documented in FAO (1993 b,c,d,e). The data available for 1992 indicate that the Pacific Ocean provides 62.3% of total world landings, followed by the Atlantic (29.2%) and the Indian Ocean (8.5%). The data by Major Fishing Area for Statistical Purposes (Figure 7) show that despite some decrease since 1988 (26.6 million tonnes), the Northwest Pacific continues to be the area of highest production with 24.2 million tonnes of landings in 1992 followed by the Southeast Pacific with 13.9 tonnes, Northeast Atlantic (11.1 million tonnes), Western Central Pacific (7.7 million tonnes) and Western Indian Ocean (3.7 million tonnes) (Figure 7). The comparison of the productions in 1970 and 1992 (Table 1) show that in 1990 the largest relative increases have been in the Southwest Pacific (+ 1000%) and Eastern Indian Ocean (+ 300%) while the Northwest Atlantic decreased by 37%. These differences do not reflect some of the important variations that have occurred between 1970 and 1992. For instance, the production of the Southeast Pacific greatly fluctuated between 5.6 million tonnes (in 1972) and 15.3 million tonnes (in 1989), due to instabilities in small pelagic stocks. A significant decrease (20% or 645.000 tonnes) was observed between 1990 and 1992 in the Eastern Central Atlantic mostly because of a decrease in European pilchard and in the activity of the fleets of the former USSR countries. During the same period the landings of the Northwest Atlantic decreased by 25% (or 650.000 tonnes) mainly due to continuous declines in Atlantic cod stocks. The greatest increase (1.5 million tonnes) was observed between 1990 and 1992 in the Northeast Atlantic where landings were at their highest level since 1985, due mainly to increases in capelin (75% or 0.9 million tonnes), Atlantic herring (11% or 0.15 million tonnes) and Norway pout.

Table 1 and Figure 7:

Geo-economic distribution

In many developing countries, fisheries represent an important source of foreign exchange with a net earning (exports minus imports) of more than 10 billion dollars in 1990, higher than earnings from other selected agricultural commodities, such as coffee, tea or rubber (FAO, 1992a). The relative contribution to the world production of developed and developing countries has significantly changed since 1970 (Figure 8A and B). In the early 1970s, the developed countries caught 57% of total landings. With the acceleration of the process of extension of the EEZs and the sharp rise in fuel prices (after the 1994 and 1979 oil crises), this share fell progressively to less than 50% in 1985 and less than 40% in 1992. The catches made by long-range fleets in distant fishing areas peaked at 8.9 million tonnes in 1989 and has decreased since to 5.7 million tonnes in 1992. Part of the increase in developing countries' share of the world catches reflects some transfer of foreign fleets' catches under coastal countries flags, through joint ventures, changing the nationality of the catch if not of the real operations. A large part of the increase, however, is due to active fisheries development programmes, often supported by national credit and subsidy schemes and backed-up by international and regional development banks.

Figures 8 (A and B)

National distribution

In 1992, the 20 top largest fish producers included 11 developing countries, dominated by China and Peru, and 9 developed countries, dominated by the former USSR and Japan. The cumulative curve (Figure 9B) shows that these 20 countries produce close to 80% of the world production. The first six (China, Japan, Peru, Chile, the Russian Federation, and USA) produce 50% of the world landings while in 1970 (Figure 9A), four countries produced 50% (Peru, Japan, USSR, China). China increased its production from 3.1 million tonnes in 1970 to more than 15 million tonnes in 1992, progressing from the 4th to the 1st rank as a result of expansion of intensive mariculture, more liberal trade and price policy, and expansion of its long range fleet. Chile progressed from the 14th to the 4th rank (from 1.2 to 6.5 million tonnes). The Republic of Korea also expanded its distant water fishing, increasing its production from 750.000 to 1.8 million tonnes and passing from the 18th to the 10th position.

Japan's catches increased slightly, from 8.3 to 8.5 million tonnes. Its catches in distant waters decreased by 41%, from 1.6 million tonnes in 1982 to 0.9 million tonnes in 1992. Japanese total production has only been maintained, however, because of the natural increase in its sardine stock between the mid-1970s and the mid-1980s, yielding more than a third of it and a decrease might be expected as sardine stocks return to long-term average levels of abundance. The United States and Canada have increased their catches from the North Atlantic and Pacific Oceans during their post EEZ era, in the seventies, but the recent collapse of demersal resources in the Northwest Atlantic (particularly the cod) has severely affected the economic and social conditions of coastal communities.

Figures 9 (A and B)

Landings from distant water fishing (in the EEZ of other nations and on the high seas) increased from 7.4 million tonnes in 1982 to a record level of 8.9 million tonnes in 1989. Catches decreased to 7.5 million tonnes in 1991 (- 16%) and 5.7 million tonnes in 1992 (- 44%) or a total decrease of about 37% in 3 years, mainly as a result of a sharp decrease in the activities of the former USSR countries. With the formation of the Independent Republics, the shift to market economies has led to a retrenchment of the long-range fleets of these countries to less distant waters and in their own EEZs. Between 1991 and 1992, the catch by the distant water fishing fleets of these countries, consisting mainly of small pelagic fish, has decreased between 20 and 71% depending on the country (Table 2) with a total decrease for all former USSR countries of about 50% in two years. Landings of the other Eastern European countries started to decrease in 1986-87. Between 1986 and 1992 the decrease was 24% for Poland, 30% for Rumania and 76% for Bulgaria, and 41% for these three countries together (from 729.000 to 430.000 tonnes). The total decrease in activity of the Eastern European fleets has affected fish-food supplies and prices of small pelagic species in West Africa and it is not yet clear whether the development of local fleets to harvest these species is an accessible and economic alternative. In addition, there has been an increase in changes in flags to open registers without corresponding reporting on catches by the related flag States.

Table 2

Trade

Detailed data on international fish trade are available for the period 1960-1990 (FAO 1992a). The volume of internationally traded fish has increased from 2,500-2,800 million dollars in 1969-71 to 35,000-40,000 million dollars in 1990. This represents an increase from about 5% to 11% of the total trade in agricultural products, and indicates that fish trade developed faster than agricultural trade. The growth in fish trade has slowed down, however, from 18% per year in 1969-76 to 8% per year in 1979-90. The trends look similar for developed and developing countries but the data available for 1979-1990 show that:

1) In the developed countries, imports have increased faster than exports (8.6% as opposed to 7,4% per year) indicating a net deficit which increased from 700 million dollars to about 15,000 million dollars between 1969-71 and 1990. These countries are the largest importers with more than 85% of the imports in value from 1969 to 1990. Japan's share of world imports has tripled during the period (from 8 to 28%) illustrating the impact of the EEZ process. On the contrary, in the USA imports have decreased from 25 to 16% of the world imports indicating an opposite effect.

2) In developing countries, high value species are exported while low value ones find their way into the national and regional markets. These countries are responsible for 70% of the trade in cephalopods, 84% in frozen shrimps, about 66% in fresh and frozen tuna and more than 80% in canned tuna. Their imports have increased less than exports (7% as opposed to 8,8% per year). Their share in the world exports has increased from 32% in 1969-71, before the establishment of EEZs, to 44% in 1990, while their relative share of the imports increased only from 10,7 to 12,9%. These countries appear therefore, as net exporters with a positive trade balance which increased from 500 million dollars to 10,600 million dollars between 1969-71 and 1990, representing a significant source of foreign exchange. Thailand, for instance, multiplied by 6 its share of world exports (from 1 to 6%) while the

Republic of Korea and Taiwan (province of China) increased their share from practically nothing in 1970 to 5% in 1990. The countries principally responsible for this net trade balance are China, Chile and Thailand. In the latter case, expansion of trade is related to the very rapid development of tuna canning and a 400% increase in shrimp culture, although there has been a reduction of its exports of fish meal, redirected towards its aquaculture industry.

The global balance of fish and fishery products is negative for developed countries with a deficit of about 15,000 million dollars per year, with Western Europe (including the European Union) accounting for more than 12,000 million dollars. Developing countries have a positive balance of more than 10,000 million dollars, with East Asian countries accounting for 7,000 million dollars. It is notable that, in a rather grim context of decreasing terms of trade[3] of agricultural products, fish trade in developing countries has progressed and represents a significant opportunity in terms of foreign exchange.

Foreign exchange and national food security objectives may often be conflicting as the incentives to increase exports are reducing the relative availability of food fish for domestic consumption in the developing world. In the medium to long term, demand will continue to grow faster than supply, as a consequence of demography in the developed world and continued increase in demand for food fish in the developed regions [4]. Combining forecasts of population growth and stagnation in fish supplies indicate that the world availability of fish for food, which had increased from 9 to 13 kg per capita[5] between 1961 and 1990, will decrease to 11 kg per capita between 1990 and 2030 (Brown, 1994). Developed countries may have the means to stabilize the availability to them by purchasing the necessary quantities. As a consequence, fish availability in developing countries is likely to decrease further because of increased exports. The overall shortage in supplies will probably further increase the price of fish and fishery products. This should compensate, at least partly, for decreased abundance and quality, particularly as the price of low value species will be pushed upwards through substitution (e.g. surimi). By stabilizing revenues, however, this increase in price, will not provide the necessary incentives to reduce fishing effort as much as is required to rehabilitate fisheries.

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[3]The "terms of trade" of a particular product is the ratio between the average unit value of this product and the average unit value of all commercial trade. This ratio reflects the evolution of the relative purchasing power derived from this product.

[4]During the last decade, developed countries have started to tighten their controls on levels of effort, decreasing harvest rates, fleet sizes and access. The recent crisis in Europe, Canada and USA should accelerate the process.

[5]Source: Fish and Fishery Products: World apparent consumption statistics based on food balance sheets (1961-1990). FAO, Rome, 1992, page 25.

Since 1980, the proportion of the total world fish production going to human food has been around 70% without any clear trend and estimates are that 95 million tonnes of fish for direct human consumption will be required by year 2010 to maintain present per capita consumption. During the same period, about 30% of the world fish production was used essentially for animal feeds in agriculture and aquaculture. The absolute quantities going to fish meal and oils have increased, however. In the developed countries, they increased from 5 to more than 12 million tonnes between 1961 and 1990. During the same period, in the developing world, the quantities going to fish meal and oils increased from 6 to 16 million tonnes, with oscillations due to the collapse and recovery of the Peruvian anchoveta, which provides between 25 and 49% of the world production, depending on the years.

Prices

Prices of fish in international trade are essential to the understanding of the evolution of world fisheries. They are affected by various factors including: demography, trade circuits[6], competition with local species[7] and products of substitution (such as surimi) which may limit imports and constrain prices. In the long run, the price of fish is affected by its availability and Figure 10 shows that the overall availability of fishery products per caput had started to decrease in 1970 and that the gap between supply and potential demand is increasing rapidly.

Figure 10

An analysis of the relationship between deflated prices (base = 1978) and landings is given in Figures 11 (for species used for human consumption) and Figure 12 (for species used mainly for industrial reduction).

For jacks, mullet, tuna, cephalopod (Figure 11A) and Alaska pollock (Figure 11B), the price has remained fairly constant despite positive changes in landings, indicating that the demand is fairly elastic (i.e., large changes in supply have little effect on prices), the market is demand-driven and the increased supply has been sufficient to satisfy the increased demand without pushing prices upwards. The downward trend for tunas and cephalopods during the last decade may reflect some market saturation and increased production of secondary species, particularly for tuna, as well as cost decreases resulting from new harvesting technology. The demand appears fairly elastic also for shrimp and salmon (during the last decade at least) indicating probably that the additional production from aquaculture has been able to compensate for the increased demand. The price of crab has increased despite increased production indicating that the increase in demand has outstepped the supply despite the success of surimi as a substitute. The demand appears very

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[6]For instance, 90-95% of shrimp imports in Japan come from Asia; 65-75% of shrimp imports in USA come from Latin America.

[7]For instance, competition between tropical penaeids and cold water shrimps in European markets.

inflexible (supply-driven) for lobster (Figure 11A), flatfish and redfish (Figure 11B), reflecting their increasing scarcity and the fact that they are difficult to substitute. It is interesting to note that the price of cod, hake and haddock has remained stable despite the significant decrease in landings (mainly as a result of overfishing), probably illustrating the fact they have been substituted on the market by Alaska pollock whose price remained stable despite large increases in landings.

Figures 11 (A and B)

The picture is less clear for the small pelagic species, partly due to their large fluctuations. In Figure 12A, the species which are partly used for human consumption show decreasing prices regardless of whether supplies increased during the last decade (sardine and herring) or remained fairly stable, stabilizing at about 200 dollars per ton. On Figure 12B, the price of pilchard, partly used also for human consumption, appears to have increased despite very large increases in landings largely related to environmental fluctuations (Bakun, 1994). On the contrary, the price of anchoveta, menhaden, Chilean jack mackerel and capelin has fluctuated apparently independently of their landings, converging at a common price around 60 dollars per ton. This reflects probably their common destination (fish meal) and the fact that the impact of their fluctuations in price are dampened by the much larger production of soya, their main substitute.

Figures 12 (A and B)

2. STATE OF WORLD FISHERY RESOURCES AND ENVIRONMENT

FAO first published, in 1971 (Gulland, 1971), a world review of fishery resources, which estimated the world theoretical potential of traditionally exploited species to be around 100 million tons, of which 80 million tons was probably achievable for practical reasons related to the impossibility to optimize management on every wild stock in a complex multispecies system. Since then there is clear evidence of an increase in the number of stocks reported as being under severe fishing pressure and the simultaneous decrease of the number of stocks offering potential for expansion (Figure 13).

A more detailed picture of the situation at the time of the last review made by FAO on the state of world fishery resources (FAO, 1994) is given in Figure 14. This review, based on an extensive analysis of the literature and the work of the FAO regional fishery bodies working groups, categorizes, region by region, the stocks for which an assessment exists, as: under-exploited (U), moderately exploited (M), heavily to fully exploited (F), overexploited (O), depleted (D) and recovering (R). The category (F) corresponds to stocks which are exploited at a level of fishing close to F_{msy} and whose abundance is close to B_{msy}[8]. The other

[8]The two sub-categories " heavily" and "fully" exploited have been combined to take account of the high level of uncertainty in the estimate of the current fishing level and of the level corresponding to "full" fishing (i.e. conventionally MSY). For stocks in this category, increased effort will

categories are exposed to respectively higher (O, D) or lower (U, M) fishing intensity. When there is uncertainty as to the exact stock status, the stock has been put in the two most likely categories (e.g. F-O) and counted twice. Some stocks or group of stocks are in an unknown state and have not been taken into account in the following analysis. Figure 14 shows the distribution of all stocks or species aggregated among these categories together with the position of the category in a system of coordinates defined by the fishing mortality (as X axis) and biomass (as Y axis). It shows that 32% of the stocks for which data is available in FAO appear as under-exploited or moderately fished and might be able to support some increase in fishing. It also shows that 69% are exploited at or beyond the level corresponding to MSY. This does not imply that 69% of the stocks are improperly utilized. "Full" utilization is generally the goal of fisheries development and the figure indicates mainly that there is little scope for further development. However, because of: (a) the uncertainty in the positions of F_{MSY}, (b) the non-precautionary nature of MSY as a management target for many stocks and (c) the inertia in fleet dynamics and the fishery development process, "the fully fished" stocks are obvious (and likely) candidates for overfishing in the near future if past behaviour persists.

Figures 13 and 14

If the situation is examined region by region, the analysis is more difficult because the proportion of stocks and aggregates of stocks for which assessments are not available may sometimes be relatively high, varying from 53% in the Northwest Pacific to 7% in the Southwest Atlantic. Because of their very aggregated nature, these values should be taken cautiously but they intend to stress that even though the situation appears serious in many respects, the database available to fully assess it is dramatically incomplete. With this caveat, we have calculated for each region the proportion of the assessed stocks that appeared to be exploited beyond F_{msy} and below B_{msy} and it is noted that, in this last FAO review, the proportion of the assessed stocks and stock aggregates which are either fully exploited, overfished, depleted or slowly recovering from depletion varies from 100% in the Northwest Pacific to 29% in the Eastern Central Pacific (Figure 15).

Figure 15

In the FAO regular reviews, the situation is also examined stock by stock (FAO, 1994). The state of the stocks varies obviously between species and regions. A statement about the average state of a species or species group, based on many stocks, in different regions and receiving different levels of fishing mortality, has little operational and statistical value. However, as similar species tend to have similar market value and are confronted with similar fishing pressures, an attempt has been made to provide for a qualitative classification of the state of stocks as follows. Values from 1 to 5 have been given to stocks considered

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not lead to any significant increase in landings.

respectively underfished, moderately fished, fully fished (i.e. at MSY or F_{max}), overfished, depleted and recovering (considered as depleted)[9]. The average value calculated for each major species and species groups, across all regions is given in Figure 16.

Figure 16:

Keeping in mind the caveats about the data, it is interesting to see that redfishes, hake and Antarctic cod, lobsters, shrimp and prawns, cod and tropical demersals are, on average, fished beyond full exploitation. It is interesting to note also that, despite the general statement often made that small pelagics are still underfished, sardine, pilchards, menhaden, and anchovy appear fully fished on average. Mackerel, bivalves and traditional tuna stocks are close to full exploitation (the potential of tropical small coastal tunas is not well known). The resources which, on average, appear moderately to fully fished are cephalopods (mainly oceanic ones) and horse mackerel.

These overall statements on average status of species or regional resources aggregates should be cautiously interpreted. Some stocks, in an aggregate, are in a much worse state average and would require more stringent measures while others are in a better state than average and could, in theory, stand higher fishing effort. There are, for example, indications that silver hake in the Northwest Atlantic could be further exploited and that anchoveta in the Eastern Central Pacific is now underfished. Mesopelagic resources are also known to offer a large potential but regular assessments are not available. Krill is usually also considered as a resource offering a large potential for increased catches, although some concern has recently been expressed about the potential impact of the ozone hole and ultra-violet light on these stocks. While the importance of inter-annual variability is progressively being recognized for most pelagics and a growing number of demersals, it is clear that the assessments of many stocks would need to be more frequently revised than they are presently, particularly in the tropics were the research capacity is often deficient. These overall statistics, nonetheless indicate that, globally the state of world fishery resources should be a subject of major concern and this global assessment is sufficiently confirmed at regional, country or stock level to be taken seriously.

Environmental issues

Reflecting the general pressure exerted on natural systems from development activities, the environmental issues[10] have become increasingly significant in fisheries, posing difficult challenges. Some problems are internal to fisheries and related to: (a) depletion of the resource base; (b) insufficient

[9] See Fig.14 for a significance of these terms.

[10] Following the practice established after UNCED, "environment" is considered here in its broadest sense and includes the living resources anf their habitat.

selectivity of gear and practices with significant consequences on by-catch and discards; (c) direct damage to the environment by fishing techniques (e.g., trawling, dynamite fishing); and (d) at-sea and on-shore processing facilities and fishing ports. Other problems, among the most serious ones, are related to impacts made on the fishery resources and environment by other users.

Discards during fishing operations are a major source of concern. Alverson *et al.* (1994) have estimated that the quantities caught and discarded (probably dead and including unknown large quantities of juveniles) by the world marine fisheries amount to about 27 million tonnes. The world reported landings being 82.5 million tonnes, this means that about 25% of the fish caught is discarded and returned to the sea where it is naturally recycled. Figure 17 shows the distribution of total marine catches (average 1988-92) and estimated discards by major FAO Major Fishing Area. It can be seen that, in general, the most productive areas are also those where discards are the highest. Although the technical and economic implications of the potential solutions to the problem are not easy to deal with, this issue is one of the most critical facing fisheries today and the most damaging for their image.

Figure 17

The progressive degradation of the marine environment is another important source of concern. The major environmental problems come from the degradation of the coastal zone which includes the critical habitats, nurseries, feeding and spawning areas which sustains about 90% of the exploited world fishery resources, and where productivity is being affected by an increasing demand for coastal space and resources from a growing coastal population. It is affected locally by fishing and competing coastal activities but also by inland industrial activities and urban development, the impact of which is transferred to the coastal zone through rivers and rainfall[11]. The consequences can be particularly acute for small-scale fishing communities and fish farmers.

An extreme illustration of the problem and its potential consequences is given by the ecological collapse of the productive system in the Black Sea which, because of its magnitude and doubtful reversibility, could probably be considered the marine ecological catastrophe of the century. The fishery resources of this area, which produced about a million tonnes of landings in the late 1980s, have collapsed, through overfishing and eutrophication, to 100-200.000 tonnes in 1991 in a degraded ecosystem, 90% of which is now anoxic. The cost of this ecological disaster has been estimated at hundreds of millions of dollars leaving more than 150.000 people without a livelihood and an important fishery sector in total disarray (FAO, 1993a; FAO, 1994). In the future, similar problems may also affect other closed or semi-enclosed, low energy, and strongly stratified water bodies

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[11]According to the IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Expert on Scientific Aspects of Marine Pollution 77% of the pollution reaching the coastal areas comes from land-based sources. (GESAMP Reports and Studies, 39, 1990).

such as the Baltic Sea and large lakes. Although the above example is an extreme one and is not representative of the risks in an open ocean, it shows that the problem is serious and that without a change towards integrated management, the fate of coastal resources may be similar to, and possibly worse than, the fate of wild freshwater resources. A reasonable level of organic contamination may, however, have positive effects and indeed increase fish productivity, particularly in shallow and enclosed or semi-enclosed seas (Caddy, 1993) and that current efforts at reducing organic pollution from land-based sources may indeed reduce fisheries potential.

Natural variations in the abundance and resilience of fishery resources and the potential impact of global climate change are also a source of uncertainty for the fisheries planning and management. A complete analysis of the trends and future perspectives of fisheries supply and management should consider the impact of climate variability and global climate change on fishery systems. Both phenomena relate to the dynamics of the Ocean-Atmosphere coupling and its evolution under global environmental change. The issue is particularly well-documented for pelagic resources but not only for them. For example, the devastating effects of El Niño on the pelagic resources of Peru and Chile (Glantz and Thompson, 1981) were described long ago. The impact of less catastrophic, but possibly more frequent environmental oscillations, tend to be blurred by fishing impacts and to remain undetected or difficult to demonstrate. Such oscillations (or "regime") changes are now being reported for a large number of stocks, both demersal and pelagic, coastal or offshore, for shallow or deep resources. Coherent oscillations of groups of species are detected (Csirke and Sharp, 1984; Lluch-Belda et al. 1992), but the overall trends are hardly predictable. Important resources have undergone increases in potential from the mid-1970s to the mid-1980s such as sardine in Japan, Peru, Chile, California; anchovy in South Africa-Namibia; North Pacific Alaska pollock and other demersal fish; lobsters and other reef resources in the tropics (Bakun, 1994). Some species, such as anchovy and sardine, seem to vary in opposite directions. It is expected that some important pelagic stocks will continue to decrease, but the overall impact on world resource potential and landings remains unpredictable. The impacts of climatic oscillations can be very serious when they result in a series of low recruitment for a fishery where effort is largely in excess to the average F_{MSY}, resulting in sudden recruitment collapses. Exceptionally good recruitment can also be a problem in the sense that, temporarily improving the state of the stocks, it may delay the necessary management measures and allow fishing to grow well beyond sustainable levels.

3. GLOBAL ECONOMIC PERSPECTIVE

The information available at the beginning of the 1970s already indicated that the fishery resources of the world had a limited potential (Gulland, 1971) which was being reached rapidly and the need for improved management, particularly of effort controls, was clearly expressed at the FAO Technical Conference on Fishery Management and Development held in Vancouver, Canada, in December 1973 (Stevenson, 1974). As clearly stated in the Chairman's summary:

"It has been unanimously recognized that the resource is not unlimited,... that there is a tendency for prices to rise faster than the general level of commodity prices, ... that the pressure (on the resource) is already intense but will become more so ...and that the need for management to sustain the yield is already the rule rather than the exception" (Needler, 1974).

Unfortunately, the process of extension of national jurisdictions, in the 1970s, seems to have turned this central issue into a secondary one for two decades leading to a largely uncontrolled increase in the world fleet size and to the poor situation in which fisheries are today. In the following sections we should examine the trends in world fleet capacity, in its performance in terms of landing rates, and the relation between the two, leading to a global bio-economic assessment of the world fisheries, the limitations of which will be discussed in the last section of the paper.

Trends in world fleet size

Statistics on world fishing fleet, although not entirely complete, indicate the extent of the size of these fleets. The 1992 Lloyds Register's of Shipping lists ships of 24 meters/100 GRT and over and fishing vessels (industrial fishing fleet) comprise 30% of the total number of all ships in the Register. Although their tonnage is only 3% of the total tonnage of all ships, the replacement value of the fishing fleet is estimated at 173,000 million dollars (FAO, 1995, page 19, table1), or almost 45% of the total replacement value of all ships included in the Register (Figure 18A; FAO, 1995)[12].

The FAO Bulletin of Fishery Fleet Statistics lists the industrial fishing fleet at 38,400 ships with a tonnage of 16.6 million tons GRT (compared to the 24,400 million vessels and 13.0 million tons GRT reflected in the Lloyds Register). The FAO data also indicates that the number of decked vessels of less than 100 GRT/24 meters is about 1.14 million with a total tonnage of 9.4 million tons GRT. The FAO bulletin lists 2.3 million undecked vessels in the world, of which 32% only are powered open boats. The tonnage of these powered vessels in not recorded, but it can reasonably be assumed (based on FAO's practical experience) that their tonnage is between 2 and 4 GRT. If a rough average of 3 tons GRT per undecked powered vessel is assumed, their fleet would represent about 0.74 million tons GRT or about 3% of the world's total gross registered tonnage. The distribution of the world tonnage in fishing vessels by continent in 1989 (Figure 18B) illustrates the large proportion of vessels from Asia and the former USSR fleets.

A time series of fishing fleet data is available, in the FAO Bulletin of Fleet Statistics 1994 for ships above 100 GRT or 24m (Table 3, column 2). For the purpose of any comparison of catches per GRT in a time series, using this data as a measure of world fleet size for decked vessels, would therefore only

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[12]For further comparisons, see Table 1, page 19, in FAO (1995)

underestimate the actual tonnage of the world fleet by the tonnage of the undecked vessels, i.e. by about 3% (see above). This time series indicates that between 1970 and 1989, the actual tonnage increased at a rate of 4.6% per year, from 13.6 to 25.3 million Gross Registered Tons[13].

There are interesting comparisons to be made. During the same period, when a large number of EEZs were claimed, the size of coastal developing countries' fleets increased from 26.7% of the total number of fishing vessels to 58%, while the tonnage increased from 12.7% to 28.8%. The developed countries had started their increase much earlier. For example, in Iceland, between 1945 and 1983, the capital employed in fisheries increased by 1300%, catches increased only by 300% and the output/capital ratio decreased to less than one third of what it was in 1945 (Arnason, 1994). Many countries (e.g. Europe, Australia, New Zealand), have started programmes to control and reduce fishing fleets, sometimes with great opposition. Following economic transition in Eastern Europe, a significant part of the fleet of these countries is to be scrapped.

Figure 18 (A and B)

Trends in landings per unit of capacity

The tonnage data available in the FAO Bulletin on fleet statistics which underestimate the total world fleet size by only about 3%, can be used as an index of world fleet size, assuming that the observed trend is representative of the trend in the overall fleet.

The data summary provided in table 3 (column 3), indicates that, during the period 1970-1989, the total marine landings increased from 59.2 to 86.4 million tonnes only at an average rate of 2.4% per year. An examination of the fleet statistics of countries exploiting the main pelagic species by type of vessels shows that very little of the increase in fleet capacity has been directed to fishing those low value and pelagic species which have produced most of the increase in world catches during the last 20 years. If the five principal low value and pelagic species[14] are subtracted from the total marine catches, the landings of the other species _ thereafter called "selected" landings _ has increased from 42.9 to 61.3 million tonnes (Table 3, column 4), at a rate of 2.3% per year, i.e. at half the rate of increase of the world fishing fleet size (4.6% per year, see above). From 1975 to 1989, the total landing rate[15] (Table 3, column 6) has varied around 3.4 t/GRT, without trend, and with 1970 value of 4.4, appearing as an outlier (see also Figure 20). The "selected" landing rate (Table 3, column 7) decreased however from 3.2

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[13]In the latest revisions of the FAO data, not taken into account in this paper, this value, for 1989, appears to be 26.0 million tons

[14]Alaska pollock, anchoveta, Japanese pilchard, South-american pilchard and Chilean Jack mackerel.

[15]Obtained by dividing simply the total "selected" landings by the GRT index.

to 2.4 between 1970 and 1989, with an average of 2,5 and, in this case, 1970, with a value of 3.2, fits perfectly with the rest of the data. It seems, therefore, that during the period 1970-1989, the apparent maintenance of the world fleet productivity in global terms (around 3.4 t/GRT) conceals the fact that its yield in higher value species decreased by 25% despite technological progress (spotter planes, factory and mother, satellites, sounders, wide opening nets, etc.).

One could have expected that this relative and progressive degradation of the species composition of the landings would have resulted in decrease in the value of the landings (or revenues) and economic yields, providing the necessary economic signals of overcapacity and of the need to regulate fishing more efficiently.

In order to check this assumption, the deflated value of the total landings[16], or total revenues, has been examined for 1970, 1978 and 1989, the only years for which this type of data is available[17], together with the index of revenue per GRT. The data given in Table 3 (columns 5 and 8) and Figure 21 show that, while the overall fleet size increased by 87.4%, total landings by only 46% and "selected" landings by only 43%, the total value of the landings increased by more than 107%. The same data show that while, from 1970-1989, the total landing/GRT appeared stable around 3.4 t/GRT, and the "selected" landing/GRT decreased by 25%, the revenue/GRT increased by 38%, from 2,100 to 2,300 dollars/GRT.

This indicates that the economic incentive for growth in fleet capacity has been at least maintained and possibly increased with time, despite the repeated signs of overfishing of individual stocks and the repeated warnings of scientists at national, regional and international levels.

The fact that the total catch and value per GRT remained stable from 1970 to 1989 does not mean that fisheries were performing well. The consequences of the expansion have been a drastic reduction in abundance and spawning potential with an increase in resource instability. The phenomenon has been verified at national level and some examples can be given. In San Miguel Bay (Philippines), for example, available data on species abundance indicate that 4 species accounted for 75% of the biomass in 1947, against 5 in 1980-81 and more than 7 in 1992-93. In the meantime, stock density decreased by more than 80%, from 10.6 to 2.0 tonnes/km^2 (Cinco *et al.* 1994). In the Philippines' Samar Sea, the resource abundance dropped from 8.0 to 3.5 kg/day between 1981 and 1990 while the number of commercial species of major importance dropped from 250 to 10 and 100% of the fishermen are living below the poverty line and even below the food threshold (Saeger, 1993).

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[16]Based on the 1978 US dollar value.

[17]These data (starting from 1990) are now included in the FAO Yearbook of Fishery Statistics: Commodities, Volume 77, 1993, Table K.

Global biological assessment

At the beginning of the 1970's, FAO predicted that the potential of the world traditional fish resources (small pelagic, large pelagic and demersal fish) was close to 100 million tons (Gulland, 1971)[18]. This work stressed, in addition, that *"in practice no more than 80% of the potential in an area may be harvestable because of the difficulties of ensuring the best management of each individual stock"*. For all practical purposes, and because it would not be feasible to extract MSY from every stock (assuming that this would even be an advisable objective) the world potential of traditional species would be close to 80 million tons. The landings from marine fisheries passed this level in the mid-eighties. Adding to these, the avarage 27 million tons of fish caught, but discarded (FAO, 1994) would bring the present catches above 100 million tons. It seems therefore clear that the maximum production of traditional fishery resources is either being approached or already reached (see Fig.1) and this seems to be confirmed by the fact that the annual rate of increase of the world marine landings is approaching zero (Fig 19).

The data available on world fleet size, "selected" landings, and landing rates from 1970 to 1989 (Table 3) point to an inverse relationship between fleet capacity and landing rates which would indicate the possibility to fit a global production model to the data provided that the data on GRT represent the trend in fishing mortality and the landing rates the trend in global abundance of world resources. During the same period, however, the average fishing power of the components of the world fleet have increased due to technological progress and the changes in landing rates (quantities landed/GRT) may not reflect the true changes in resource abundance, and indeed underestimate its decrease.

Fitzpatrick (1995) estimated the relative value of the "*technology coefficient*" calculated for 13 different types of fishing vessels ranging from super trawlers (of 120 meters) to pirogues (of 10 meters) in 1965, 1980, and 1995, taking the value of the coefficient in 1980 as a basis. On average, this coefficient has increased from 0.54 ± 0.26 in 1965 to 1.0 in 1980 (the basis) and 2.0 ± 0.9 in 1995. The evolution of this relative coefficient approximates the changes in the efficiency of these vessel types, from a technological point of view. The coefficient apply to new vessels and not to entire fleets where vessels of various ages and technological levels are mixed. However, new technologies tend to be adopted rapidly by existing vessels often with government subsidies. We assumed therefore that the trend indicated by Fitzpatrick reflected the trend in efficiency for the world fleet and that these relative efficiency values could be combined with data on world fleet size in GRT to better reflect the likely increase in fishing pressure exerted by this fleet. Interpolating between the 1965, 1980 and 1995 values given by Fitzpatrick, we have estimated the relative technology coefficient for the years 1970-1989 (Table 4). Multiplying the world fleet capacity in GRT (Table 4, column 2) by the relative coefficient of technological efficiency (Table 4, column 3), a

[18]This estimate did not include discards.

corrected index of world fishing fleet capacity in "standard" GRT (indicated below as GRT*) has been developed (Table 4, column 4). The corrected fleet capacity and index of fishing mortality appears to have increased by 332%, from 9.3 million GRT* in 1970 to 40.2 million GRT* in 1989. The "selected" landings[19] per unit of fleet capacity, and abundance index of the "selected" species, decreased from 4.4 to 1.2 tons per GRT* (Table 4, column 5). The total landings per unit of capacity, which appeared stable in Table 3, decreased from 6.4 to 2.4 t/GRT* (Table 4, column 6).

The relationships between the fleet corrected capacity, landings, and landing rates, for "selected" and total landings are graphically represented on Figure 20. The limitations of the available data are easily recognized as well as the problems of applying the production model theory to an aggregated world "stock". For want of a better global approach to the dynamics of the world fishery sector, and because the relationships appear coherent, a simple exponential model (Fox model) has been fitted to the data to take into account the non-linear appearance of the relationship. The results are:

(a) For "selected" landings

n: 13
R^2: 0.95
a: 5.180
b: - 0.033
MSY: 57.7 million tons
f_{MSY}: 30.5 million GRT*

The results indicate that the Maximum Sustainable Yield of the "selected" species (excluding the five principal pelagic species) would be at 58 million tons and that the corresponding index of effort would be of 30.5 million tons of corrected GRT*. The comparison of this estimate with the effort and landings in 1989 (the latest data point available in the analysis) shows that the GRT* in 1989 was 132 % of the MSY level for selected species and that the landing in 1989 was 106 % of the estimated MSY. The results indicate therefore that the world resources of "selected" species is exploited beyond the MSY level with an overcapacity of at least 30%[20].

(b) For total landings

n: 13
R^2: 0.95
a: 5.41
b: - 0.025

[19]Excluding the five main low value and small pelagic species.

[20]By reference to the capacity required to produce MSY. A more precautionary approach would require larger reductions in capacity.

MSY: 82.8 million tons
f_{MSY}: 42,0 million GRT*

The results indicate that the Maximum Sustainable Yield of the total world resource would be at about 83 million tons and that the corresponding effort would be 42 million GRT*. The comparison of this estimate with the effort and landings in 1989 (the latest data point available in the analysis) shows that the GRT* in 1989 was 98% of the MSY level for the total world resource and that the landing in 1989 was practically equal to the MSY. The results indicate therefore that, when all species are considered together (including the 5 main pelagic species) the world resource appears as exploited at MSY level.

The two results would confirm that the species of higher value (the "selected" species) are more affected by the overcapacity and require more drastic measures than the small pelagic species. The results tend to confirm that the progressive inclusion of fluctuating small pelagic species to the world landings have concealed the overfishing of the high value species. They are also in close agreement with the more detailed resources assessments provided in section 2 which showed that 69% of the resources for which data is available are either fully or overfished (Figure 14) and that, with the exception of some pelagic resources and molluscs, most types of resources are fully fished or overfished (Figure 16).

Figures 19 and 20

Global economic assessment

The production curve obtained above for the total world fishery resource may be combined with data on value to produce a total world revenue curve which may be combined with data on the cost of fishing for a very approximate bio-economic assessment of world fisheries.

Based on data from FAO (1993, page 17, Table 21), showing the estimated total landed value of marine landings in 1989, an average price of 862 dollars per tonne has been calculated for the world landing in 1989. Multiplying the production curve for all species by their average unit value, a total world revenue curve, in US dollars, has been obtained (Figure 21). A rough and conservative estimate of the total and operating costs for 1989 (not including the opportunity cost of capital and debt servicing) have been calculated by FAO (1993, page 52, Table 29). These values are respectively about 3600 and 4600 US dollars per GRT (uncorrected)[21] leading to total and operating costs of about 91,000 and 116,000 million dollars respectively for a fleet size of 25.3 million GRT or 40.2 million corrected GRT*. These two points have been plotted on figure 21 and joined to the origin of the graph to represent the relation between total world fleet capacity and operating or

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[21]It is interesting to note that the present cost of a GRT of a fishing vessel is about 10 times the cost of a GRT in any other type of vessel, excluding military ones (Fitzpatrick, pers. comm.).

total costs, assuming a simple linear function. For the sake of comparison and validation, the calculated deflated value (base = 1989) of the total catch for 1970, 1978, and 1989 (respectively 34.0, 57.5 and 70.0 thousand million dollars) have been reported on the graph at their corresponding respective levels of corrected capacity. Their position in relation to the calculated revenue curve (calculated without using them) shows a surprisingly good agreement and indicate that, despite the obvious approximations in the analysis, the results are coherent. The conclusions that might be drawn from the analysis are:

(a) The Maximum Sustainable Revenue (MSR) for the entire world resource of traditional species (at 1989 prices) is 71,400 million dollars corresponding to a fleet size of 42 million GRT*.

(b) The theoretical value for the revenue at equilibrium corresponding to the fleet capacity available in 1989 (40.2 million GRT*) is practically equal to the MSR and very close to the actual value of the landings, estimated at about 70,000 million dollars (FAO, 1993, Table 21, page 17). It could therefore be concluded that the situation prevailing in 1989, both in terms of fleet size and economic yields corresponded practically to the MSR.

(c) The total costs (about 116,000 million dollars) and running costs (91,000 million dollars) incurred in 1989 are much higher than both the actual and equilibrium revenues for that fleet size (around 70,000 million dollars). The deficit (not including the opportunity cost of capital and debt servicing) is of 46,000 million US dollars (in relation to total costs) and 21,000 million dollars (in relation to running costs). These levels of deficit have already been emphasized by FAO (1993).

(d) To make the world fishery sustainable on an economic basis, at 1989 levels of fleet size, would therefore require lowering the costs per unit GRT by about 43%, or increasing ex-vessel fish prices by 71%, or else a combination of the two. Price increases will be limited by the price of products of substitutes. A substantial lowering of the cost of production could be obtained by making more efficient use of artisanal fisheries and reducing the use of long-range fleets.

(e) To reduce the deficit by only adjusting the fleet capacity, it would be necessary to reduce the fleet to the point where the cost and the revenue functions intersect. For the revenues to cover operating costs, (point X on figure 21) the world capacity should be reduced by 25% (from 40.2 to about 30.0 million GRT*) with a loss of revenues of about 4% only. For the revenues to cover total costs (point Y on Figure 21), the world fleet should be reduced by 53% (from 40.2 to about 19 million GRT*)[22] with a loss of

[22]It is interesting to note in this respect that the draft objectives for the European Union fisheries for the period 1994-97 foresee a 30% reduction in effort in most of the important fisheries (CEC, 1993).

revenues of 21% only. These reductions in fleet capacity would lead to a significant improvement in catch rates of about 20% in the first case (point X) and 60% in the second case (point Y).

In practice, it is likely that an overall economic rationalization of the world fishery would require a combination of measures related to prices, to unit costs and to fleet capacity, in particular when one of the objectives will be to maximize employment.

CONCLUSIONS

After a long history of fisheries growth all available data point to the conclusion that the total potential of traditional species has been reached on the average even though there are differences between species groups and regions. The species composition of landings has changed over time, showing and that the world fish supply is increasingly relying on small pelagic and other low value species, characterized by large fluctuations in year to year productivity, concealing the slow but steady degradation of the demersal high value resources.

The extent to which this generalization is correct varies between species groups and regions but the problem of overfishing, stressed in the 1946 London Conference on Overfishing, has clearly become general and concerns now all regions of the world. Following the extension of exclusive economic zones, developing countries are progressively taking a "leading role" in the overfishing problem as they develop their own fishing capacity, from 28% to 58% of the world fleet complement, prompted by a high demand on their local markets as well as on the developed countries' markets. More than half of the 20 top producers in the world are developing countries. The trade in fish and fishery products has increased from 5 to 11% of the trade in agricultural products and the developing countries appear as net exporters while developed countries appear as net importers. Trends in prices depend on species groups and reflect increased scarcity for some high value as well as the effect of substitutes (surimi) and aquaculture production. For industrial species used for fish meal, the fluctuations in price are dampened by the much larger production of soya, their main substitute.

The analysis of the state of stocks by species groups and by region show that about 70 % of the fish resources for which data is available are either heavily or fully fished, over-exploited, overfished, depleted, or recovering from depletion. High value demersal resources (cods, hakes) are the most affected but many small pelagic stocks are also affected. The analysis also shows that in all regions, there is a need to control more strictly the expansion of effort and to reduce it in most cases. It is suggested that despite the approximations affecting the analysis, the results confirm that, globally, the state of world fishery resources should be a subject of major concern and taken seriously by all Governments, in their EEZs and in the high seas. It is also stressed that the situation created by the world overcapacity is compounded by the progressive degradation of critical environments in the coastal areas and, possibly by climate change.

The analysis of the trends in the size of the world fleet (in GRT), landings and landing/GRT show that, while the total world fleet size and technological capacity to fish increased, the world fleet landing rates were maintained at about 3.4 t/GRT, but the landing rates of the higher value species decreased by 25% despite technological progress. Revenues per GRT, however, increased by 38%, providing the incentives for fisheries growth despite the resource decline. This decline, already apparent in the "selected" species group without correction for the fleet efficiency, becomes even more conspicuous when taking into account the effects of technological improvements, indicating a 62% decrease in the global abundance index and 73% decrease in "selected" species index, between 1970 and 1989.

When the main pelagic and low value species are excluded, the world resources appear to be overfished with an excess capacity of about 30%. When all species are included in the analysis, the world resource appears to be fished at the level corresponding to MSY, a result which hides the fact that many resources are severely overfished and some still moderately exploited but indicates also that: (a) there is little or no room for major increases in world catches of traditional species, and (b) that the world priority should be on arresting the growth of fishing fleets and in implementing fleet reduction schemes to return to safer and more economic levels of resource biomass. The analysis confirms that there is little hope that landings of traditional species can be sustainably increased on traditional species with the present fishing regimes and discarding practices.

The economic analysis shows that despite the decrease in the resource base, the incentive to fish and to increase fleet size remained because prices increased, maintaining and even raising the revenue extracted per GRT. It also confirms that the present revenues from fisheries at capture level cannot cover the cost of fishing and that a global deficit of 46,000 million dollars exist, which would require a reduction of fishing costs (-43%), or an increase in price (+71%), or a reduction of the world fleet capacity (-25 to -53%) and probably a combination of the three types of measures.

DISCUSSION

In preparing this paper, we had to face the challenge imposed on us by the organizers of the meeting, i.e. to show and explain the global trends in fisheries. We were aware of the dangers of aggregating data to such high levels and of the difficulty to interpret their changes. However, as the data were pooled together and the analysis progressed, a coherent picture emerged despite the sources of potential bias in the data and the analysis, which have probably been pushed to their limits. We are aware of the fact that non-weighted "averages" of relative levels of exploitation applied to species groups across regions far apart, and to regions across species with widely different life cycles and resilience, is certainly a perilous exercise. Using indexes of world fleet capacity (from an incomplete database), global indexes of fishing efficiency, and total landings (of dubious accuracy) to develop a production model for the whole world is also certainly dangerous and may even appear unreasonable to some scientists. We would argue though that, in the absence of better data and alternative analysis, this is the "best scientific evidence available" at the moment (using the terminology of the 1982 UN Convention for the Law of the sea) and that it would not be very "precautionary" to totally disregard it, in spite of the significant implications it has for fisheries sustainability, because it does not satisfy some of the traditional statistical requirements.

We cannot be sure of the accuracy of the findings but the emerging picture is so bleak that we believe that it is our duty to put out the information and the warning it contains (once again). A global picture is required, by Governments, by the press and by NGOs, because world fisheries have attracted attention, at global level, in the UN General Assembly, at the UN Conference in Environment and Development (UNCED), in the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, and in FAO where an International Code of Conduct is being developed. No doubt that better analysis could certainly be undertaken, at regional and national level, with less aggregated data. Some have already been done. Too many are lamentably lacking. We hope that this paper will promote more analysis of this kind, particularly at country level, were the dynamics of the entire fishery system is often still to be properly understood, if only to disprove locally the global conclusions arrived at in this paper.

The analysis indicates that the world fleet presently available is practically at the f_{msy} level and that no significant additional landings or revenues can be expected by simply increasing fishing capacity. The present fishing pressure is not evenly distributed and the conclusion that fish resources are "globally" fully fished conceals the fact that some are already overfished, while a few others others may be able to produce more. The results obtained in the paper seem to confirm, at global level, the diagnosis already repeatedly established for many national and international fisheries (for which a lack of economic analysis is obvious). The results imply that:

- at current levels of costs and prices, global fisheries can only be maintained through significant subsidies to the capture sector, partly externalizing its high costs. This conclusion is supported by many analyses carried out at national level where the sector has been shown to be dissipating the resource rent, supported by important direct or indirect subsidies.

- at present capacity levels, costs could be reduced by making better use of artisanal fisheries and using fishing techniques which reduce costs, such as passive gears (set or drifting gillnets, longlines), and concentrating fish (such as fish aggregating devices and artificial reefs).

- substantial reductions in effort levels would reduce costs, or boost productivity or both. One of the first measures to contain and reduce fleet sizes will be to reduce or suppress subsidies or redirect them towards effort-reducing measures (buy-back schemes, etc.).

- ex-vessel prices may be too low and vertical integration between the capture, processing and distribution sub-sectors may also be required to ensure that part of the profits made by processors and retailers is redistributed to better cover the cost of capture. Alternatively, prices could be improved through more competition, by increasing the independence of fishermen in negociating prices from buyers.

Stock productivity could be boosted by rehabilitating degraded critical habitats, and reducing impacts on juveniles (by closed areas and seasons). It is impossible to assess the potential impact of reducing discards, and improving their marketing would not improve sufficiently the total revenue to be of relevance (even though, the problem must be addressed for biological and ethical reasons). All of these measures would move upwards the yield curve.

It is not certain that this global assessment depicts correctly what would happen if a substantial reduction in capacity was implemented as the model cannot capture the complex reactions of the fishery sector, and the depressed resource base, to such a reduction. The abundance and landings of large predators and other preferred species would certainly increase and this would tend to improve prices. In many areas the protection of juveniles, using closed areas and seasons, could raise the production curve substantially, in tonnage and value, as shown in Cyprus and in the Philippines where biomass and MSY could be doubled in 18 months (Garcia and Demetropoulos, 1986). However, if these improvements were obtained too rapidly, the prices could also fall abruptly through market saturation, as shown in Italy, when such a closed season was experimentally introduced.

Altogether, it seems difficult to avoid that, in the future, a large part of the presently hidden costs of fisheries be made more transparent (i.e. known to society), and progressively reduced or passed to the consumer. The fact that prices may sometimes be "too low" relative to costs is illustrated in a recent analysis by Westlund (1995) of the perspectives of pelagic fisheries in West Africa and has confirmed that "*small pelagics are available in the sea but it seems that consumers (i.e. low income groups) cannot pay the price covering the costs of (industrial) production*".

The large imbalance between the cost of fishing and its revenues has already been underlined in Garcia (1992) and FAO (1993). In this last paper it was roughly estimated that, in 1989, the investment in fishing fleets was about 320,000 million US dollars. The opportunity cost of this capital, based on a 10% annual return on capital, is 32,000 million dollars per year, or 46% of the ex-vessel value of the world landings (which amounts to about 70,000 million US dollars). Despite the approximations involved, this figure illustrates the disproportionate share of the wealth extracted from the ocean fishery resources being absorbed by a fleet capacity which is grossly in excess of what would be required from the economic and biological standpoints. The large deficit observed would indicate that the world capture fisheries are operating under conditions of over-investment and overcapacity. If the excess of technology is largely imported, as in many developing countries, the wealth generated by fisheries in these countries may be partly transferred abroad[23].

The progress of world landings in the last 30 years has concealed the worrying and sometimes alarming situation of some of the major fish resources and, in particular, the high value demersal species. The real situation was, however, very well known. Global assessments such as presented here may not have been so frequently available, but an important number of assessments have been published, at national and regional level and were accessible to managers and policy makers. Put together, they left very little doubt about the relative state of the world resources and fisheries and, for the most part, have been disregarded.

A perspective view of the process of development of world fisheries since 1945, the date FAO was established, has been provided by Garcia (1992), Garcia and Newton (1993). These papers described how the heavy fishing rates (and often the overfishing) which characterized the North Atlantic before the Second World War progressively spread to the North Pacific in the fifties, to the Eastern Atlantic (West Africa) and Eastern Pacific (Latin America) in the sixties, to the Indian Ocean and the Antarctic in the seventies, to the South Pacific and Southwest Atlantic during the eighties. This extension of fishing pressure has been supported by remarkable progress in technology (boat design, gear, positioning systems, detection equipment, on-board fish preservation) which has allowed long-range fleets to stay away from home for longer and longer periods of time.

The increase in fleet size and the development of larger and safer vessels have resulted in significant excess fishing capacity, which can be rapidly transferred from one overfished stock or area to the next. The drastic measures being taken to reduce effort or restructure fisheries in the North Atlantic and Eastern Europe is releasing an important excess effort which is on the market at very low cost. As a consequence, the full exploitation and depletion of the remaining world resources which, in the 1950s, would have taken 10 years or more to reach, can now be reached practically instantly. In addition, the extension of jurisdiction and restriction of access to resources have led to transfers of at-sea processing capacity from developed to developing countries, accessible through forms of barter arrangements (processing capacity against fish). Last, but not least, modernization of artisanal fisheries gear (e.g., introduction of monofilament and multi-monofilament set gill-nets, medium-scale driftnets, modern purse-seines with outboard engines, portable echo-sounders and positioning systems, etc.) can increase many times their fishing capacity and pressure on the resources, rapidly, dramatically and at a relatively low cost.

The process of "colonization" of distant fishing grounds, originally by a limited number of developed countries (USA, Japan, Eastern and Western Europe) was accompanied by resource collapses, provoked by a combination of exceptional

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[23]e.g., the acquired excess fleets generates employment and revenues in the developed countries shipyards.

climatic conditions and excessive fishing (e.g., Peruvian anchoveta, Namibian pilchard, Atlanto-scandian herring) or purely through overfishing (e.g. Mauritanian lobsters, Western Sahara seabreams, Gulf of Thailand demersal fish, Philippines coral reef resources). It has generated conflicts between coastal countries and Distant Water Fishing Nations (DWFNs) which led to the extension of national jurisdiction to 200 miles through a process which started in 1947 and which, eventually, was completed with the entry into force of UNCLOS at the end of 1994. The resources of the high seas, which represent about 10% of the world catches have been progressively deteriorating (FAO 1992b, 1993; Garcia and Majkowski, 1992) because of inadequate or lack of national and international control of high seas fishing and non-compliance with management measures agreed to, with difficulty, in international or regional fishery management fora.

All these developments, added to the powerful incentive represented by rising prices in a market globally limited by supplies, has led to a very volatile situation for most world fishery resources, particularly in developing countries, with a very high risk of overfishing. The impact of mismanagement (including lack of consideration of natural variability in stock potential and resilience) on the northwest coast of the Atlantic is costing hundreds of million US dollars per year with a loss of an important number of jobs in the fishery itself, plus many more in the related industries and activities. The economic disaster in the Black Sea is of the same order of magnitude and it is doubtful that developing countries could afford such an economic shock.

It is, therefore, too late to argue about the probability of occurrence of something which has already become a sad reality; it is time to "bite the bullet" and one of the questions is: how much should the capacity be reduced? The UN Convention on the Law of the Sea (1982) requires that stocks be maintained at the level at which they could produce their Maximum Sustainable Yield (MSY). Recognizing the scientific uncertainties about this concept and the exact position and value of MSY, and the need for a precautionary approach to fisheries management, the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, 1993-1994), with the advice of FAO, has proposed to consider MSY as a minimum international standard, particularly for stock rebuilding strategies and not as a target for catch levels. Under that interpretation, stocks should be exploited, in most cases, at levels of effort below f_{msy}, maintaining stock biomass at levels higher than B_{msy} and these reference points would be considered as thresholds at which corrective action has to be taken (Garcia, 1994; FAO, 1994b). Similarly, overfished resources should be rebuilt <u>at least</u> to B_{msy} and preferably at even higher biomass levels.

The large direct and indirect subsidies required to keep the world fishery going indicates that fisheries represent a significant cost to the world society[24]. It may be that fisheries generate social and other benefits, particularly in the

[24]Not including other costs such as those related to environmental degradation from fishing and damage to biodiversity.

coastal areas, which are not reflected in the fisheries revenue curve and justify the subsidies received. But it is not clear whether, confronted with an objective choice, society would not prefer to see its contribution used differently, e.g., for better schools or health systems. Such an analysis, at world level is impossible and meaningless, but it should be undertaken at national and regional levels (in case of shared resources).

As a consequence of strengthened management schemes, the real or opportunity price of access to fish stocks in developed countries is likely to increase. On the contrary, in developing countries the need to obtain foreign exchange through fishing agreements and the deficiencies in management schemes (including monitoring, control and surveillance systems) will put the price of access to their resources at a lower level, particularly if developed countries subsidize the "expatriation" of their excess fleets. The consequence, in environmental and economic terms, is that, as already stressed by Garcia and Newton (1993), the risk of depletion of the developing countries' fish resources to the benefit of the developed markets is increasing through international trade. The trends observed since the early seventies, in both fleet transfers through joint ventures and international trade, may indicate that the process has already started and that the differential in the price of access to the resource between the two worlds, combined with subsidies, has led to increased use rates in developing countries. The recent examples of economic disasters in the Northwest Atlantic demonstrate without any doubt that the risk is not just theoretical for countries that will never have the economic capacity of developed countries to stand the socio-economic consequences of such a crisis.

The interaction between environment and trade is one of the most explosive issues following UNCED. It should be obvious that, a world fishery system based on active exchange through trade[25] and large exports to the developed world can only be globally sustainable if the resources supply in the developing exporting world are exploited in a sustainable manner. This is obviously not the case in most areas and, if developed countries continue to export their excess fleet capacity to the developing world, the system can only continue to deteriorate while fisheries will further increase the debt of the developing world.

ACKNOWLEDGEMENTS

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[25] Particularly as a consequence of the GATT Uruguay Round.

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Fishing Area	Landings (10^3mt)		
	1970	1992	
Northwest Pacific	12.1	24.2	+ 100.0%
Southeast Pacific	13.8	13.9	+ 0.7%
Northeast Atlantic	10.6	11.1	+ 4.7%
West. Cent. Pacific	3.9	8.2	+ 110.3%
West Indian	1.6	3.8	+ 137.5%
East Indian	0.8	3.3	+ 312.5%
East. Cent. Atlantic	2.5	3.3	+ 32.0%
Northeast Pacific	2.6	3.2	+ 23.1%
Northwest Atlantic	4.1	2.6	- 36.6%
Southwest Atlantic	0.7	2.1	+ 200.0%
West. Cent. Atlantic	1.4	1.7	+ 92.8%
Mediterranean	1.1	1.6	+ 45.5%
Southeast Atlantic	2.5	1.5	- 40.0%
East. Cent. Pacific	0.8	1.4	+ 75.0%
Southwest Pacific	0.1	0.9	+ 800.0%
Antarctic	0.4	0.4	+ 0.0%

Table 1: Total marine landings in 1970 and 1992 and relative increase

Country	1991	1992 (dif.%)
Russian Federation	1,705,870	1,020,876 (-40%)
Ukraine	728,466	396,145 (-47%)
Lithuania	438,515	145,238 (-67%)
Latvia	335,720	94,349 (-72%)
Estonia	286,714	81,998 (-71%)
Georgia	51,109	40,125 (-20%)
Former USSR	3,546,394	1,778,681 (-50%)

Table 2: Reported landings from long range fleets (in metric tonnes)

Year	GRT (10^6t)	Total Landings (10^6t)	"Selected" Landings (10^6t)	Total Value (Deflated) (base=1978) (10^9\$)	Total Landing rate (t/GRT)	"Selected" Landing rate (t/GRT)	Value/GRT (Deflated) (base=1978) (10^3\$)
1970	13.5	59.2	42.9	28	4.4	3.2	2.1
1975	17.3	58.6	49.2	n.a.	3.4	2.8	n.a.
1978	19.3*	63.0	52.7	35	3.3	2.7	1.8
1980	19.8	64.5	52.5	n.a.	3.3	2.7	n.a.
1981	20.0	66.5	52.5	n.a.	3.3	2.6	n.a.
1982	20.8	68.3	52.3	n.a.	3.3	2.5	n.a.
1983	21.2	68.3	53.1	n.a.	3.2	2.5	n.a.
1984	21.8	73.9	54.6	n.a.	3.4	2.5	n.a.
1985	22.5	75.7	55.2	n.a.	3.4	2.5	n.a.
1986	23.5	81.1	57.3	n.a.	3.5	2.4	n.a.
1987	24.1	81.7	59.9	n.a.	3.4	2.5	n.a.
1988	24.8	85.7	61.4	n.a.	3.5	2.5	n.a.
1989	25.3	86.4	61.3	58	3.4	2.4	2.3

Table 3: **Fleet capacity (>100 GRT or 24m), total landings, "selected" landings (excluding the 5 main pelagic species), total deflated value (1989 base) and indexes of catch per unit of capacity (in tons per GRT) and value (in thousands of dollars per GRT).**
*** The tonnage for 1978 has been interpolated.**

Year	GRT (10^6t)	Technology Coefficient	"Corrected" GRT* (10^6t)	"Selected" Landing rate (t/GRT*)	Total Landing rate (T/GRT)
1970	13.5	0.69	9.3	4.6	6.4
1975	17.3	0.84	14.5	3.4	4.0
1978	19.3*	0.93	17.9	2.9	3.5
1980	19.8	1.00	19.8	2.7	3.3
1981	20.0	1.07	21.4	2.5	3.2
1982	20.8	1.13	23.5	2.2	2.9
1983	21.2	1.20	25,4	2.1	2.7
1984	21.8	1.26	27.5	2.0	2.7
1985	22.5	1.33	29.9	1.8	2.5
1986	23.5	1.39	32.7	1.8	2.5
1987	24.1	1.46	35.2	1.7	2.3
1988	24.8	1.53	37.9	1.6	2.3
1989	25.3	1.59	40.2	1.5	2.1

Table 4: **Fleet capacity (> 100 GRT or 24m), technology coefficient, corrected fleet capacity and landing rates for "selected" and total landings.**

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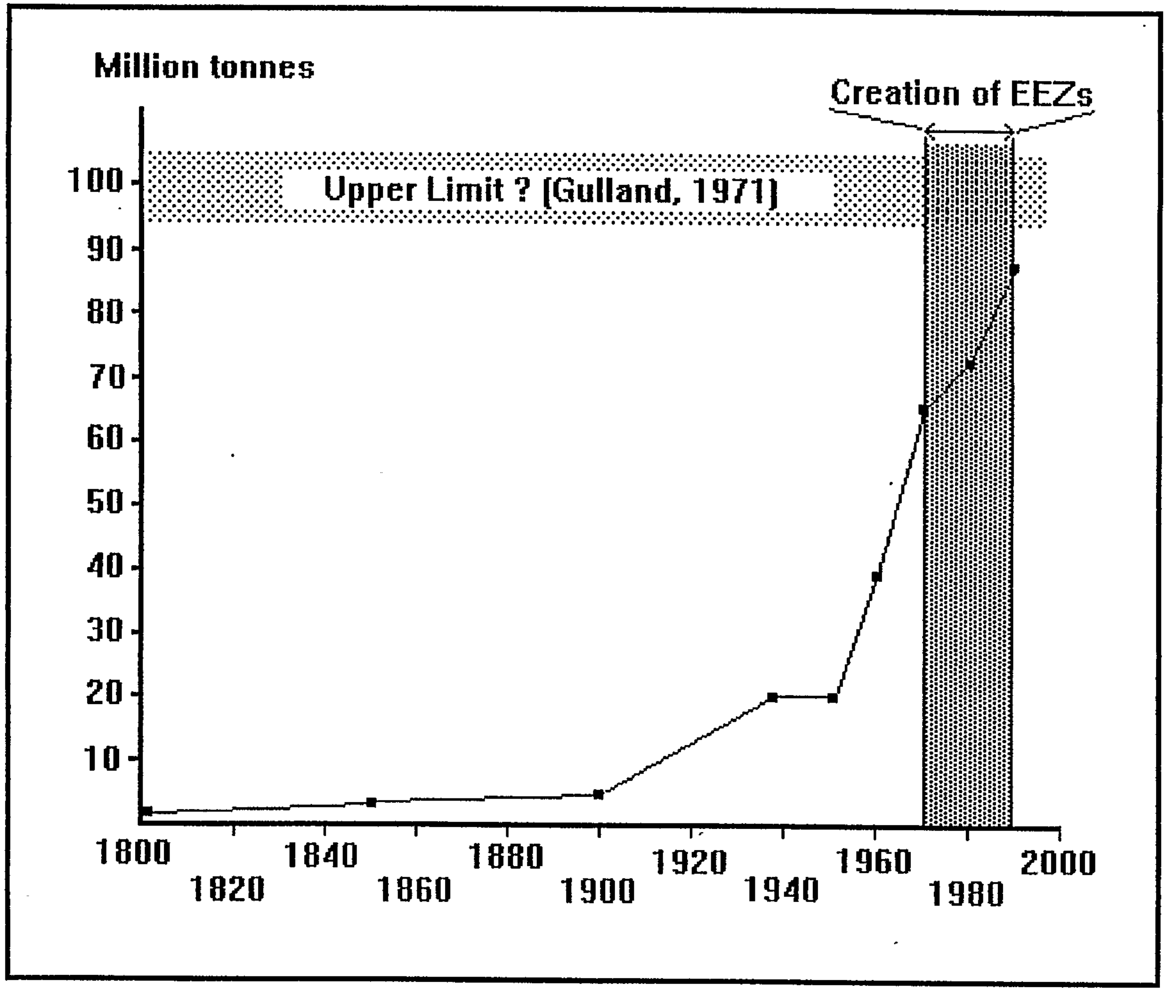

Fig 1

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Fig 2

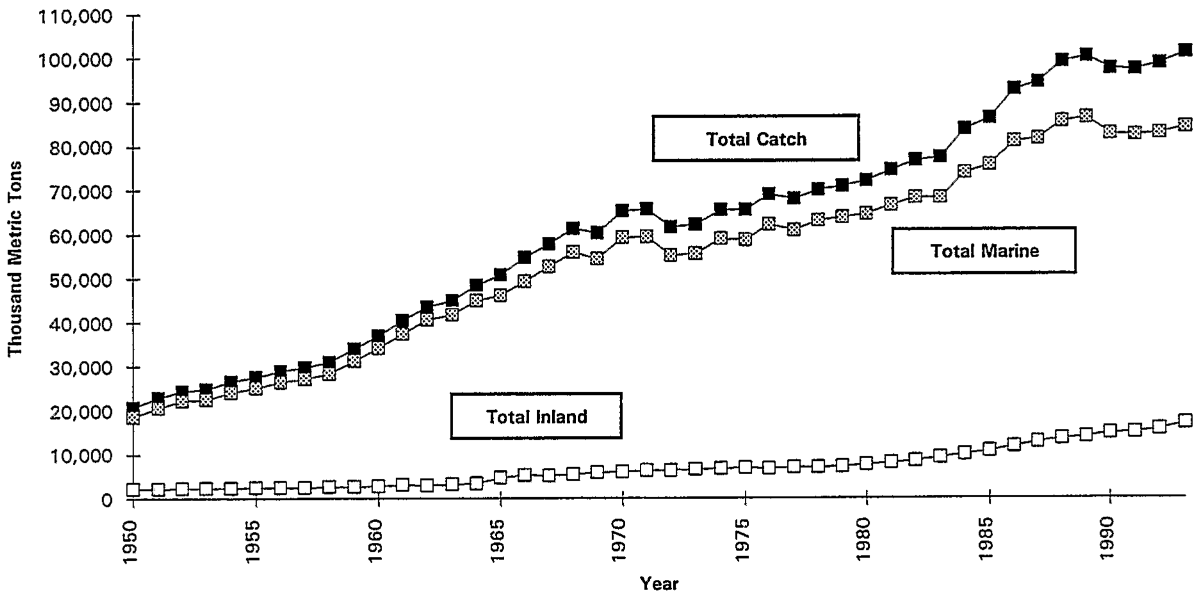

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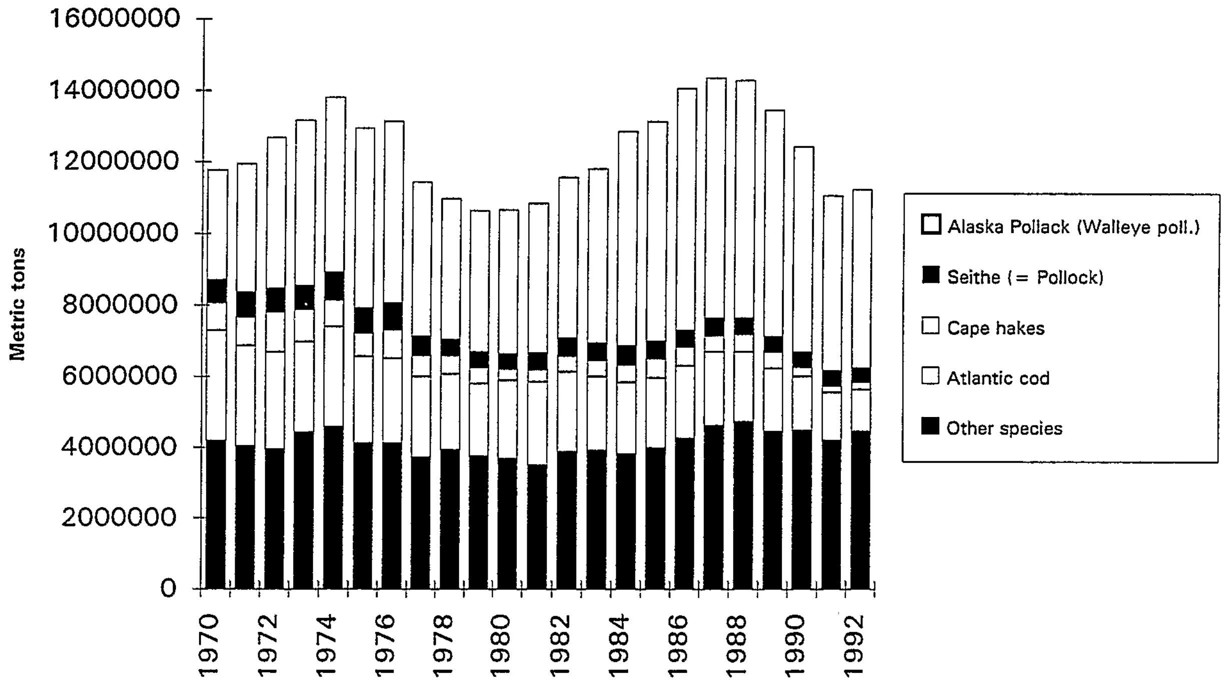
Fig 3



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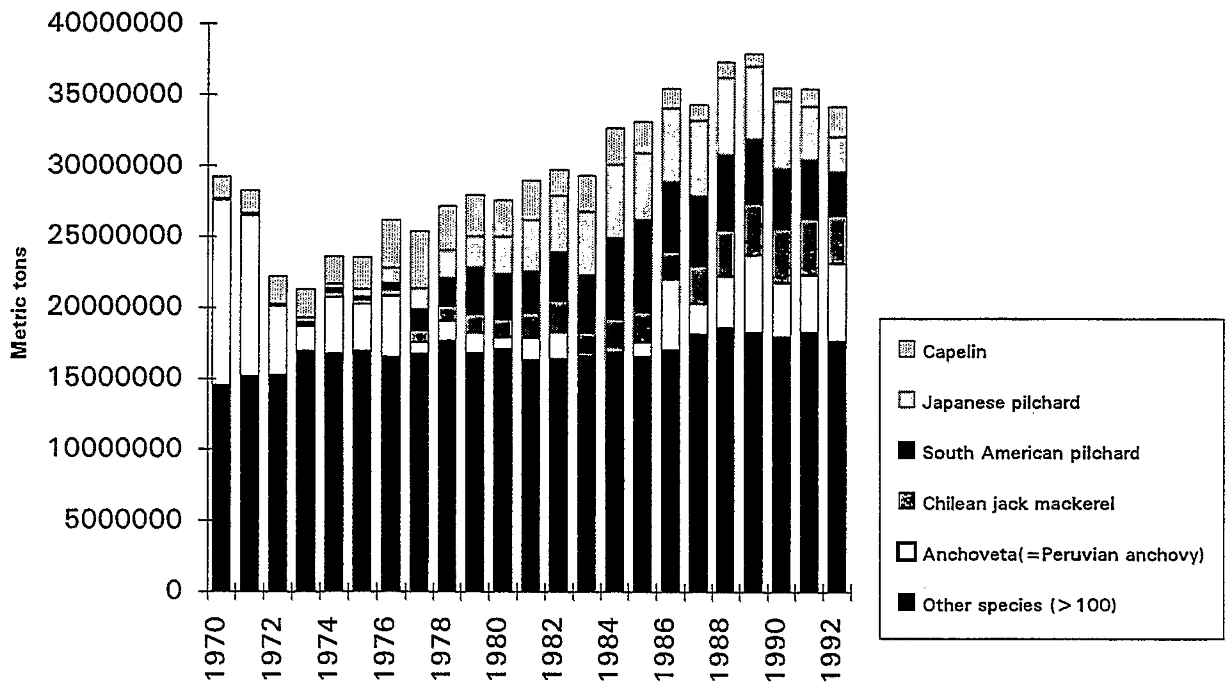

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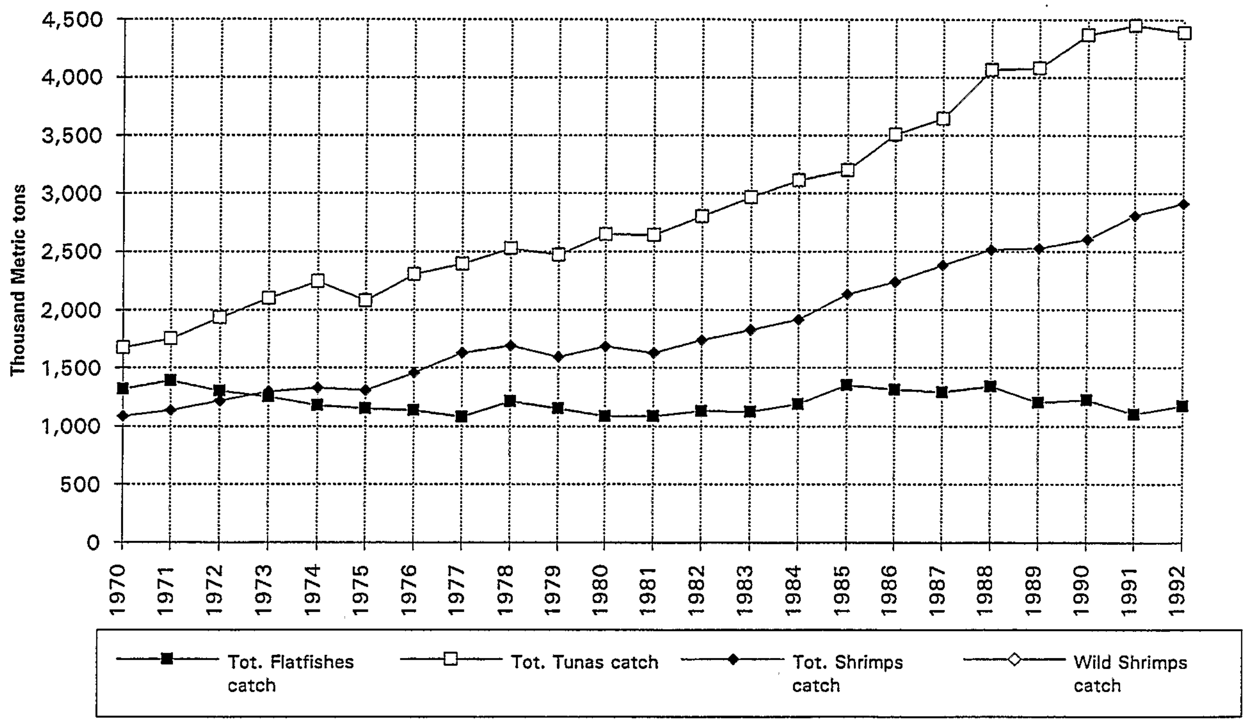

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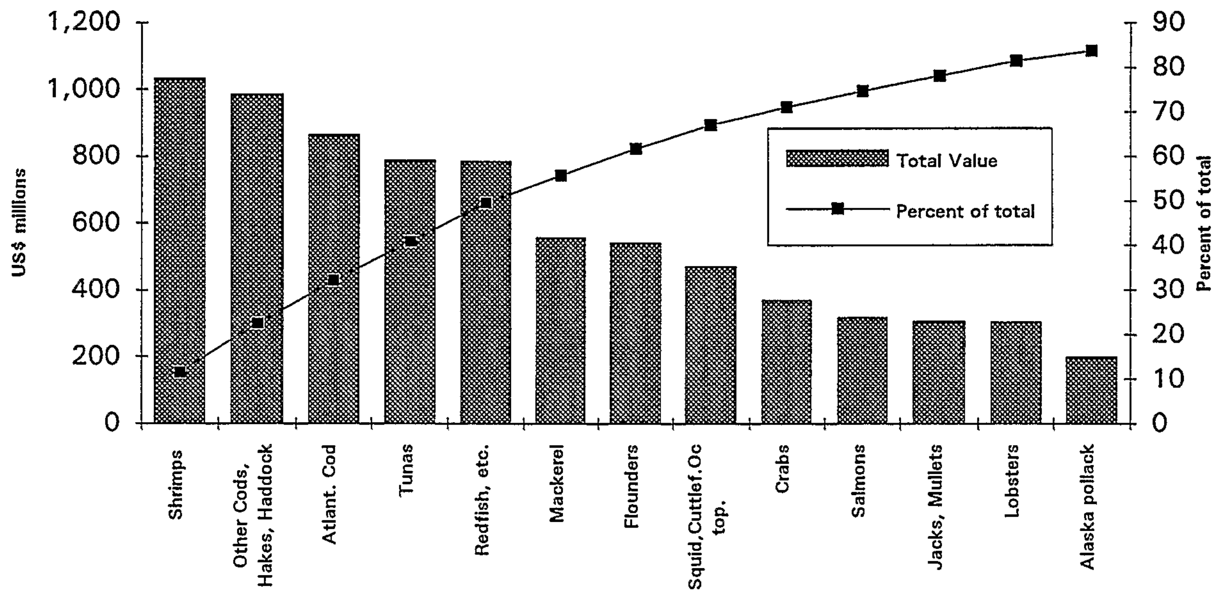

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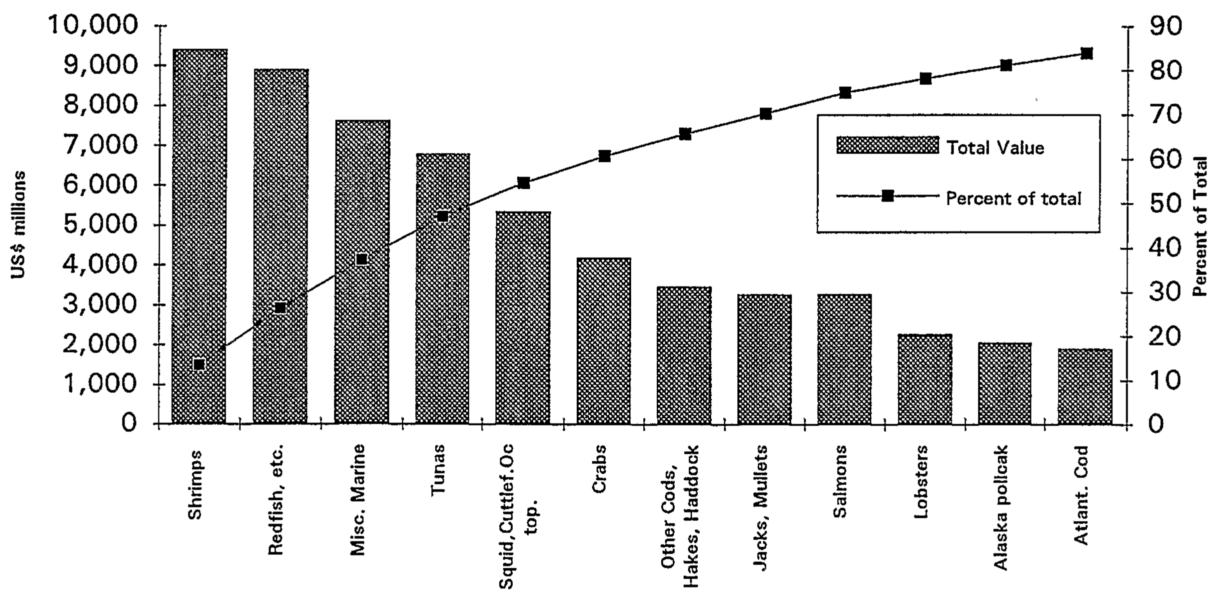

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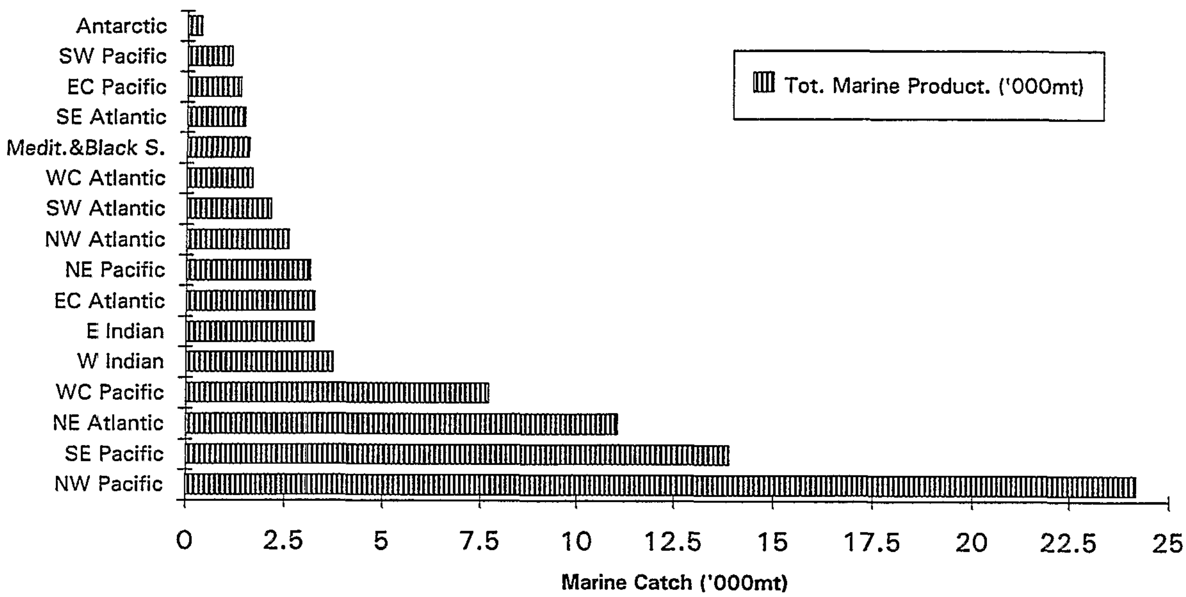

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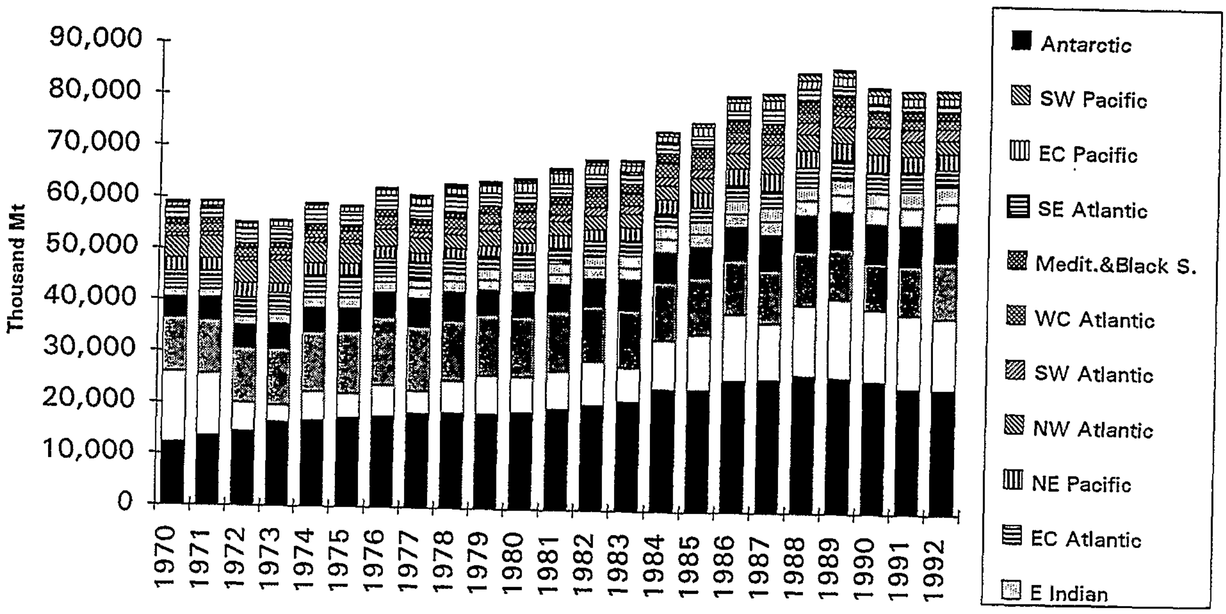

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Develp93.xls

Fig. 8A

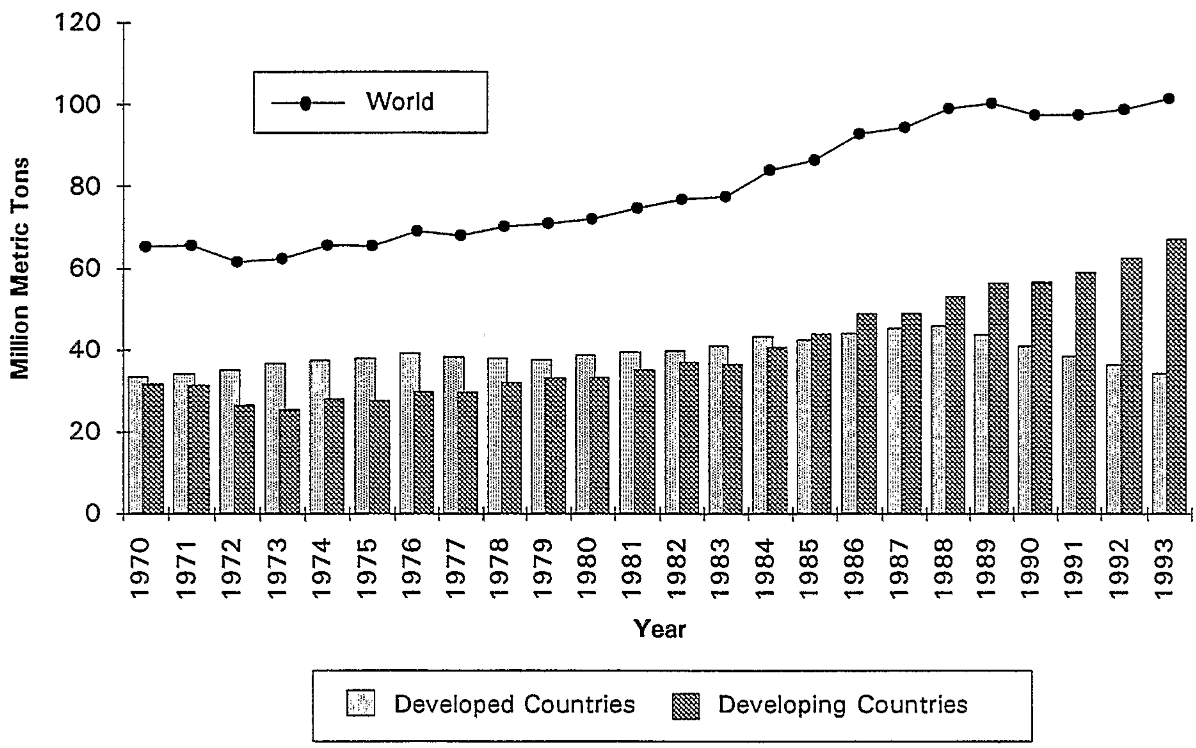

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Fig. 8B

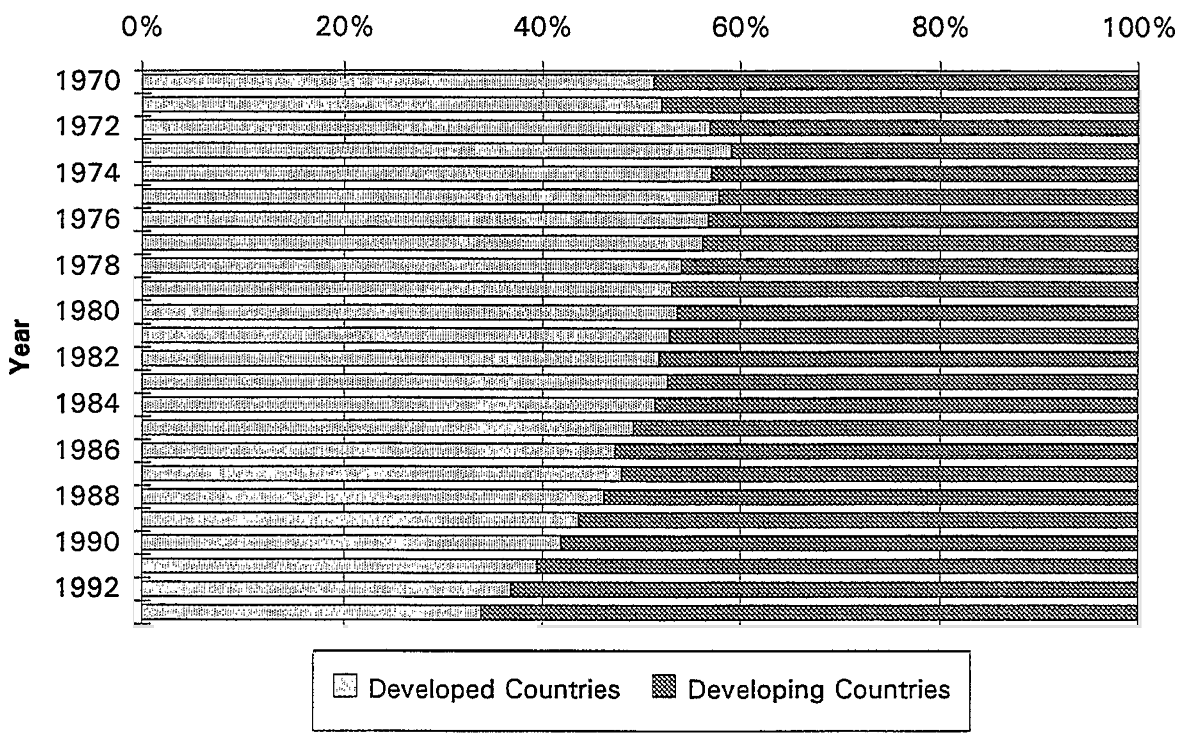
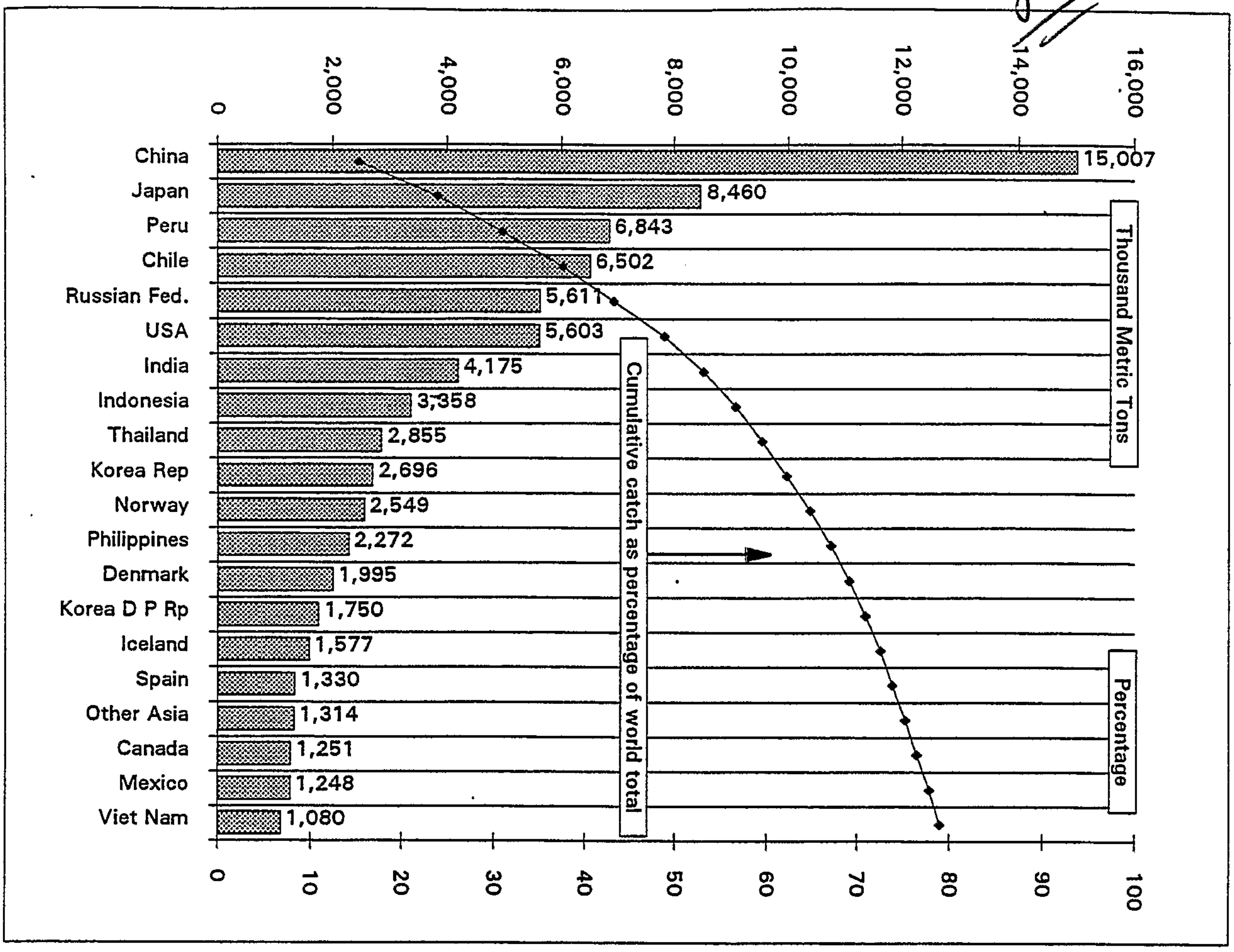


Fig 9

1992



1970

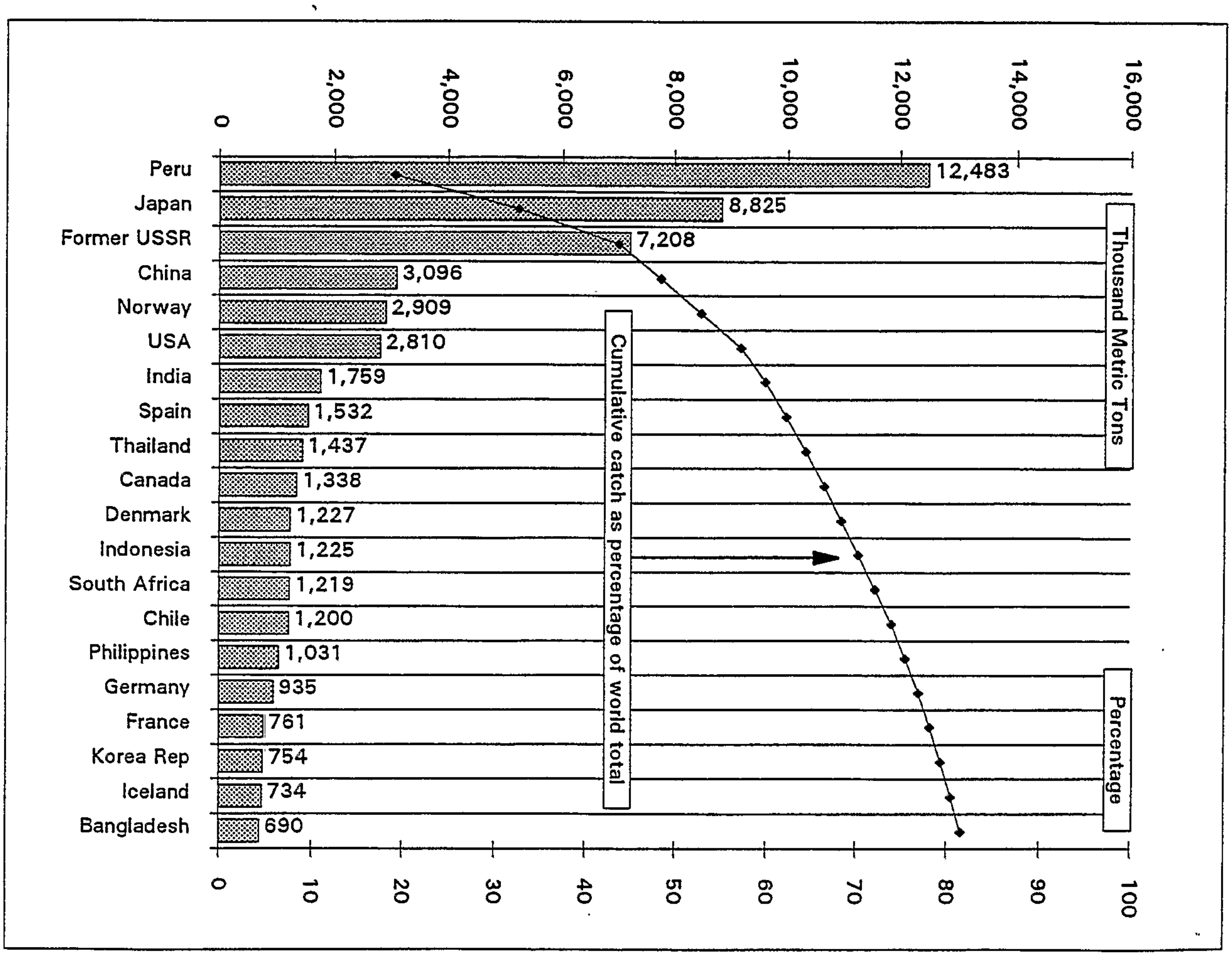


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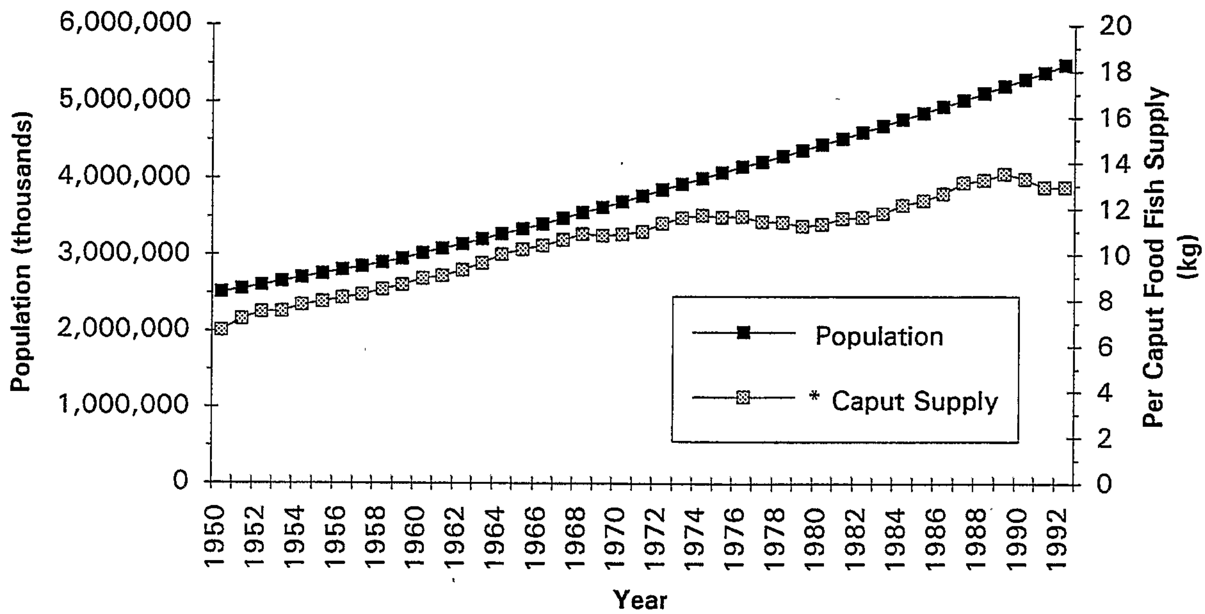
Fig 10



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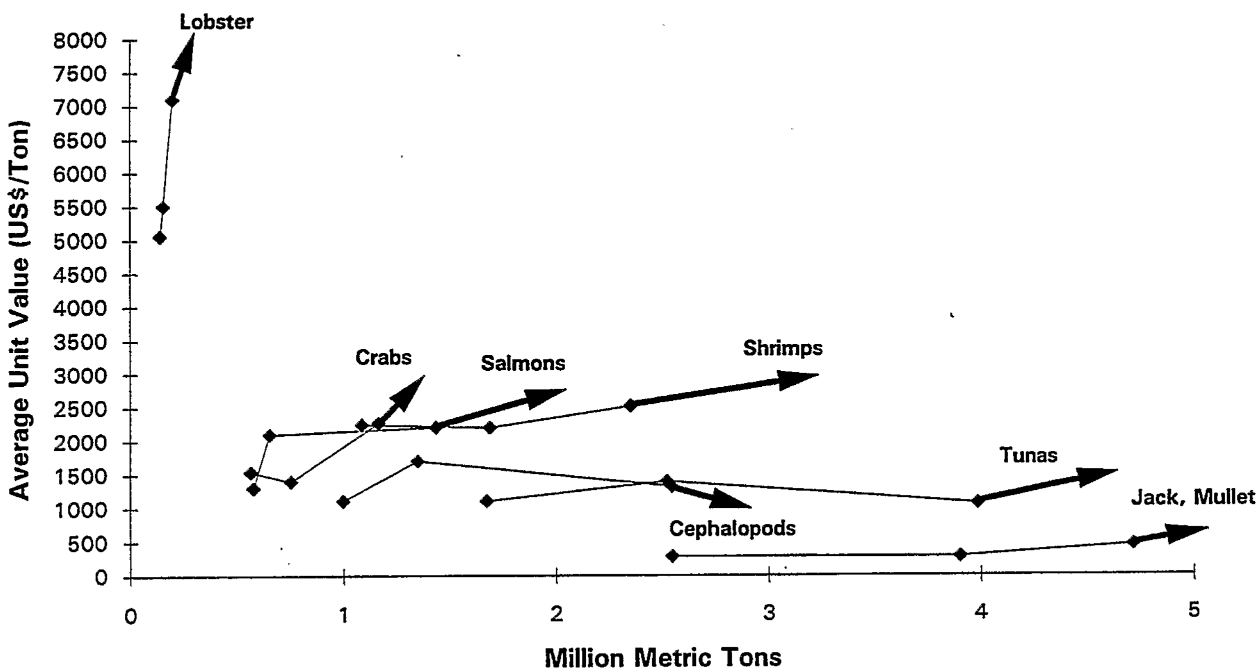

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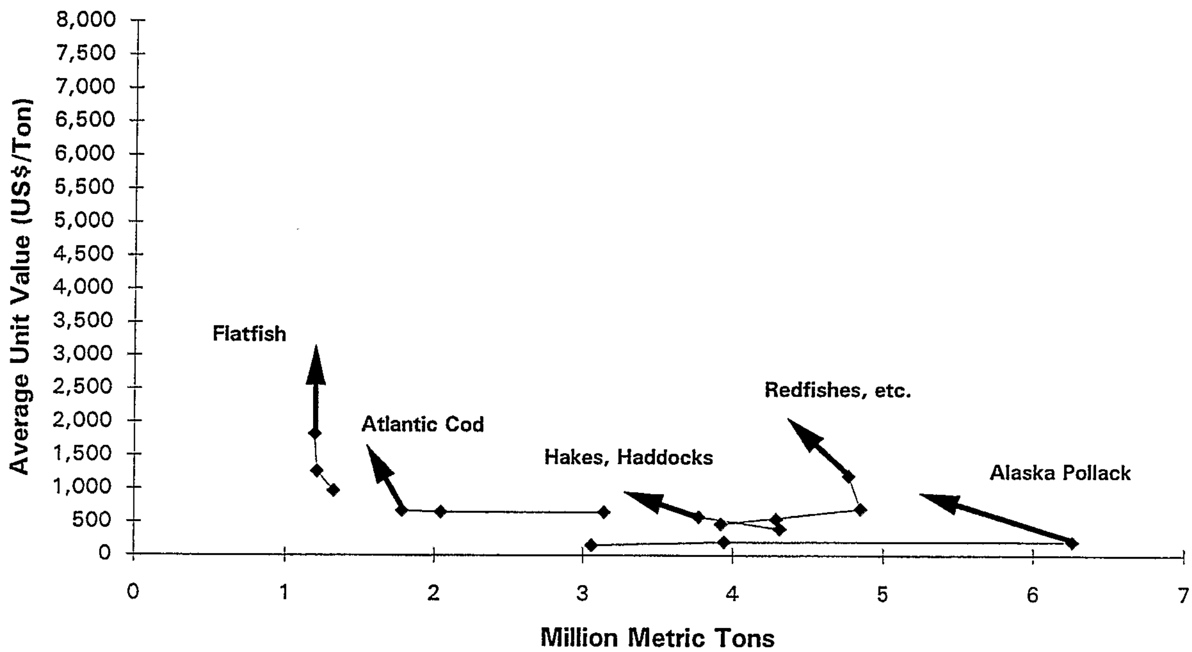

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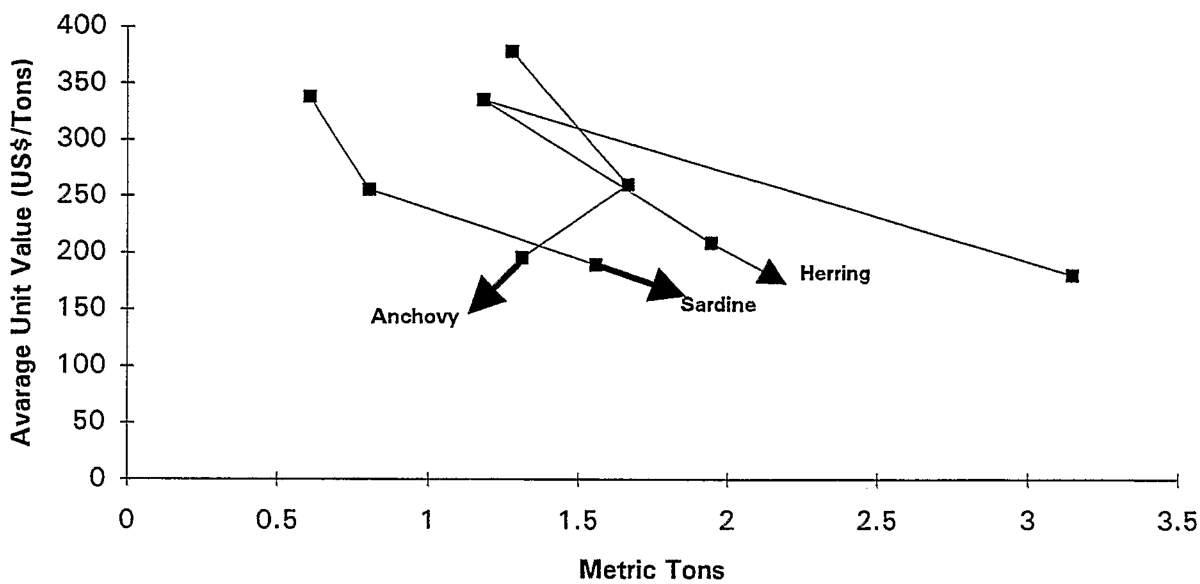

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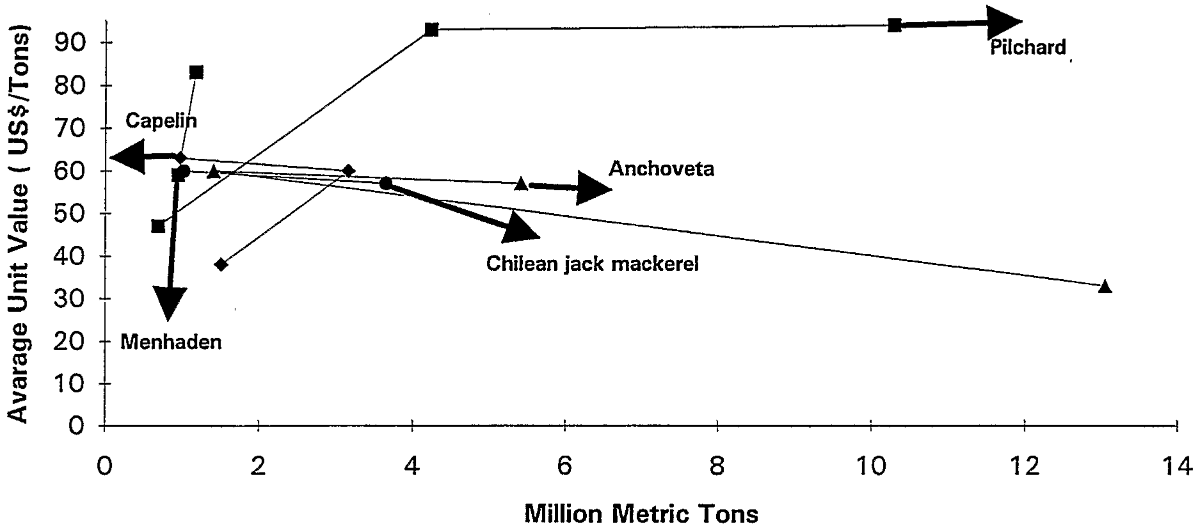


Fig. 13

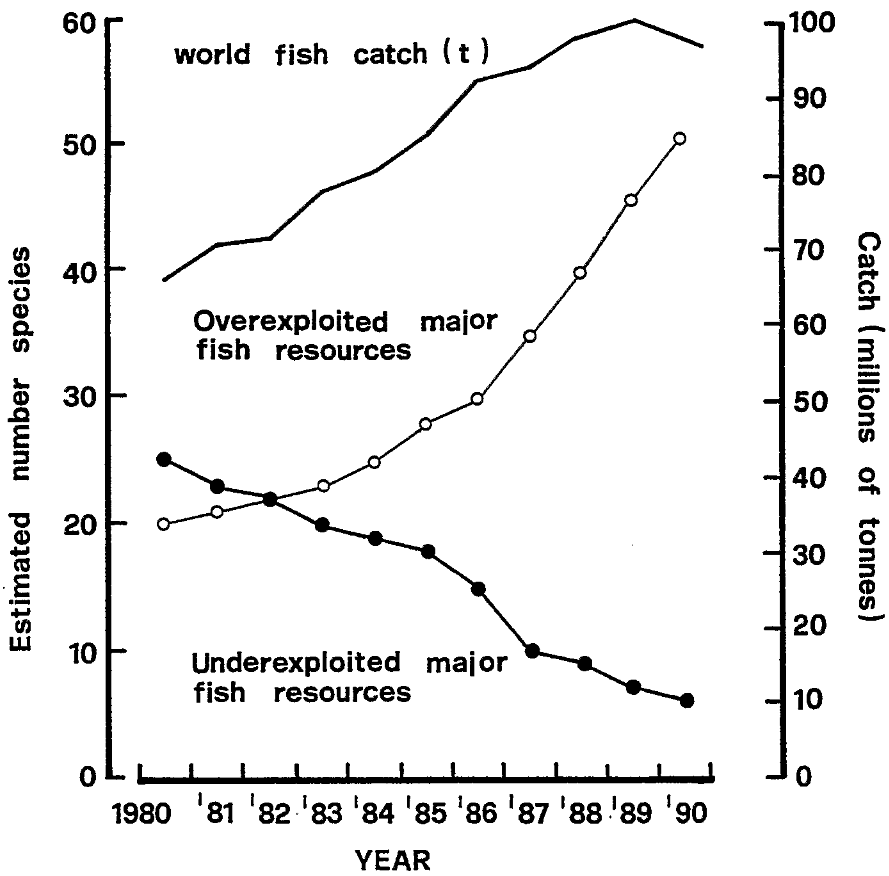
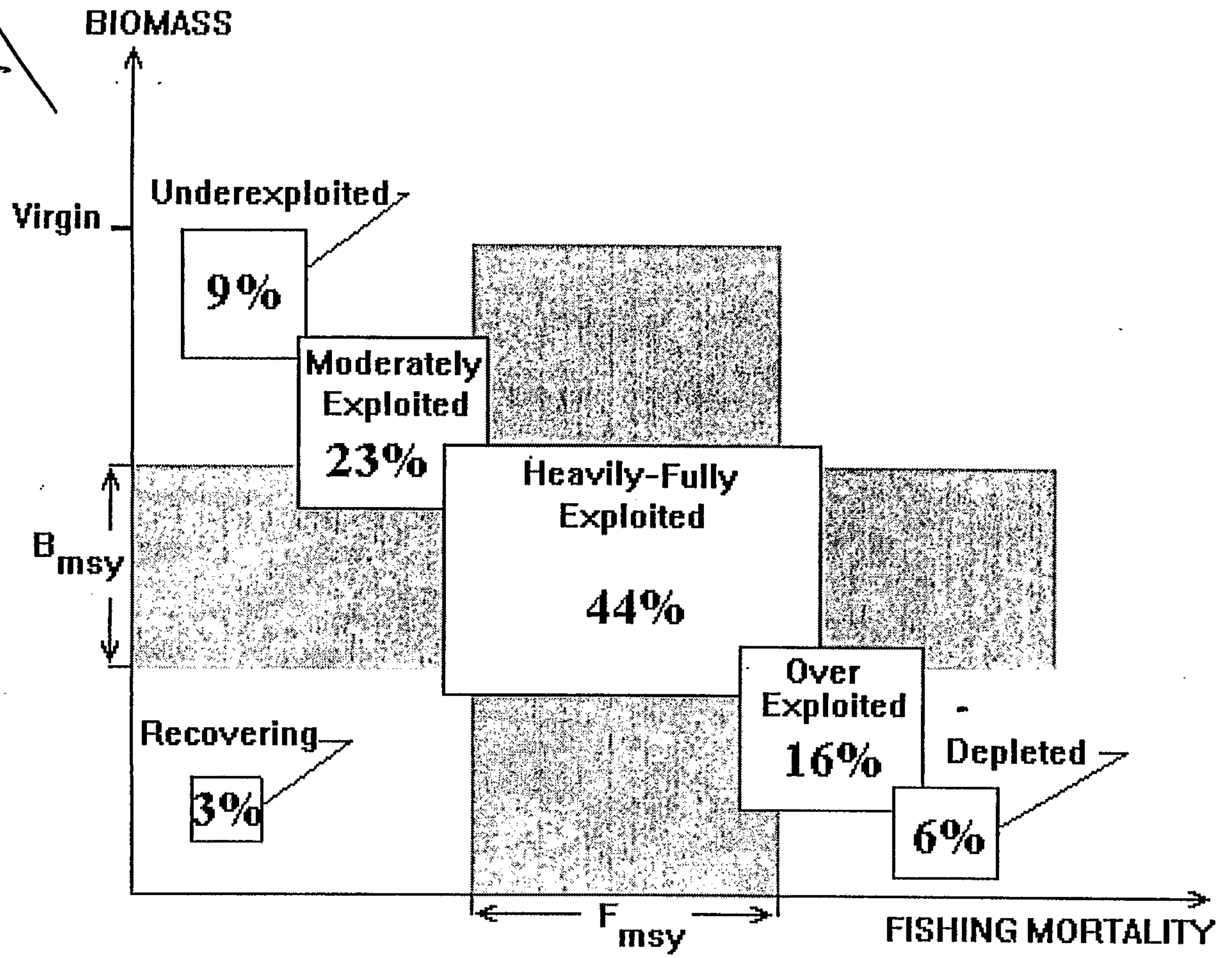

world fish catch (t)
Overexploited major fish resources
Underexploited major fish resources
Estimated number species
Catch (millions of tonnes)
YEAR
1980
'81
'82
'83
'84
'85
'86
'87
'88
'89
'90
0
10
20
30
40
50
60
70
80
90
100

Fig 14

gara 14.bmp
150%



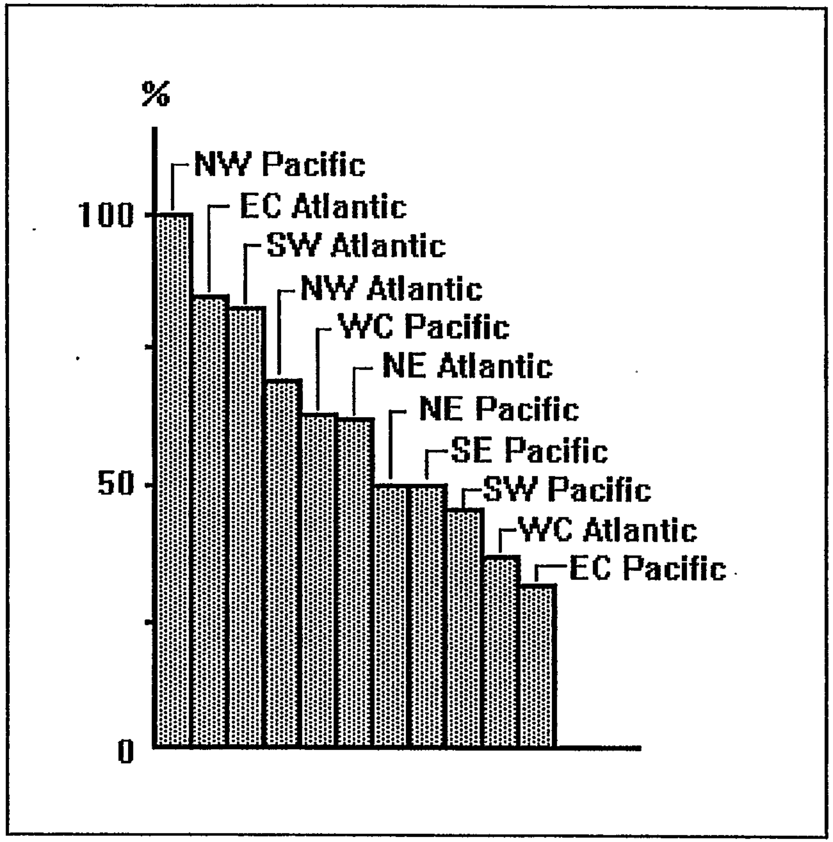
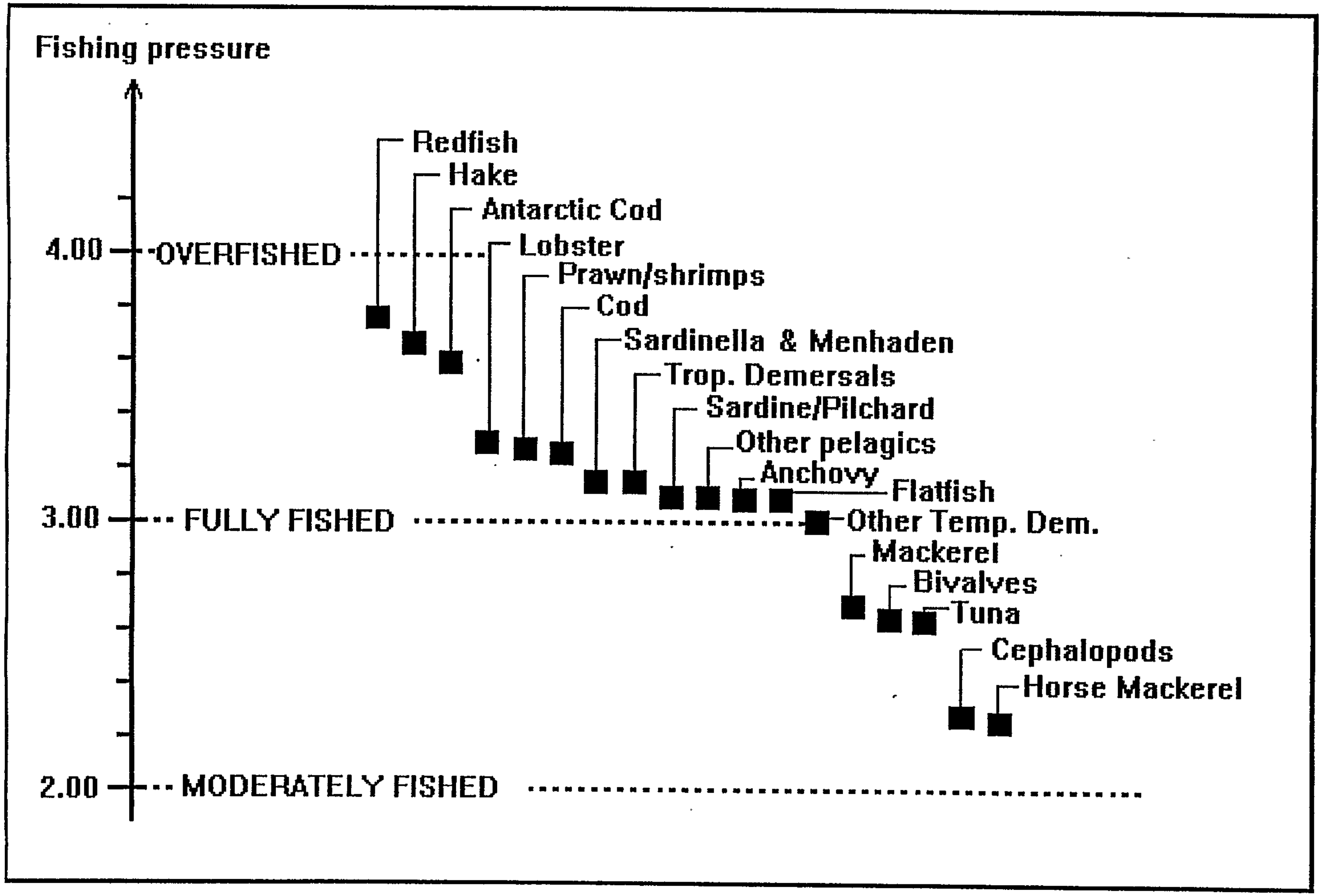
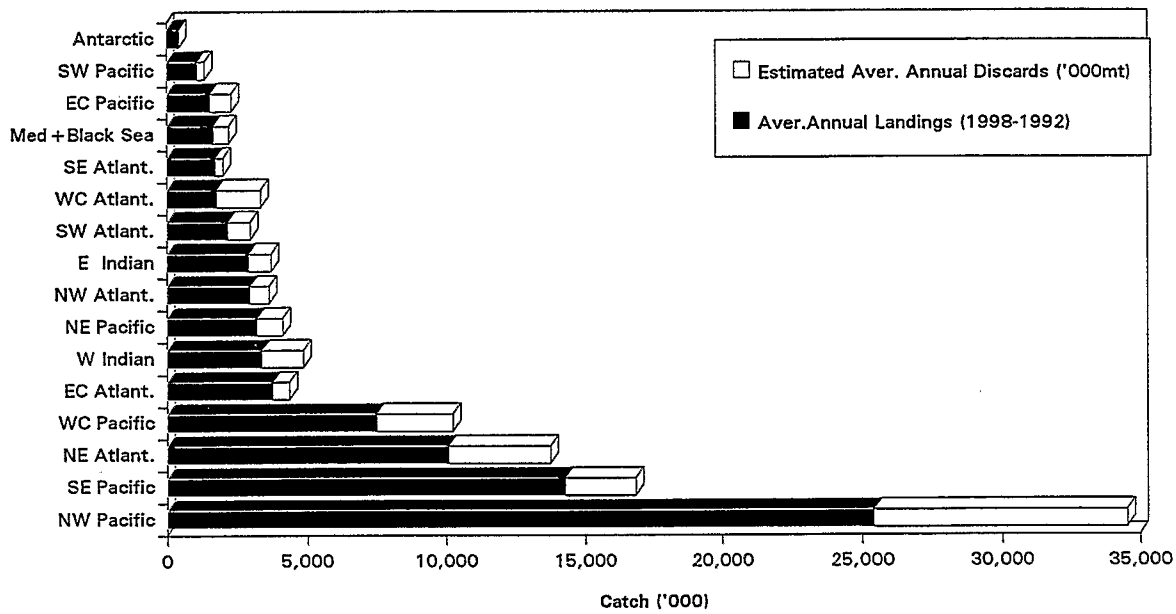

%
100
50
0
NW Pacific
EC Atlantic
SW Atlantic
NW Atlantic
WC Pacific
NE Atlantic
NE Pacific
SE Pacific
SW Pacific
WC Atlantic
EC Pacific

Fig 16


Fishing pressure
4.00
OVERFISHED
3.00
FULLY FISHED
2.00
MODERATELY FISHED
Redfish
Hake
Antarctic Cod
Lobster
Prawn/shrimps
Cod
Sardinella & Menhaden
Trop. Demersals
Sardine/Pilchard
Other pelagics
Anchovy
Flatfish
Other Temp. Dem.
Mackerel
Bivalves
Tuna
Cephalopods
Horse Mackerel

fcatt94.xls

Fig 17



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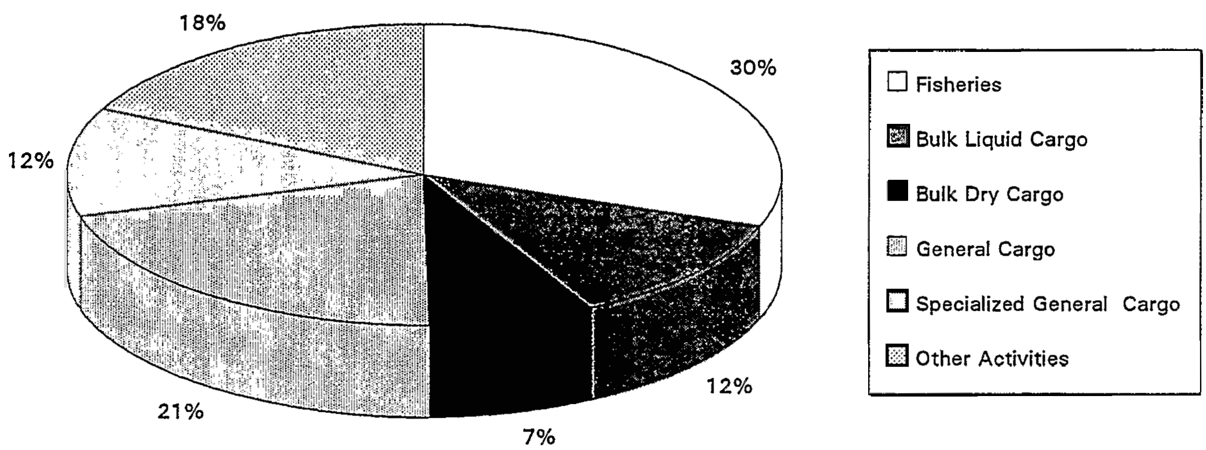
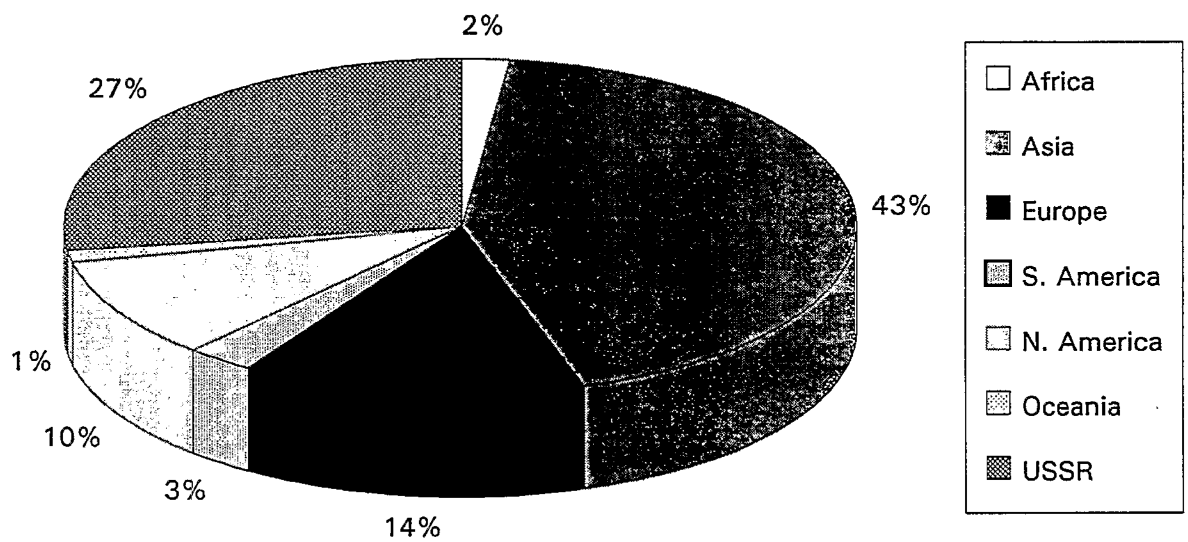
18A



* Source: World Fleet Statistics, Dec. 1992. Lloyds Register, London.

Feattle94.xls

18B



Garci13.bmp
150%

Fig. 13

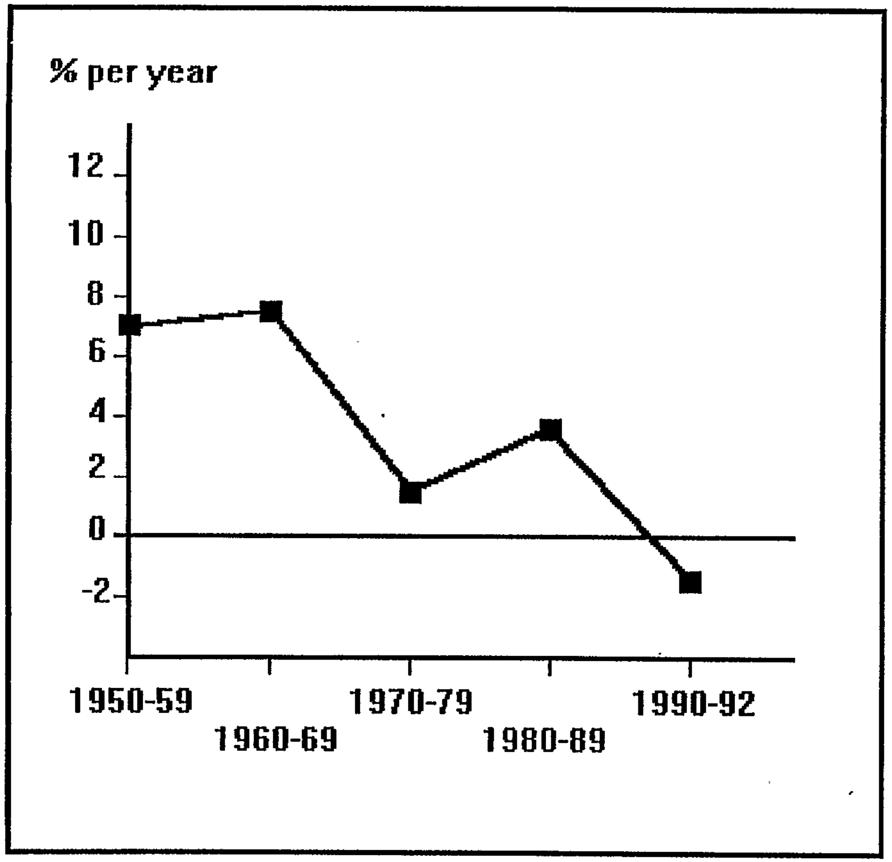


Fig 20 ORIGINAL NO FIG Hand drawn

Fig 20

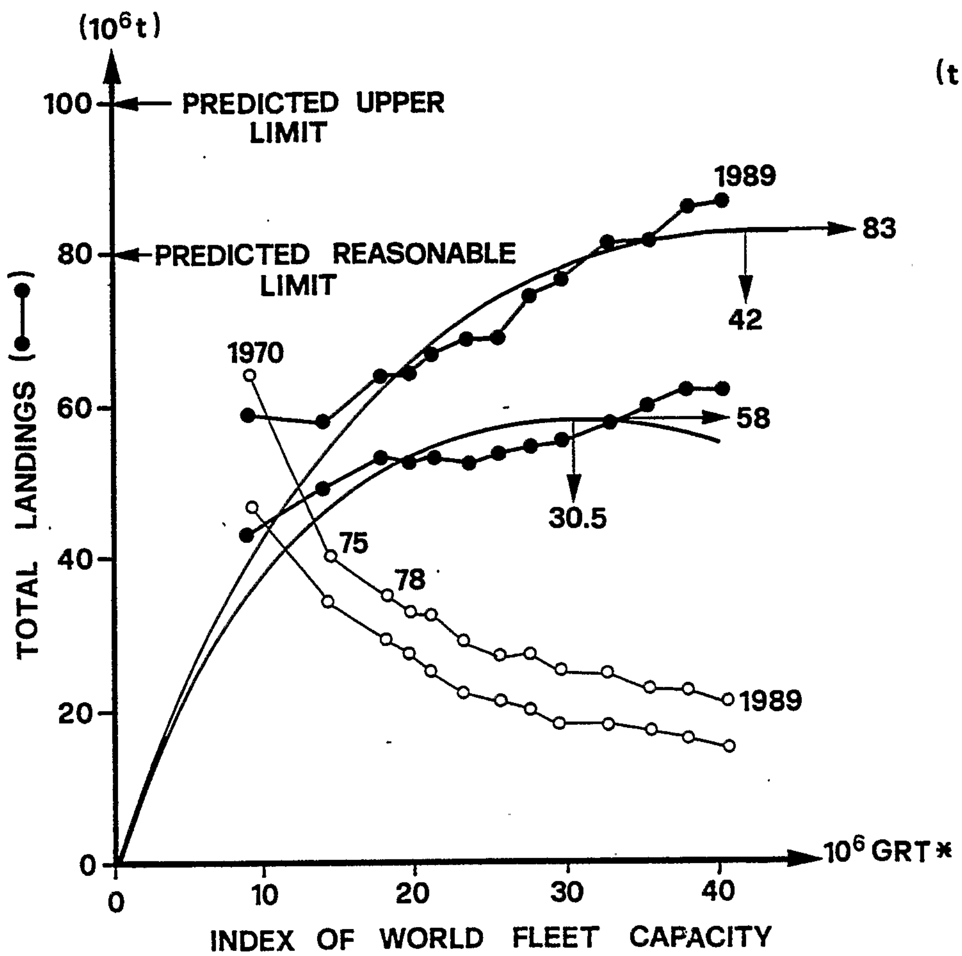


Fig 21
ORIGINAL
NO. File
Hand drawn.

Fig 21