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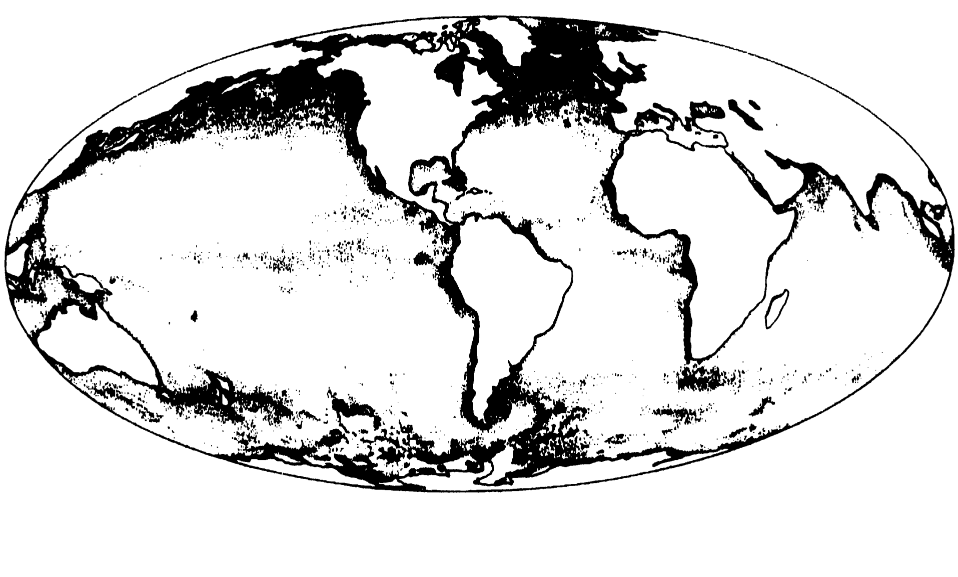

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Review of the state of world marine fishery resources

Marine Resources Service
Fishery Resources and Environment Division
FAO Fisheries Department

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PREPARATION OF THIS DOCUMENT

Since the widely-quoted review prepared by the Marine Resources Service on global marine fishery resources, (Gulland, 1971), almost every biennium FAO has updated a document entitled "Review of the State of World Fishery Resources. Part 1, The Marine Resources" (Fisheries Circular 710). This Circular is regularly presented as a background document to the Committee on Fisheries (COFI), but is of restricted distribution and, strictly speaking, is not a citeable document. The latest and 8th revision printed in December 1992, was presented at the 20th session of COFI early in 1993, was a significant expansion over Revision 7 with a more readable format and provided the basis for the present document. Bibliographic references were never included in Circular 710, but this text has been revised to include some of the source material and literature used in its preparation.

Many persons have contributed to this present technical paper, both inside and outside FAO. These persons included: Areas: 21 (J.F. Caddy); 27 (H. Sparholt); 31 (J. Csirke and D. Die); 34 (T. Do Chi); 37 (J.F. Caddy); 41 (J. Csirke); 47 (T. Do Chi); 51 (A. Bakun); 57 (P. Martosubroto); 61 (S. Chikuni); 67 (A. Bakun); 71 (J. Csirke and D. Die); 77 (J. Csirke and A. Bakun); 81 (D. Die); 87 (J. Csirke); 48, 58 and 88 (R. Shotton). The special topics on tuna and tuna-like species, whales and dolphins and environmental issues in fisheries were prepared by J. Majkowski, R. Shotton and A. Bakun, respectively.

Overall editing was provided by G. Turner, J. Caddy, R. Shotton, J. Majkowski, G. Burgos and A. Brunamontini, and statistical data provided by G. Cagnacci, and assistance in data analysis was provided by C. Stamatopoulos.

Distribution:

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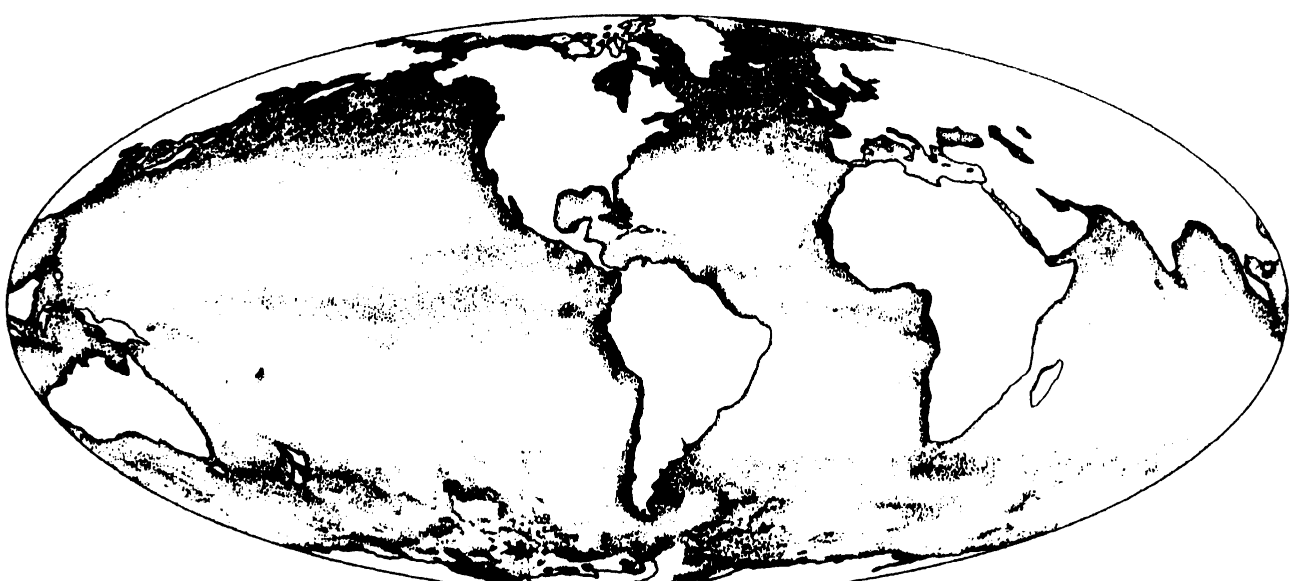
ABSTRACT

This document provides a review, commentary and tabulations of the main trends that have occurred in exploitation of fisheries resources since 1970's, largely as they are reflected in the FAO database on fishery landings; supplemented with selected information from the fishery literature. Reviews were prepared separately for the 15 main FAO Statistical Areas that the World's oceans are divided into, and then compared from a global perspective to reveal relative trends by species and areas, which are highlighted. Several special topics are reviewed, including those on tuna and tuna-like species, whales and dolphins, and environmental issues in fisheries.



This design provides the first global view of the geographical distribution of the production of plants (phytoplankton) in the oceans, which is the basis for food chains leading to marine fisheries. It is redrawn from a composite image of ocean chlorophyll production based on remote sensing imagery for 1978-81 prepared under the NSF/NASA-sponsored, US Global Ocean Flux Study.

TABLE OF CONTENTS

"BOX" INDEX

A. INTRODUCTION

The origin for this report can be traced back more than 20 years to Gulland's 1971 publication "The Fish Resources of the Ocean", which became the 'bible' for anyone seeking an overview of the status of fisheries in any one of the major oceans or sub-regions. In addition to the reviews on the status of fisheries, Gulland described hydrographic factors controlling primary and secondary production, and discussed estimates of the fisheries potential. The service provided by his book is evident from the frequency that it is still cited by those preparing regional reviews of fisheries resources. Every two years or so , FAO Fisheries Department has provided an update of the regional information on the status of stocks throughout the world, and this has been the purpose of the FAO Fisheries Circular No. 710 which has now gone through eight revisions. With the last such revision it was felt that an expansion of this document and more source material should be provided to help those who use this Circular to obtain more explicit references to facts and figures. In this FAO Fisheries Technical Paper therefore a major effort has been made to provide sources for an important part of the background information that has been used in compiling the publication. Because FAO staff use data from a number of sources which often are not published or exist in a non-citable form, this endeavour is inevitably less than complete. The Paper is composed of:

(i) a general review of trends in world fisheries,
(ii) more specific reviews of fisheries and marine resources in each FAO statistical area and
(iii) reviews on tuna and tuna-like species, whales and dolphins and environmental issues in marine fisheries.

From the high seas resources, only tuna, tuna-like species, whales and dolphins are reviewed on a global scale in this report: other high seas resources and fisheries are mentioned in the regional reviews. Also, high seas resources and fisheries are reviewed by Garcia and Majkowski (1992) and straddling and highly migratory resources by FAO (1993c).

Recent trends in world fisheries

Up to 1970, judging from statistics available to FAO, the world catch of marine fish continued to rise at an overall rate of some 6% per year, but in the early 1970s, especially with the collapse of what was then the world's largest fishery for Peruvian anchoveta, this slowed dramatically, and during 1980-89 the overall rise was only some 2.3% annually. In 1990 came the first decline in FAO's year global data series since 1976 (FAO, 1993a); a drop of some 3% to 83 million tonnes (Table 1; Figure 1). A discussion of the socio-economic factors that underlay these main statistical trends is found in the special SOFA chapter on "Marine Fisheries and the Law of the Sea: A Decade of Change".[1] This important document signals that the emphasis on management that FAO has been promoting for at least the last two decades in areas with long histories of industrial fishing, is now also required for the so-called "developing country fisheries". A change from a focus on short-term development of fishing fleets, to proper management is a necessary, but not sufficient, condition for sustainable development (COFI, 1993). The SOFA fisheries chapter also clearly shows that "Sustainable Development" as promoted at the United Nations Conference on Environment and Development (UNCED) in

[1] *The State of Food and Agriculture, FAO, 1992.*

1992 (UN, 1992), cannot be achieved under open access regimes, whether these are within or outside EEZs. The diagnosis offered by the SOFA chapter relating particularly to economic considerations, parallels some of the more purely resource-related issues mentioned later in this document.

Are we then reaching in the 1990s the limits of production from "wild" marine resources predicted by FAO in the early 1970s? The answer to this question seems not only in the affirmative, but for many resources this limit was reached decades earlier than the peak in global landings. A combination of factors has helped to mask the depletion of many conventional resources. These include:

(1) The increase in global landings in the 1980s was largely due to increased landings of a relatively few species. The five largest fisheries fell within the low-value category of small pelagic fish, (with the exception of Alaska Pollock whose unit value has now risen with the advent of surimi technology - Roache, 1987; Lanier and Lee, 1992), (Figure 2). These accounted for 13 million tonnes of the increase in world landings, but made a much smaller contribution to their total economic value. Small pelagic stocks are subject to wide natural fluctuations (Cushing, 1973; Parrish et al., 1983) over close to decadal time periods, and in past years, wide swings in abundance of some of these have masked declines in some smaller, high value resources.

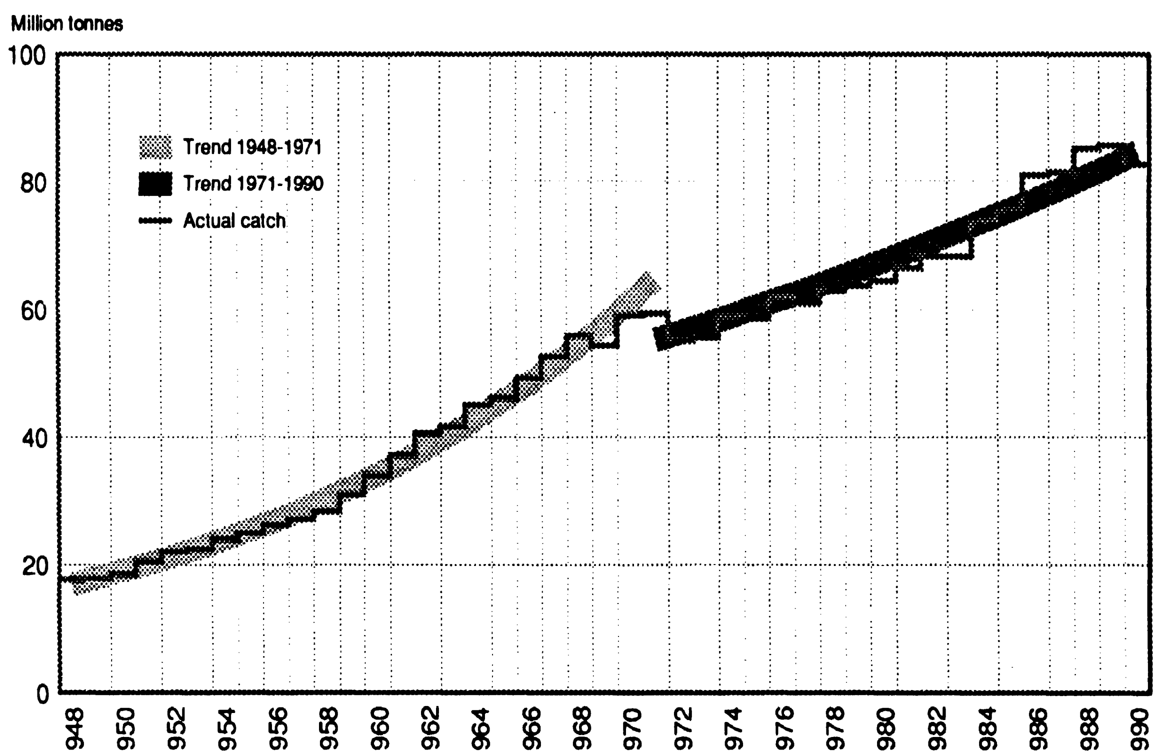
(2) In contrast, the SOFA chapter notes that as few as eight species (or uniform species groups) made up almost 50% of the total global value, but a much smaller percentage of the weight of marine landings. The finfish made up 19% of this value, and their value was dominated by tunas, salmons, Alaska pollock and Atlantic cod. A higher proportion (29%) was made up of invertebrates: shrimps, cephalopods, crabs and lobsters. A continued investment in fishing fleets throughout the world has meant that although catch rates and abundance of these high value species have often declined, the overall level of fishing effort has increased so that roughly similar levels of landings are being taken at a much greater cost to many fishing nations. Thus, the exploration of new fishing grounds in the 1960s and 1970s, initially by distant water fleets but later by coastal states, although it has added smaller populations of traditional resources to the pool of exploited stocks, has not resulted in any significant net increase in the supply of fish on world markets.

Table 1

Annual world landings of aquatic resources (million tonnes)
(excluding mammals and seaweeds)

	1948 -52	1953 -57	1958 -62	1963 -67	1968 -72	1973 -77	1978 -82	1983 -87	1988	1989	1990
Inland waters	2.5	3.8	5.8	7.3	8.9	6.8	7.7	10.9	13.4	13.9	14.5
Anchoveta	0.0	0.1	3.7	9.0	10.0	2.8	1.4	1.6	3.6	5.4	3.8
Marine (less anchoveta)	19.4	25.1	30.3	37.6	48.2	56.4	63.8	74.5	82.1	81.0	79.0
Total	21.9	29.0	39.8	53.9	67.1	66.0	72.9	87.0	99.1	100.3	97.3

GROWTH IN GLOBAL MARINE CATCH



Source: FAO

Figure 1 *Growth in the Global Marine Catch, 1948-90*
(million tonnes)

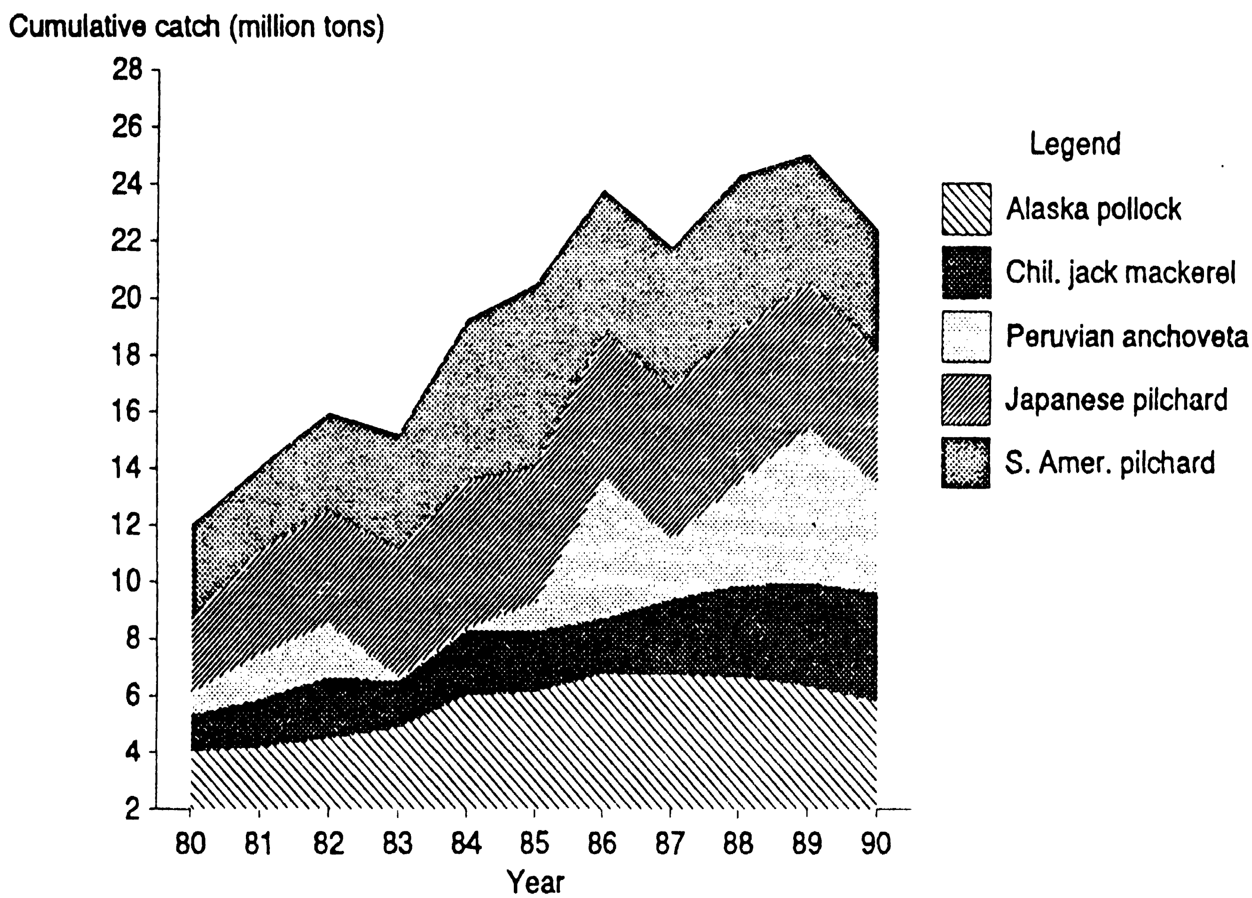


Figure 2 Catch of the 5 major species 1980-90

(3) There has been a continual replacement of declining stocks of traditional resources by new resources of generally lower value. This has occurred in two ways: first, by the exploitation of new resources that have expanded in size to replace those species that have been depleted by fishing. Among this replacement group are many short-lived species, and many but not all (e.g., squids) are of lower unit value, lower in the food web, and some have a higher potential to support heavy fishing. A significant proportion of the former target species in statistical (ISSCAAP)[2] groups 31-33, the demersal fish, are predators high in the food chain. Second, as the stocks of predatory fish have been depleted, formerly discarded species have taken their place in landings and markets. Species replacement in landings for both of the above reasons has been particularly evident for the slow-growing, high-valued species such as the sea perches and gadoids; the Atlantic cod and haddock, the Cape hake, and several other economically important species such as the Atlantic herring and mackerel, and is referred to in the sections that

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[2] *International Standard Statistical Classification of Aquatic Animals and Plants*

follow. In tropical seas this change has been paralleled by declines in high value 'top predators' such as snappers and groupers, and increases in small, short-lived trash fish, penaeid shrimps and cephalopods.

(4) Increases have nonetheless been observed in some higher value species:

- an extra million tonnes of tuna catches came mostly from the Western Central Pacific and Western Indian Ocean and were mostly landed by distant water fleets (FAO, 1990b; 1992h).

- shrimp production rose significantly, to a large extent due to increased aquaculture production, and was accompanied by the increased use of 'trash' (by-catch) fish as aquaculture foodstock, to the detriment of fish supplies for food.

- the world catch of cephalopods has grown, again, largely as a result of distant water fishing focussing on relatively few outer shelf and oceanic areas especially in the Southwest Atlantic, Northwest Pacific and off West Africa (Caddy, 1983). Here, the effects of intensive harvesting of these resources are already being felt.

(5) The possible role of reporting errors in causing inflation of landing figures is less easy to establish. In some cases, improvements in statistical reporting certainly have occurred, especially in the species breakdown of landings (WHOI, 1991; FAO, 1992b). Elsewhere reporting may have deteriorated, as small scale fleets have taken over from the larger, more easily monitored industrial vessels. This issue is one of the more urgent ones to resolve globally if true trends in marine productivity are to be established as will be needed, for example, in order to evaluate the effects of climate change.

(6) For some inshore and semi-enclosed areas, such as the Mediterranean and Black Seas, there is growing evidence that nutrient runoff from land may be responsible for increases in both biological production and landings, and with further eutrophication, their subsequent decline (Caddy, 1993).

(7) Continued high fishing intensity will contribute to a loss of biological diversity and there are fears that this may lead to more unstable, and possibly lower, catches in the long term.

Analysis of the FAO Yearbook of landing data (FAO, 1993a) by species group over the last 21 years (1970-90 incl.) shows that although the aggregate total for landings of most species groups rose over the period, when these species are placed in sequence from fast increases to very slow or no increase in overall landings, the short-lived species rose fastest, and for the long-lived conventional resources the long-term rise was slow, and essentially stopped in the late 1980s (Figure 3).

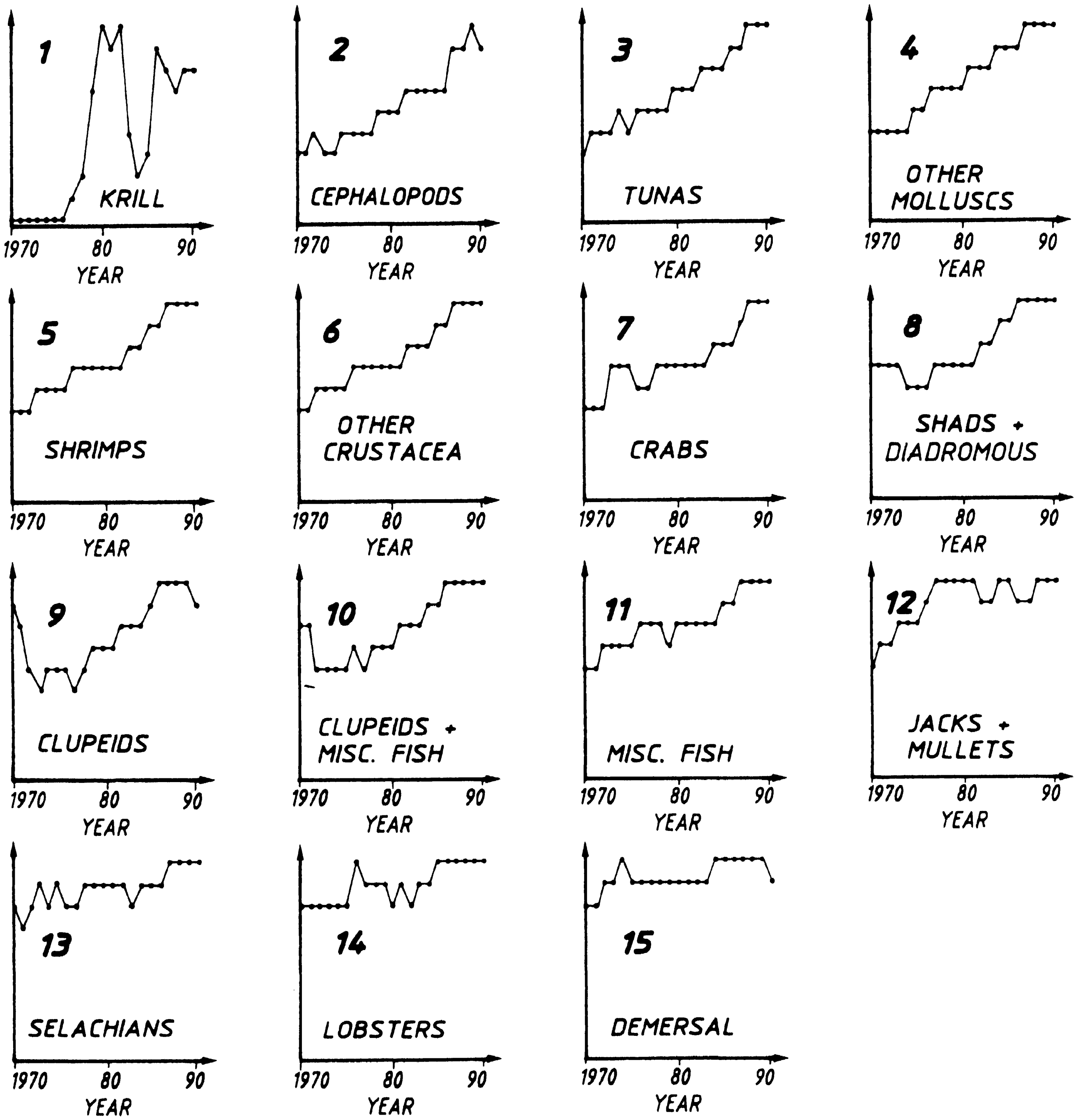


Figure 3. Ranking of global landings by species group from the FAO Yearbook data from species groups showing a high rate of increase (e.g. 1: krill) to almost no increase or a plateau (15: demersal fish)

Care must be taken not to extrapolate these global conclusions to fisheries for individual species in a country or region. This will be discussed later in this report in the sections on statistical areas. Several salient features do emerge however, namely (apart from tunas) the high rate of increase (and high ranking) of invertebrate resources, and the low ranking for conventional bottom fish resources. It is interesting to consider in more detail what is the species composition of the trend in global marine landings shown in Figure 1 and how the number of participating countries in global marine fisheries has changed. Some indirect evidence on these points emerges from Table 2.

Table 2, based on the FAO Yearbook statistics again, compares changes in the number of countries reporting and the number of species they reported landing at the start and end of the 21-year interval 1970-90 for the more important marine statistical areas (see Figure 4 for geographic boundaries of major fishing areas). Table 2 also illustrates that the small increases in global landings, especially since 1970-72, should be considered in the light of a 25% average increase in the number of countries fishing in each FAO statistical area and an average 16% increase in the number of species reported landed.

Table 2 also throws light on the relative efficiency of reporting within each area, and/or on the selectivity of fishing, if one considers the index in the last column. If all countries were sampling the same marine species mix in a statistical area and fully reporting them by all species, the ratio C/(AxB) would equal 100%. Evidently, a 100% value for this index is improbable, since not all countries fishing an area harvest the whole range of habitats and species available or they may have gear that is selective by species and may either discard unwanted species or report them as undifferentiated catch.

Many fishing gears are relatively unselective. Thus, reporting one or only a few species in a trawl fishery, for example, implies that either non-reporting or discarding is taking place (Vendeville, 1990; Prado, 1992). The very low values of this index of the number of species caught for most of the statistical areas means that many species caught are not being individually reported by some countries. The tentative conclusion may be drawn that the total for global landings is significantly higher than reported, although the extent of under-reporting cannot be established without independent data which is unavailable to FAO.

The increase in the number of species for which landings are now being reported to FAO, to some extent reflects more recent accurate identification of resources which were already being landed in the past, and either left unidentified, or discarded, but probably more realistically, reflects an increase in market price for lower value species. Here, increased availability of field guides such as the FAO Species Identification Sheets has undoubtedly played a role[3], although it would be misleading to assume that a better breakdown of landings by species has necessarily been accompanied by improved accuracy of reporting.

[3] *One consequence of the greater dissemination of species identification guides is that catches that previously may have been aggregated into one species get disaggregated into several. This can give a false impression that there has been change in the species composition of the catch (Fischer, 1989; Fischer et al., 1987; Cohen et al., 1990)*

Table 2

Summary statistics on numbers of countries reporting catches from key FAO fisheries statistical areas in 1970, the number of species reported, and the number of country species units reported. The brackets show percent increases of these three categories by 1990

FAO statistical area	A Countries reporting		B Species reported		C* Number of countries species units		C% / A x B
	No.	% ↑	No.	% ↑	No.	% ↑	
21	11	(27.0)	78	(11.5)	104	(56.7)	12.1
27	20	(20.0)	110	(9.0)	371	(50.4)	16.9
31	33	(18.0)	99	(17.2)	251	(39.4)	7.7
34	28	(14.3)	76	(21.1)	212	(43.9)	10.0
37	16	(37.5)	94	(19.1)	254	(48.8)	16.9
41	3	(33.3)	76	(10.5)	97	(18.6)	42.5
47	11	(0.0)	49	(20.4)	75	(13.3)	13.9
51	29	(6.9)	78	(9.0)	179	(9.0)	7.9
57	7	(14.0)	84	(22.6)	105	(47.6)	17.9
61	7	(14.3)	139	(2.9)	195	(36.4)	20.0
67	1	(100.0)	31	(19.4)	25	(112.0)	81.0
71	19	(21.1)	119	(21.0)	316	(24.1)	14.0
77	14	(14.3)	60	(20.0)	116	(18.1)	13.8
81	3	(33.3)	56	(19.6)	67	(37.3)	39.3
87	5	(20.0)	67	(17.9)	93	(22.6)	27.8
Mean values		(24.9)		(16.1)		(38.5)	22.8

The total countries species units in an area is equal to the total number of species reported in an area times the number of countries fishing that area.

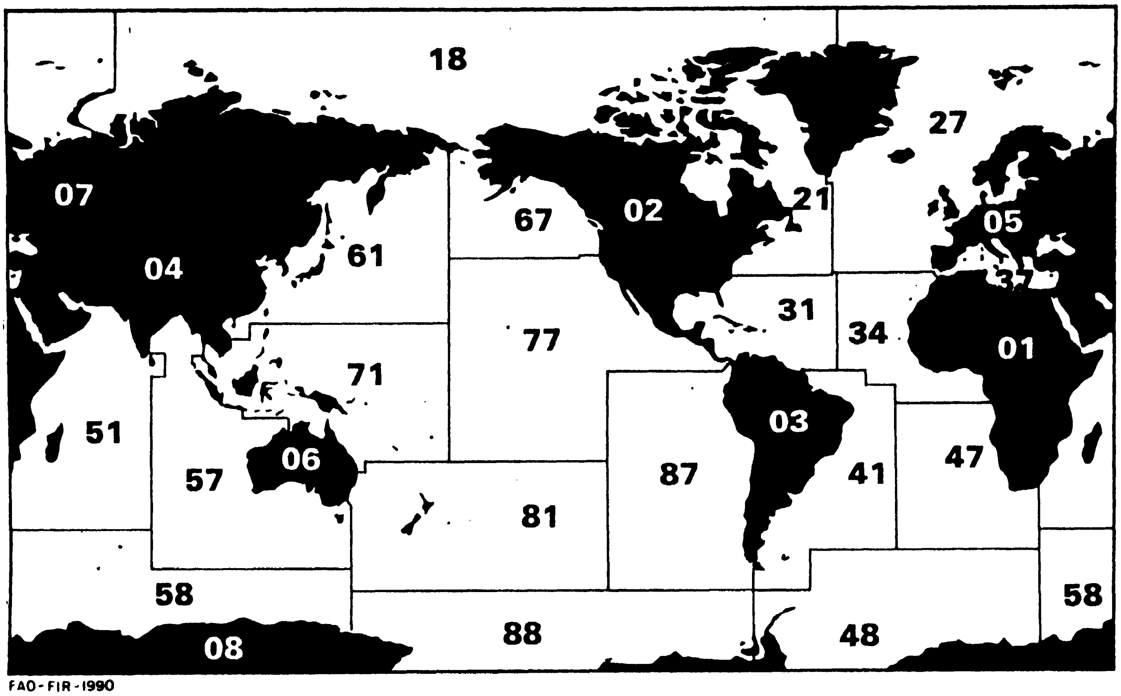


Figure 4 Geographical boundaries of FAO marine statistical areas

The category "Miscellaneous Marine Fishes" in the FAO Yearbook (FAO, 1993a) throws some light on this situation. The 'developed' fishing areas of the North Pacific, North Atlantic (in bold in Table 3), show declining landing trends in this category, suggesting some improvements in reporting by species. Other areas show increases in this category, implying perhaps, a worsening of the statistical situation and/or an increase in landings of 'trash' or low value fish, which are commonly associated with intensively exploited tropical trawl fisheries for shrimp.

Conclusion: To a significant extent, the above analysis of Yearbook data suggests an actual increase in number of species subject to directed or mixed species fisheries, with better identification of by-catch species and reduction of discards, improved fishing methods, and new species entering the market, largely due to a growing scarcity of conventional species. It also reflects a marked broadening in the number of countries fishing for these species. This means that the very modest recent increases in global landings shown in Figure 1 are largely counteracted by declines in individual resources, reflecting the fact that a significant number of stocks have begun to be overexploited over at least the last decade.

The results of ranking the FAO statistical areas according to the percentage of the species groups showing overall catch declines are shown in Table 4. Over the 21-year period 1970-90, a long development in resource harvesting is generally associated with a relatively high position in this table. Those areas with long histories of fishing (D) that are already fully or overexploited, have shown both increases and decreases in landings of species groups, whereas those with shorter histories of industrial fisheries (U), except for those harvested by distant water fleets, as yet show low percentage declines in species groups.

Table 3

Ranking of trends in "Miscellaneous Marine Fishes" for the main FAO statistical areas from 1970-90

Rank		Statistical Area	Comment
1	81	Southwest Pacific	
2	41	Southwest Atlantic	
3	51	Western Indian Ocean	
4	57	Eastern Indian Ocean	Increasing trend
5	31	Western Central Atlantic	
6	87	Southeast Pacific	
7	61	**Northwest Pacific**	
8	67	**Northeast Pacific**	
9	77	Eastern Central Pacific	
10	71	Western Central Pacific	
11	34	Eastern Central Atlantic	No trend
12	37	**Mediterranean and Black Sea**	
13	47	Southeast Atlantic	
14	27	**Northeast Atlantic**	Decreasing trend
15	21	**Northwest Atlantic**	

This provides few grounds for complacency however, given the speed with which fleet build-up can occur and any further increases in fleet size should be preceded by careful appraisal of the status of stocks.

A relatively high proportion of long term declines of species groups occurs in those areas where fishing has a long history, areas which have been considered as role models for fisheries management. This must be of special concern and raise some fundamental questions as to the efficiency of strategies that have been used to manage marine fisheries over the last two decades. We now seem to be at a critical stage in searching for improved or alternative practical strategies for managing coastal fisheries to replace the standard open-access management systems that have dominated most marine fisheries to date (Pearse and Walters, 1992). Such management systems, to a significant extent, depend on the availability of data from which to assess the potential yield from stocks.

Although the 1980s has been a period of growing awareness and concern for environmental change, it is important to continue to single out overfishing (and its economic counterpart, over-investment), as the main culprit for local resource degradation over the last 50 years, and that may now be leading to a reversal of the long-term positive global catch trend. Recent analyses have been quite explicit in this regard in identifying the scope and nature of the problem. One index extracted from FAO statistics (FAO, 1993b) is that over the period 1970-89, the global industrial fleet size was increasing at a relative rate which was double that shown by global landings.

The negative consequences of this may be equally serious from an economic as well as from a resource perspective (COFI, 1993) and the SOFA chapter arrives at a parallel and remarkable conclusion in this regard, namely, that the annual operating costs of the global marine fishing fleet in 1989 were on the order of US$ 22 000 million greater than the total revenues, even without considering capital costs!

The perspectives offered in the previous paragraphs have focused principally on the gross picture that is emerging with respect to trends in landings from global marine fisheries. This is of an unsatisfied demand for fish and fish products that has encouraged individual fishermen, governments and entrepreneurs to make individual investment decisions in the means of capture and processing that in total are far in excess of any possible level of productivity of the natural resources. This situation has been made possible, and exaggerated, by a general failure of most management systems to adequately contain the pressure from improved technology and from new entries to marine fisheries. More detailed examples are given in the descriptions of events for the individual FAO statistical areas that follow. The wide diversity of fisheries situations covered by these reviews reflects the wide differences in development both of the fisheries and the differences in availability of fisheries information between 'developed' and 'underdeveloped' statistical areas.

B. REGIONAL REVIEWS

NORTHWEST ATLANTIC (Area 21) (Table 5)

Total landings of finfish and invertebrates in 1990 were 3.2 million t, up slightly from 1985 to 1989, but still below the level of landings in the early 1970s. This figure includes a decrease in catches of most groundfish species (particularly, cod, haddock and flatfishes) and an increase in catches of redfishes, of most invertebrates (lobster, shrimps, squid, scallops and oysters), and of small pelagics (capelin, herring and menhaden). Considerable geographical variations remain, both in the state of the resources, as well as the criteria used for management.

The coastal States in the Northwest Atlantic have sharply curtailed or eliminated distant-water effort in their exclusive economic zones, and with the exception of stocks on the tip of the Grand Banks, and those for which advice has been requested by coastal States, management of shelf areas seaward of 200 miles has been conducted through the Northwest Atlantic Fisheries Organization (NAFO). This organization has attempted to maintain, not completely successfully, stock levels or a stock rebuilding strategy by harvesting depleted stocks at the $F_{0.1}$ level[4] (Gulland and Boerema, 1973).

[4] *The $F_{0.1}$ level is the effort level at which the increase in yield produced by one additional unit of effort is 1/10th of the rate of increase in yield obtained by applying one additional effort unit*

Table 4

Ranking of FAO areas in terms of increasing proportion of 15 selected ISSCAAP species groups and super groups showing declines in landings: 1970-90 (see also Figure 1)

Rank		Statistical Area	Decline %	Increase %	Level of Development
1	67	Northeast Pacific	42	25	D
2	47	Southeast Atlantic	42	25	M
3	21	Northwest Atlantic	33	50	D
4	27	Northeast Atlantic	17	25	D
5	77	Eastern Central Pacific	17	42	M
6	61	Northwest Pacific	8	42	D
7	34	Eastern Central Pacific	8	42	U
8	81	Southwest Pacific	8	58	M
9	87	Southeast Pacific	8	75	M
10	31	Western Central Atlantic	-	25	M
11	71	Western Central Pacific	-	33	U
12	41	Southwest Atlantic	-	42	M
13	51	Western Indian Ocean	-	58	U
14	37	Mediterranean/Black Sea	-	58	M
15	57	Western Indian Ocean	-	92	M

U = Coastal States with underdeveloped fisheries
D = Coastal States with developed fisheries
M = Mixed: both U and D present

NAFO, of which all coastal states except the United States are members, is responsible for assessing straddling stocks considered to overlap Canada-Greenland-France (St. Pierre and Miquelon) boundaries and stocks exclusively fished by coastal States but which extend beyond the 200 mile limits into international waters and provides regional statistics (NAFO, 1993a;c), and reports of its scientific deliberations (NAFO, 1993b). The $F_{0.1}$ criterion is still used in the Canadian zone (CAFSAC, 1992) and for some NAFO stocks, but quota control has been essentially abandoned for most fisheries in southern area 21 (NMFS, 1992a). Some member countries of NAFO are promoting the use of F levels higher than $F_{0.1}$ and object to some NAFO recommendations. Fishing by non-members compounds the problem of setting TACs intended to lead to stock conservation.

Difficulties have been experienced in collecting catch data for fitting realistic age-structured models for some stocks and there is a growing awareness of the difficulties of quota management, especially in mixed species fisheries, where estimates of total removals are affected by misreporting (both between species and sub-areas) and by discarding as by-catch. Problems of setting stable quotas are made more serious by wide inter-annual variations in recruitment for species such as haddock.

Experience in southern subarea 21 suggests that in the absence of quota or access control, commercial catches are likely to decline, as has been largely the case for stocks of haddock, hakes, redfish and yellowtail flounder; however, this is also the case for a number of northern stocks under quota control. The debate on appropriate catch levels has placed emphasis on the allocation process, and it is clear that improved biological advice is only a small component of an efficient fishery management system. The search for more efficient mechanisms for interaction between fishermen, biologists, economists, managers and politicians will continue to be a priority in this region for the foreseeable future.

Long-term changes in production in the Northwest Atlantic, show the influence of the physical environment, especially where a species is close to the extremes of its range. Warm/saline and cold/diluted periods in oceanic climate typically last for three to five years: a similar periodicity has been noted for northern cod stock recruitment where the catches of cod in the Davis Strait increased slightly in 1987 after years of decline. Although winter temperatures were below normal, increased summer temperatures in recent years probably account for increased shrimp landings and may also affect catches of squids, clams, scallops and crabs, all of which showed significant increases, as did northern shrimp landings from the Davis Strait and off Greenland.

The general increase in landings of invertebrates has been notable over the last decade in Area 21; they comprised 32% of the catch in 1990 and a higher proportion of the total value. Noteworthy was the American lobster: this valuable species is subject to heavy pressure throughout its range and it seems unlikely that recent steady increases are due to improvements in management of the resources rather than environmental considerations.

1. Northern areas:

Assessments inside the Canadian east coast EEZ are carried out by the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC, 1992), and include a three-year management plan for groundfish. The industry has asked for stable groundfish quotas in order to assist in planning. It has been pointed out that this can only be achieved by constant changes in fishing effort from year to year. The CAFSAC plan calls for fishing at the $F_{0.1}$ level, or higher rates of removal if biomass levels are adequate. A new modelling framework ("ADAPT" - Gavaris, 1988; Mohn and Cook, 1993) simultaneously takes into account both survey and catch data, giving greater consistency of results. The use of teleconferences between fishery assessment workers from widely separated locations in eastern Canada is commonly used. 'Precautionary' TACs at fishing rates below $F_{0.1}$ levels are routinely applied in the case of species where quantitative information is poor, such as many herring stocks.

For straddling stocks, NAFO has been facing a crisis situation in recent years with the recommendations of its scientific committee (NAFO, 1993b;c) being jeopardized by the uncontrolled fishing activities of non-contracting parties to its convention within its regulatory area. Delays in catch reporting by members have also contributed to assessments with incomplete data. A minimum cod-end mesh size is now being promoted in the region with the only exceptions being for capelin and squid (for which 60 mm stretched mesh applies).

Some events in the fisheries of the northern part of Area 21 may be related to a period of local low temperatures of coastal waters. These cold water anomalies (Drinkwater, 1993; Petrie and Drinkwater, 1993; Sigaev, 1993) could be due to the effect of increased ice break-up, which are believed to be correlated with the impact of climatic change in West Greenland. The recent dramatic declines that have occurred in the cod fisheries of the Grand Banks and Flemish Cap may be in part a consequence of this (see Box "The northern cod fishery").

The following comments apply for the more important resources:

(a) **Demersal fish:** Cod catches from the once largest Northwest Atlantic cod stock on the Grand Banks and off Labrador increased rapidly after the 1950s with spawning and pre-spawning concentrations heavily exploited by distant water fleets. Peak catches of 800 000t occurred in 1968 with a steady decline thereafter to 1978. Inshore catches also declined from some 160 000t in the 1960s to 35 000t in 1974. Management was formerly by the International Commission for Northwest Atlantic Fisheries (ICNAF), later replaced by NAFO. Early management was restricted to mesh size regulation but TACs were introduced in 1973. Following extension of jurisdiction by Canada in 1975, CAFSAC has regulated the fishery suggesting a target fishing mortality below or at $F_{0.1}$ to encourage stock rebuilding (see Box: "The northern cod fishery").

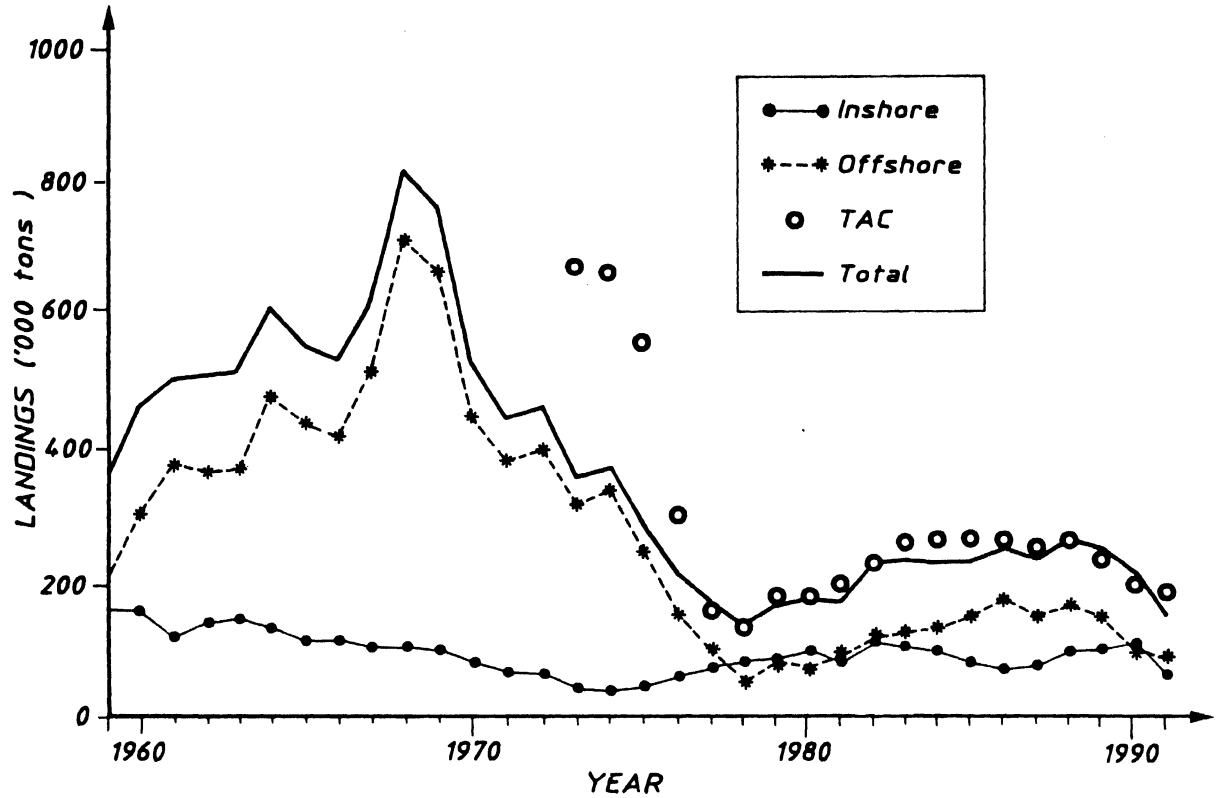
The Flemish Cap cod stock was at a minimum in 1987 and further declined in 1990-91; catches were then set at the lowest level possible (Vazquez, 1993). Cod landings in northern, eastern and western Gulf of St. Lawrence dropped from 106 000t in 1983 to 47 000t in 1989, the lowest historical level, partly due to the exclusion of one of the major fleets, France (St. Pierre and Miquelon), from this fishery. There are two diverging interpretations of stock status based on survey data and commercial catch statistics respectively. The former suggests biomass has declined, the latter suggests that the stock is lightly fished and stable. This latter estimate may be biased by misreporting and discarding which are believed to be significant in this fishery. In the southern Gulf and adjacent Scotian Shelf stable catches and rising biomass levels are occurring under a system of enterprise allocations applied to cod landings by vessels of 50 ft.

BOX: The northern cod fishery

Depletion of the northern cod stock was evident in the mid-1970s with respect to historical levels (Bishop et al., 1993; Davis et al., 1993) and the quota levels lagged behind stock declines (Box Figure). A special meeting of NAFO in June 1992 recommended that catches should not exceed 50 000t: the low range of $F_{0.1}$ values. The meeting could not specify the cause of decline, but in addition to overfishing, other negative influences included the impact of current cold water in the Northwest Atlantic on cod recruitment, and increased predation on young cod by harp seal populations which have increased in size since culling was banned. Recent declines in capelin, the principal food organism of cod, might also be involved.

Disagreements on the management objective for this straddling stock may be a prime cause of stock depletion, but the differences in the scientific advice based on commercial catch per unit effort versus research survey indices, also contributed to uncertainty of advice. Possible biases in abundance trends can probably not be excluded, due to a fixed calender of research surveys on a seasonally migrating stock, in a period of changing seasonal patterns. Serious differences in the advice formulated using several population dynamic models was the main reason why it was not possible to make an agreed stock projection in June 1992.

The stock decline, about which no one disagrees, also raises a number of controversial political issues. These include the need to reinforce the role of fisheries commissions and of coastal States in regulating fisheries on those portions of straddling stocks lying beyond EEZs. Although the areas falling outside the Canadian 200 mile zone are relatively small, a more significant part of the stock, through migration, may occur in these areas at certain periods of the year. Here, there has been a disagreement between the coastal States who recommend $F_{0.1}$ management criteria and distant water fishing countries wishing to fish at higher levels of exploitation, as well as problems in deciding on a uniform approach to fishery surveillance of all participants. This case also illustrates the difficulties faced by Commissions not having independent means to control biases in statistical reporting and surveillance, particularly when such reporting has direct implications on the quotas in the following year. The inertia of the quota allocation mechanism (Box Figure) is clearly evident, particularly in a period when declining abundance was not unambiguously reflected in all of the assessments. The closure of domestic fisheries by the Canadian Government in 1992, followed by a compensation package to support fishermen in a province with high unemployment and few job alternatives, has had severe consequences for overfishing for coastal communities (McClellan, 1993).



Box Figure: Landings, TACs and allocation in the northern cod fishery

LOA, with trip limits applied for smaller vessels. Recent good recruitment is compromised by the high discard rates observed by the observer programme on commercial vessels. In the Gulf of St. Lawrence, density-dependent growth of cod appears of greater importance than other environmental effects. Investigations are considering the impact of size-selective mortality in leading to selective survival of slow-growing populations.

On the eastern Scotian Shelf, enterprise allocations and trip limitations also apply with by-catch being regulated (CAFSAC, 1991). Yields of cod from fixed gear drop rapidly as mobile gear effort increases since the latter gear intercepts younger fish. Commercial trawler catch rate is a poor index of abundance since skippers now aim for an optimal species mix and size composition to avoid discarding. Observer data appears more reliable, with assessments relying more on catch rates from fixed gear which is protected by a special catch allocation.

Since 1984, a maritime boundary has divided the Georges Bank and Gulf of Maine. Cod and stocks northeast of this boundary are considered separate from stocks to the southwest. Northeast of the boundary, conservation measures include limited numbers of trips, trip limits, and obligatory use of square mesh in trawls.

Stocks of haddock from the Grand Banks to Georges Bank are in a fragile condition (CAFSAC, 1991) as elsewhere in the Northwest Atlantic, with heavy dependence on a few age groups. They are subject to high incidental catch as juveniles in other fisheries and low or reduced catches have been recommended. In eastern areas, no directed fishery is allowed for haddock to assist rebuilding of the stock. On the Scotian Shelf, directed fishing dropped to a low level in the early 1970s, but the species quota has still been exceeded due to by-catches in other fisheries. The situation is not aided by misreporting between species and areas, which industry admits to be a common feature of quota management. In attempting to avoid discards of by-catches, an aggregate cod/haddock/pollock quota was introduced in 1989, divided between three 4-month periods. It appears however that there are still problems with discarding of the less valuable catch of pollock. A haddock nursery area was introduced in 1987 to aid stock rebuilding, and areas were closed to fishing where survey cruises had located abundant juveniles. Haddock catches on north-eastern Georges Bank declined from 60 000t in the 1960s to a few thousand tonnes in 1976. There is some recent evidence of slight stock recovery.

Catches of redfish peaked in the 1960s and 1970s (CAFSAC, 1991). Where effort was controlled, stocks in the 1970s and 1980s have shown some recent signs of recovery, as in the Gulf of St. Lawrence and some redfish stocks on the Scotian Shelf and Grand Banks. Redfish are seriously depleted off Greenland, possibly due to the by-catch of juveniles in the shrimp fishery, which may be controlling redfish recruitment. On the eastern Grand Banks quotas for this species have been exceeded each year and the stock continues to decline.

Landings of American plaice are far below historical levels on the Grand Banks and effort reduction is recommended (CAFSAC, 1991). Other flatfish (witch flounder and yellowtail) are also at a low level here, except for Greenland halibut where catches appear to be stable from Davis Strait to Grand Banks. There is some evidence that declines in ambient temperature and not overfishing is responsible for stock declines of American plaice in northern areas. Elsewhere, high discards of small flatfish (some 40-80% by number) are a persistent problem in other fisheries. American plaice catches are stable in Flemish Cap. American plaice, and witch and yellow flounder are covered by a common quota on the Scotian Shelf, but there has been a general decline in catches; the quota is taken largely as by-catch.

(b) Small pelagic fish: Inshore fisheries for capelin roe were carried out off Labrador in the 1980s, mainly for the Japanese market, stimulated by the closure of the Barents Sea fishery in 1986. Acoustic surveys play a large part in assessment as commercial catch rate is not considered a good indication of stock size: catch rate in passive gear (traps) is considered less biased. Scientific advice cautioned against heavy catches being taken from close to inshore spawning areas because of the effect this might have on future spawning and on inshore cod populations feeding on these stocks (CAFSAC, 1991). Although capelin catches on the southern Grand Banks have been below quotas in recent years the stock appears to be declining and a TAC not exceeding 10% of the biomass has been recommended. On the southern Grand Banks a peak catch of 132 000t was taken in 1975 but the fishery was closed for 1979-86 and, with fishing set at less than 10% of the long-term mean spawning biomass, no harvest will be allowed in 1993.

Herring are caught in a wide variety of gears (purse-seines, midwater trawls, gill nets, weirs and traps) which exploit autumn and spring spawning stocks. Their abundance is estimated from data on sales receipts indicating quantities landed and log books collected at point of landing.

These data are now supplemented by acoustic surveys which require a calibrated acoustic backscattering cross section: the ratio of incident sound reflected per unit weight of sonified fish. Preliminary estimates indicate that acoustic procedures may have overestimated stock biomass, and in the case of herring, stock distribution areas in the southern Gulf of St. Lawrence have changed. Herring fisheries on the southwestern Scotian Shelf peaked in the 1960s, reaching 196 000t due to development of the fishmeal industry and west purse seines but subsequently the taking of herring for meal was banned and it is now used for human consumption.

The herring stock on Georges Bank was formerly the largest in the West Atlantic with landings peaking at 374 000t in 1968, but crashed in 1977 under an intensive international fishery. After a decade of apparent extinction, there is now evidence of spawning, but no directed fishery will be encouraged prior to significant stock recovery. Recoveries have been registered among other herring stocks in eastern Canada since the mid-1980s, but further increases in TACs are regarded as a cautionary approach. However, to a significant extent herring catches have varied in relation to fluctuations in markets for fish and roe and restrictions on fish meal processing.

Northwest Atlantic mackerel stocks are managed as a single unit despite two spawning areas; (1) in the Gulf of St. Lawrence and (2) between Cape Cod and Hatteras. Both groups overwinter in Sub Areas 5 and 6 where they were subject to an intensive fishery by non-coastal states which harvested a peak of 430 000t in 1973. This fishery was halted in 1977-78 with extension of maritime jurisdiction of USA and Canada. There is no catch limit imposed in this fishery which with catches of some 50-90 000t, is well below $F_{0.1}$ harvest levels. Potential removals of some 200 000t annually from a biomass of some 1 million tonnes would not be likely to endanger this stock.

International fisheries for Atlantic salmon are subject to coordination by the North Atlantic Salmon Conservation Organization (NASCO) and in the USA are covered by a management plan that forbids commercial fishing. For stocks in Canadian rivers, the management objective is to realize a target escapement of spawners through the offshore and river fisheries. With respect to the fishery off Greenland, which intercepts salmon from European and North American rivers, the preemptive quota of 900t was not caught in 1989-90, and lower returns to rivers are expected in 1991.

(c) Molluscs: Canadian scallop catches on Georges Bank east of the International Court of Justice (ICJ) line established in 1984, have averaged around 5 500t/yr (CAFSAC, 1991). The last peak recruitment which gave annual catches of 11 000t was in 1977-78. Catches are controlled by an overall TAC, split up under an Enterprise Allocation Plan. A minimum allowable meat weight for random samples of adductor muscles in the catch (the only part landed), was enforced in 1986. The fishing effort unit used in this fishery (crew-hour-metre) takes into account not only the crew size (which determines extraction rate of meats), but also the hours fished and the size of the dredge. US sea scallop fisheries are covered by a management plan that specifies a maximum average count of 30/lb of adductor muscles ('meats').

Catches of squid on the Scotian Shelf off Newfoundland peaked at 162 000t in 1979, but dropped to 2 000t in 1983-88, showed a slight recovery in 1989-90, but again declined in 1991. Climatic factors are believed to influence abundance of these annual species. A substantial clam resource, Spisula polynyma, has been located on the Scotian Shelf, which, together with ocean quahogs, appears to offer potential for a new fishery.

(d) **Crustaceans:** Shrimp stocks in Hudson Strait and off Greenland are at the lowest level since 1987 (Skuladottir, 1993). Efforts are being made to increase mesh size and monitor the fishery to reduce discarding. Effort control does not appear to have worked well in the snow crab fishery of the Gulf of St. Lawrence and consideration is being given to season/area closures in combination with quotas. A claw hardness gauge has been proposed to test for soft shell crabs which may lead to closures when soft shells are too abundant. Surveys are now routinely using 'kriging', a statistical procedure adapted from mining prospection to outline distribution areas of shellfish species.

II. Southern areas

United States fisheries are subject to management by regional councils made up of government and fishery sector representatives and technical advisers. A Fisheries Management Plan is drawn up for most major resources, which takes into account a range of relevant biological and socio-economic factors (NMFS, 1992b). The growing importance of sports fishing in the southern half of Area 21 is leading to a reaction against uncontrolled effort levels by commercial fishing. Limited entry has been accepted in at least some US fisheries and Individual Transferable Quotas (ITQs) have even been adopted in the surf clam fishery. This, despite resistance on the basis of the unequal distribution of societal benefits that some have feared would result for formerly open-access resources. There is growing concern in the USA that present marine harvest strategies are not sustainable, and other alternatives to limited entry are also being discussed, notably the concept of the ecological reserve or marine park. This has the attractive feature that closed areas favour a larger role in reproduction to larger, older more fecund fish.

Fisheries in the southern part of Area 21 (Subareas 5 and 6) have begun to show progressive symptoms of overfishing in recent years, especially by the trawl fishery (NMFS, 1992a). In the New England area this fishery for 10 key species is covered by the Northeast Multispecies Fishery Management Plan which specifies gear type and area/season closures but although permits are issued, no quotas are set. The landings of several high value species (cod, haddock and yellowtail flounder) are now at or close to all-time low values. In some heavily fished areas such as Georges Bank, there appears to have been a change in the fish community favouring low valued species in place of a fish community formerly dominated by high value gadoids. Landings have shifted to formerly lower value species, including pollock, dogfish (of little value), silver hake, skates and flounders.

Redfish are now taken primarily as a by-catch of the mixed-species otter trawl fishery in the Gulf of Maine and by 1987 stock biomass had declined by over 80% since the late 1960s. By 1987, commercial catch rate indices and research vessel survey abundance indices of yellowtail flounder had also declined to record-low levels and the fishery remains heavily dependent upon incoming year classes. Recent recruitment of yellowtail flounder stocks has been poor on Georges Bank and in the Gulf of Maine. Survey abundance indices for most of the 'other flounder' stocks also exhibited declines in 1987. The exploitable biomass of pollack was expected to decline beginning in 1987 and landings in 1988 had fallen from the record-high level in 1986 but still remain significant. Recruitment of silver hake in the last several years has been of average strength, but decreased fishing effort from distant-water fleets has helped to steadily increase stock biomass from the very low levels of the mid-1970s. Up until 1987, Atlantic herring landings in the southern part of Area 21 had remained fairly constant. Maine vessel landings increased slightly and landings in the fixed gear fisheries remain at historically low levels.

Offshore clam fisheries are the subject of a management plan under the Mid-Atlantic Management Council and are the only east coast US fisheries to be subject to an overall quota and ITQs, set as percentages of the quota. Closed areas exist to protect predominantly small clams. Soft-shell and hard-shell clam landings in many areas are depressed, and have been partly compensated for by increased landings of ocean quahogs. Only landings of scallops showed an increase, probably due to the impact of favourable environmental conditions during recruitment of currently exploited year classes, a situation that seems to occur at intervals of eight to ten years. The abundance of Loligo squid in research vessel surveys was the lowest in the 1968-87 time series but landings of Illex were up significantly in 1987.

Judging from statistics reported to FAO, resources that have shown recent declines include estuarine species (e.g., tomcod, oysters, bay scallop, smelt and char), which may reflect deterioration in estuarine environments as much as overfishing. However, landings of Atlantic salmon have shown some increase, which may be due to improved river and high seas management and curtailment of commercial sea fishing. Increased landings of blue mussel appear to reflect increases in aquaculture. Fisheries for other species that have shown declines are inshore species such as scup, cusk and wolf fish which are vulnerable to inshore fishing.

Several fisheries have shown recent increases, and among these are species such as those formerly discarded, e.g., Cancer crabs (by the lobster fishery), brill and skates (by trawlers). Two valuable crustaceans have posted significant upward trends, American lobster and pink shrimp, both of which have been heavily fished, and whose landings are subject to environmental (climatic) changes. American lobster fisheries in southern Area 21 are the subject of a management plan specifying size limits and trap design.

Tuna and billfish stocks in the region fall within the mandate of the International Commission for the Conservation of Atlantic Tunas (ICCAT) and total landings are listed in Table 21. However, within US waters, billfishes and swordfish are the subject of separate management plans.

NORTHEAST ATLANTIC (AREA 27) (TABLE 6)

Total reported catches in 1990 were 9.2 million t, down slightly from 9.9 million t in 1989 (FAO, 1993a). Of the 9.2 million t 8.2 million t, were finfish and 1.0 million t were invertebrates. Most of the demersal stocks continued to exhibit long-term downward trends due to excessive fishing pressure, undesirable fishing patterns (i.e., too much fishing on young fish and discarding) and poor recruitment, probably related to reduced spawning stock biomass and unfavourable environmental changes.

The level of exploitation of the North Sea cod, haddock, and whiting stocks is very high. Most of the catch consists of fish which are one or two years old, and fewer than one third of the fish alive at the start of the year survive to the end of the year. The fisheries are therefore very dependent upon newly-recruited young fish.

The North Sea cod stock has been fished down to the lowest level ever observed (some 1 000t in 1990 down from some 250 000t in the 1970s) and it is uncertain whether it can produce enough recruits to maintain itself (ICES, 1992a). Fishing mortalities must be reduced to give the stock a chance to recover. The year-classes 1986-90 are all below average. Spawning stock biomass has fallen to 66 000t in 1990, below the lowest acceptable level of 150 000t. The prospects for the haddock stock are also bad although not quite as bad as for cod. The year-classes 1987-89 are all very much below average, but year-classes 1990 and 1991 are only a little below average. Spawning stock biomass was at a record low level in 1991 of 64 000t but will improve to above 100 000t (advised as the 'lowest desirable' level) in 1993 due to the 1990-91 year-classes. Spawning stock biomass and catches of North Sea whiting increased in 1990 and 1991, and the prospects are a further increase in 1992 and 1993 due to above average recruitment in 1988 and 1990. Fishing mortality is high, but whiting is a predator on other commercial species and it is not desirable to have too big a stock. The situation is less clear with the North Sea saithe. There has been a declining trend in the spawning stock from 107 000t in 1985 to 74 000t in 1990, but it now seems to have stabilized.

The landings of Baltic cod were at a record high in 1980-85, of between 335 000 and 441 000t (ICES, 1992b). The stock suffered a high fishing mortality and has since then been constantly declining. The spawning stock has declined from over 800 000t in 1980 to 115 000t in 1992 and is now below the minimum biologically acceptable level. The International Council for the Exploration of the Sea (ICES) recommends a total stop for the cod fishery in the Baltic except for the small stock in the western Baltic where ICES recommends that fishing mortality be reduced to the lowest possible level. In setting the first TAC for cod in the Baltic it was recommended that fishing mortality be reduced to the lowest possible level and this was agreed by the countries participating in the fishery in 1989. The agreed TACs have always been much higher than those recommended by ICES and the resulting fishing mortalities have been at an almost constant and very high level. For 1993 the managers have agreed on a 40 000t TAC for cod. This corresponds to a reduction in fishing mortality to half of the previous level but is still higher than F_{max} by approximately 50%. Recruitment to the stock shows a general downwards trend since 1976. Lack of inflow of high salinity water rich in oxygen from the North Sea to the Baltic has resulted in a decline in salinity and oxygen content of deep waters of the Baltic. This might have resulted in a high mortality on cod eggs which sink after extrusion.

The Northeast Arctic cod stock was one of the world's largest, with landings on average of about 700 000t in the 1970s, peaking at 1.1 million t in 1968 and 1969. This fishery was controlled by a USSR/Norwegian joint commission (ICES, 1992a). Cycles of production tend to be driven by good recruitment when Gulf Stream drift affects Barents Sea temperature. Quotas were over-optimistic until recently, and the landings were 332 000t in 1989 and in response to stock declines quotas were halved to 172 000t in 1990 and 1991. The earlier low in capelin abundance contributed to poor condition, cannibalism and poor recruitment. Spawning stock increased from 172 000t in 1989 to 571 000t in 1991 mostly due to the good survival of a big 1983 year-class.

The catches and spawning stock of North Sea sole increased sharply in 1990 due to a big 1987 year-class, and should stabilize at an average (1971-90) level (ICES, 1992a). However, it is recommended that the spawning stock biomass should not be lower than 50 000t in order to buffer the possibility of two successive poor year-classes. This stock is known to have widely fluctuating year-classes. For North Sea plaice, fishing mortality, yield and recruitment have steadily increased from 1964 to 1990. The spawning stock size has decreased slightly in the same period, but is still above the lowest acceptable level of 300 000t.

The stocks of mackerel in the North Sea and west of the British Isles have been declining since 1973-74. The spawning stock of the North Sea mackerel is at its historic lowest level and is only a small percentage of the stock-size in the 1960s. The western spawning stock biomass has been rather stable between 1.8 and 2.2. million t in 1984-90. Fishing mortality has increased since 1984 but is still at a reasonable level.

The industrial fishery in the North Sea is targeted on small species like sandeel, Norway pout, and sprat for fish meal and oil production (ICES, 1992a). Landings were around 1.8 million t in the mid-1970s and have fluctuated between 1.0 and 1.5 million t since then. Sandeel is the most important species and makes up more than 60% of the total in all years.

The Barents Sea capelin stock is rapidly recovering from almost complete depletion with spawning stock biomass rising from 17 000t in 1987 to 2.6 million t in 1990 (ICES, 1992a). The 1988 capelin year-class is good although still below the long-term average and its growth rate is exceptionally high. The fishery was closed from May 1986 to January 1991. The mean annual landings in 1973-90 were 1.3 million t and in the winter and spring of 1991 the catch was 679 000t. The Iceland/East Greenland stock fell below the minimum safe limit of 400 000t during 1989 and 1990. Because of the short lifespan of capelin the state of these stocks is highly variable.

The North Sea herring stock collapsed in the mid-1970s after extremely high fishing pressure (ICES, 1992a). From a previous level of several million t of spawning stock biomass and a stable annual catch of about 0.5 million t, the spawning stock decreased to 52 000t in 1977 and the fishery was banned. Since then the stock started slowly producing larger and larger year-classes. Now the spawning stock is at 1.3 million t and the catch has been from 492 000 to 646 000t since 1986. The spawning stock is well above the minimum acceptable level of 800 000t which is the minimum spawning stock size for which the recruitment is not suspected to be hampered. Large herring are fished for human consumption and young herring for producing fish meal and oil, which is, however, not the intention of management since this fishery for young herring constitutes 'growth overfishing' and significantly reduces the potential spawning stock size.

The Icelandic summer-spawning stock supported slightly increasing catches of around 100 000t in 1988-90 (ICES, 1992a). The spawning stock biomass has stabilized around 0.5 million t, the highest level since 1947. The Norwegian spring-spawner stock, once the largest herring stock in the world with a spawning stock biomass of 10 million t in 1957, has been slowly recovering from virtually zero in 1972 to about 1.5 million t in 1990. However, the stock is still at only 60% of the lowest level (2.5 million t) known to have given good year-classes in the period prior to the collapse. Landings in 1990 were 86 000t compared to 10 000-20 000t during 1972-83.

Other smaller herring stocks which have increased or are still at a stable level, include those of Skagerrak-Kattegat and western Baltic, several areas west of Scotland and Ireland and several in other parts of the Baltic (ICES, 1992b). The main stock in the Baltic has experienced a decrease in fishing mortality and an increase in spawning stock biomass which is now approaching 3 million t (ICES, 1992b).

An epidemic of the fungus Ichthyophonus spp. started in 1991 in the adult herring of the Norwegian spring spawner stock, the North Sea stock, and the western Baltic stock. The processing industry periodically stopped processing herring due to low quality and high frequencies of infected fish and mass mortalities were observed during the autumn of 1991 in the Sound between Denmark and Sweden. In the autumn of 1992 the frequencies of infested fish were still high. The disease is lethal, but it is still not possible to quantify its impact on the sizes of the infected stocks.

Catches and exploitation levels in the traditional redfish fisheries around Iceland, East Greenland and the Faroe Islands have been at a fairly constant level between 120 000t and 170 000t since 1980 (ICES, 1992a). The size of the stock is uncertain due to problems in age determination. A new fishery began in 1982 on an oceanic stock of Sebastes mentella, in international waters between Greenland, Iceland and the Atlantic Ocean north of the Azores. Catches rose from 60 000t in 1982-83 to 105 000t in 1986, but have declined significantly since to 23 000t in 1991.

Hake landings have remained fairly stable since 1978 around 70 000 to 80 000t (ICES, 1992a). The stock status is uncertain, but there is clearly a high mortality on young hake, the catch of which are generally discarded. The landings of sardine have decreased from about 200 000t in 1980-85 to 139 000t in 1990. Catches of European anchovy have fluctuated between 5 000 and 34 000t since 1979.

Landings of the northern blue whiting dropped from 1.1 million t in 1979-1980 to 529 000t in 1990 (ICES, 1992a). The spawning stock was at an historic high of 6.3 million t in 1976-77, declined to a minimum of 1.9 million t in 1984 and increased to 2.5 million t in 1990. A fairly strong 1989 year-class will result in a stock increase in coming years. Horse-mackerel landings have increased in recent years with 441 000t reported in 1990. The stocks are supported by a very strong 1982 year-class, but unless other strong year-classes appear the resource will be unable to support continued landings at the present level.

Pollution has caused environmental deterioration in some parts of Area 27. The level of nutrients, heavy metals, and poisonous organic compounds are high in most sea areas influenced by river outlets. Except for the Baltic Sea this is mostly a coastal problem. The pollution of heavy metals and poisonous organic compounds have generally decreased in recent years. However the pollution by nutrients in river discharge initially increased, but with the clean-up of the major river systems (notably the Rhine) in recent years, nutrient inputs may have declined somewhat with repercussions on coastal productivity. Especially the eastern part of the North Sea (influenced by the rivers Rhine and Elbe) but also the Skagerrak and Kattegat, and the whole Baltic suffered in the 1980s from frequent oxygen depletion due to eutrophication. Cod and plaice stocks in these areas seem to have been affected. Increased levels of fish diseases are often observed in areas of oxygen depletion of bottom water and close to river outlets, but on too small a scale to affect entire fish stocks.

The scientific advice on which management measures are based (e.g., total allowable catches (TAC), minimum mesh-sizes, etc.) is provided by the ICES through its Advisory Committee on

Fisheries Management (ACFM) (ICES, 1992a). However, ICES revised its procedure in 1991-92 and form of fishery management advice and now only makes recommendations in cases where stocks are exploited outside safe biological limits, i.e., where stocks are below or are expected to fall below a 'minimum biologically acceptable level' in the near future at present rates of exploitation. Minimum biologically acceptable levels for a particular stock are usually defined as the smallest spawning stock size that can produce average year-classes or as the smallest historical spawning stock size. When stocks are exploited within safe biological limits, ACFM will provide options without indicating a preference - but will indicate the biological consequences and risks associated with each option. The choice of a particular option is left to the managers. Thus, biological reference points such as F_{max}, $F_{0.1}$, etc., will no longer be the basis of ICES recommendations. They might still be relevant for stating the consequences of a certain policy. Advice relative to the management of Atlantic salmon throughout the North Atlantic (excluding the Baltic) has been provided by ICES to NASCO since 1984.

The Total Allowable Catch system has been used as the standard tool in managing the stocks in Area 27 (ICES, 1992a). As a general rule, agreed TACs throughout Area 27 have exceeded the TACs recommended by ICES and actual catches have exceeded the agreed TACs. Enforcement of management measures has not been adequate in all areas and problems arise from the fact that many of the regulated stocks are harvested in mixed fisheries. The reliability of reported landings statistics has deteriorated for some stocks as a result of management/enforcement problems which, in turn, has reduced the reliability of the scientific advice on those stocks. Discarding of undersized fish or due to low prices for specific sizes appears to be an increasing problem. Besides this obvious waste of resources this phenomenon makes the assessment of the stocks more difficult as data on the amount discarded are difficult to obtain.

ICES has in some cases in recent years departed from the practice of giving advice based on a TAC. For cod in the North Sea misreporting undermined the TAC system and ICES recommended an effort reduction with restrictions on the number of days each fishing vessel is allowed to fish in addition to TACs. ICES has recognized the need for multispecies assessment and advice taking into account both the biological relationships among species and the technical interactions in the mixed species fisheries and has been actively involved in the relevant research and development of methodologies (see Box: "Multispecies stock assessment").

BOX: Multispecies stock assessment

Multispecies models are under development within ICES for the North Sea and the Baltic and reflect the fact that consumption of fish by other fish is a major cause of death for many species. These models have been under development for the last 10-12 years, collecting data and testing them. The models are called Multi-Species VPAs (MSVPA) (Sparholt, 1990; Sparre, 1991) because they are conceptually simple extensions of the Virtual Population Analysis (VPA) which back-calculates the numbers of fish at earlier ages in the population from the death rates and the age composition of the catch. VPAs for many species are done simultaneously so that the prey interact with their predators. This affects the death rate due to natural causes used in the VPA for the prey species.

In addition to the data needs of a VPA analysis, the MSVPA require data about what and how much the predators eat (Helgason and Gislason, 1979). This has been obtained by extensive experimental and field studies on stomach contents, digestion rates of fish and their diet. In the North Sea two major stomach sampling projects were carried out in 1981 and 1991 collecting about 100 000 stomachs of the major fish predators. On the basis of the 1981 data, such a model has been established and tested. Data from 1991 should be the 'final' test of the model, and if no surprises occur, the model is then ready for use in routine assessment. These models cannot predict recruitment which is estimated outside the model, hence they cannot provide information on the recruitment to be expected from a given strategy to each species.

The two most important findings by the model are that predation mortalities on young fish are very high, often over 65% per year and that the current fishing pressure remains below that providing the maximum yield-per-recruit. The main practical conclusion of the model is that the total value per recruit (all species) in the North Sea fishery may decrease if effort decreases on predatory species, since this will reduce the abundance of their prey. As there is no stock-recruitment relationship built into the model it can only be expected to be reliable within stock sizes which are above the 'minimum biological acceptance level' However, as noted in the main text, many stocks are below this limit, which is a serious constraint on the model's applicability. The MSVPA model for the North Sea has confirmed that whiting is an important predator in this ecosystem and that the total value of North Sea catches will benefit from an increased fishery on this species. This is therefore a tool which managers can use with recruitment forecasts to 'tune' the output.

In the Baltic, about 80 000 cod stomachs have been sampled from 1977 to 1990 and the MSVPA model is now used in the routine assessment of herring and sprat. The assessment of cod will also be done by the MSVPA model in the near future. The fish component of the ecosystem in the Baltic is simple with cod as the only important predator, and herring, sprat and small cod as the relevant prey, but the MSVPA model will have a significant impact on the biological reference points used and on the management strategies followed. Due to the decline of the Baltic cod stock a lot of research is at present focused on developing stocking programmes for cod. The MSVPA gives valuable information about the likely loss of released juvenile cod due to cannibalism. The average cod stock from 1977 to 1990 eats each year about 5 000t of young cod less than 20 cm in length. One has to count on producing an additional 50 000t per year just to be eaten by other cod if the aim is to bring back the previous size of the cod stock by stocking.

WESTERN CENTRAL ATLANTIC (Area 31) (Table 7)

This area includes the Caribbean region, the Gulf of Mexico, the north eastern coast of South America and the south Atlantic coast of the USA. The Caribbean basin coastal oceanography is dominated by the effects of three of the largest river systems in the world; Mississippi, Orinoco and Amazon. The runoff of these rivers is related to mesoscale climate changes and has been linked to El Niño events in the equatorial Pacific. Inter-annual variability in this area is also influenced by the frequency and intensity of hurricanes, both of which are also related to the equatorial Pacific climate. The influence of hurricanes on fisheries productivity is confined to localized areas, and largely depends on the intensity and timing of the storm. The influence of river runoff patterns however, extends over large areas of the coast and shelf, and is probably the major source of variability in fisheries productivity in the area, other than fishing pressure (e.g., on Gulf of Mexico shrimp and menhaden, Guyana-Brazil shrimp). It is also well known that coastal habitat degradation, due to the pressures of coastal development and tourism, is one of the major reasons for decreases in reef fishery productivity in this area.

Reported landings in the area have decreased from a high of 2.6 million t in 1984 to 1.7 million t in 1990 (FAO, 1993a). Most of this reduction can be attributed to declines in the catches of three US fisheries: the Gulf menhaden, the American oyster and the calico scallop. These three fisheries constituted 60% of landings from Area 31 in 1984, but only 40% of landings in 1990. Landings from the other remaining fisheries of the region have remained stable over the last decade at around a million tonnes.

The main fisheries within Area 31 are for small pelagics (menhadens, flyingfish, mackerels), large pelagics (tunas, billfishes and sharks), reef fish (snappers and groupers), coastal demersal fish (drums, weakfish, croaker), crustaceans (shrimps, lobsters and crabs) and molluscs (oyster, scallops and conch) (FAO, 1993a). There are some under-utilized resources like cephalopods (squid and octopus), small pelagics, deep water shrimps and deep water snappers which may lead to increases in landings, but it is unlikely, excepting cephalopods, that these increases will be significant in the near future.

Except for some US, Mexican and Cuban fisheries, there are few resources in the region administered through a management plan with a regular mandate for stock assessments. As a consequence, knowledge on the status of fishery stocks is limited. However, experts in the region agree that a number of the resources are fished at their maximum sustainable level and many are overfished.

There may be hope for increased landings of small pelagics in certain areas, but the total landings will always be dominated by the US menhaden catch. Because the Gulf menhaden is fully exploited and the Atlantic menhaden is over-exploited, only a limited increase in landings can be expected from the latter as stock sizes recover through quota management (NMFS, 1992b).

The stocks of coastal migratory pelagics (mainly mackerels) are probably heavily exploited in most areas and overexploited in a few. The migratory behaviour of these fish and the fact that they support artisanal, industrial and recreational fisheries makes their assessment and management a very difficult task (Haughton, 1987). These fisheries are highly seasonal and the potential for conflict between user groups is high as evidenced by the management problems faced by these fisheries in the USA. Problems with resource sharing within the USA between commercial and recreational fisheries, and with other Caribbean States internationally also have their parallel in Central American waters and the Antilles where island nations share the same resource. However, for the Lesser Antilles, joint management of shared resources by island countries is fostered by a common management approach. For Trinidad and Tobago, consultation on resource sharing is now occurring with Barbados for the flying fish resource and with Venezuela for shrimp.

Distant-water fisheries for large pelagics have expanded within the region in recent years; those for tunas by Venezuela, and swordfish by US vessels, being especially notable. Since many of these species migrate over considerable distances their utilization and rational management will also require close collaboration between the countries of the region.

In general, our knowledge of the status of reef fish stocks is very poor even in places such as the USA (FAO, 1989a; Joseph 1984). The major problem is that statistics are unreliable because the fishery harvests a large number of species and uses a type of gear (handlines, traps, gillnets) for which estimation of fishing effort is a difficult task. Deep water resources in the region may be underexploited but their estimated potential yield seems small. Reef resources within the continental shelves of the Caribbean islands and some areas of the mainland are probably extremely overexploited (Joseph, 1984; Friedlander and Beets, 1988) and there is widespread concern on the high level of artisanal effort and the use of unselective gear such as fish traps (FAO, 1989a). Few reef fish can be considered underexploited. Evidence of this is the fact that catches of snapper/grouper species have remained at roughly the same level over the past decade in spite of the expansion of the fishery to offshore grounds and increased landings of low valued species. The snapper-grouper fishery off Venezuela has shown increased landings from 1989 to 1990 which is primarily due to changes in the port of landing and on increased reporting of the catch. A serious problem with overexploitation of groupers, here and elsewhere in the tropics, relates to their extreme vulnerability to fishing on spawning aggregations. A similar expansion in the snapper fishery has also occurred in Suriname. Many other groups of reef fish (e.g., parrotfishes and grunts) show signs of overfishing in several countries of the area.

Landing figures for coastal demersals do not include the catch by sports fishermen, or the quantities discarded at sea by commercial shrimp trawlers which can be very significant. Along the US Gulf and South Atlantic coasts, the catches of preferred species by sports fishermen generally exceed the commercial catches. In fact, the growing economic importance of sports fishing has seen progressive restrictions being introduced in some areas on the commercial fishery. Concern has increased in recent years over the effect that the intense trawl fishery for shrimp in the northern Gulf of Mexico has had on species taken incidentally in the catch, notably, marine turtles and, primarily in the USA, the juvenile stages of fish of interest to the important sport fisheries. Although the long term potential yield of most US stocks of coastal demersals is unknown, all their stocks are probably overexploited. Increased landings have been registered for sharks and rays, but groundfish stocks on the outer shelf and slope have remained relatively untouched throughout Area 31.

Most shrimp resources of the region seem to be fully exploited, and the industries overcapitalized, due to the open entry policy of most countries. The conflicts that the shrimp industry has with the US Government over by-catch issues seem to be leading to an increasingly unpredictable future for this fishery. Turtle excluder devices have been legislated for use in some areas and interest is centred on more selective ways of harvesting shrimp. Considerable attention has recently been focused (e.g., Mexico, USA, Venezuela, Guyana) on improving management of these key resources using economic as well as biological criteria (WECAF, 1989). Cooperation in management of common shrimp resources takes place between the USA and Mexico in the Gulf of Mexico and the first steps in this direction have been made in the Guyana-Brazil region. Discards by shrimp trawlers continue to be significant for different shrimp fisheries in the area. These reduce the possibilities for further expansion of bottom fish catches. Given that valuable shrimp fisheries continue to receive priority, a more effective use of by-catch is an obvious way of increasing yields.

The US spiny lobster fishery has maintained stable landings over the last decade but again at the expense of increased overcapitalisation of the fleet (the same landings could be achieved with roughly half the present number of traps) (NMFS, 1992b). Legislation has recently been passed to reduce the number of traps in the Florida fishery by establishing trap transferable licences. The Florida stock seems to be very heavily exploited and few recruits survive each designated fishing season because increased fishing effort over the last decade has progressively shortened the effective fishing season (see Box: "Caribbean spiny lobster: a fishery for annual recruits"). With the exception of the Bahamas, most other lobster stocks in the region are heavily exploited and recent expansions of the fishery to offshore banks (as for Pedro Bank in Jamaica) do not seem to warrant new increases in effort and these grounds seem to be fully exploited now, although some stock components in deep water may be still underexploited. In several countries (Cuba, Puerto Rico, USA) there is evidence that stocks suffer growth overfishing and that landings might increase if larger minimum legal sizes were imposed (Burnett-Herkes et al., 1986). Declining recruitment in these stocks suggests that there is localized recruitment overfishing. Several countries (Mexico, Cuba) are successfully using artificial habitats (casitas) for harvesting and to enhance survival of juvenile lobsters. Cuba has restricted fleet size and effort, leading to significant catch increases.

The American oyster fishery in Area 31 has shown a significant decline in landings over the last eight years due to disease and is still not showing signs of recovery (NMFS, 1992b). Landings from the US calico scallop fishery have historically responded to the wide fluctuations in abundance experienced by the populations of this bivalve. Past peaks in landings should not be taken as the norm, but rather as events which repeat themselves at intervals of several years.

Conch is fished throughout the area and because of its vulnerability and slow growth is very prone to overfishing (Appeldoorn, 1992; Berg and Olsen, 1989). Intensive fishing in most areas has depleted conch population to the point of forcing permanent (USA, Mexico, Bermuda- Berg et al. 1992a;b) or temporary (Cuba) closure of the fishing grounds to commercial fishing. Reseeding programmes to rebuild conch stocks have been tried in many countries but few of such initiatives survive today (Mexico, Netherlands Antilles). Concern has been expressed regarding the possibility of a reduction of genetic diversity due to conch reseeding programmes (Berg et al., 1986; Campton et al., 1992). Recruitment to the different adult populations is highly variable with some areas receiving a fairly stable supply (Cuba, Bahamas, Belize, Turks and Caicos) and other areas characterized by highly variable recruitment (Bermuda, Mexico). Most countries that harvest conch today rely on a steady supply of recruits. Stocks in Cuba seemed to recover quickly after a temporary closure of the fishery and stocks in the USA are steadily increasing after many years of fishing closure. In Bermuda, however, in spite of more than ten years of protection, stocks have not recovered from overfishing. Countries like Mexico and the Netherlands Antilles maintain reseeding programmes as their only hope to rebuild their stocks.

Octopus fisheries now occur in a limited number of locations, most notably on Campeche Bank (Mexico), in Cuba and in Venezuela; this, despite a much wider distribution and growing market which could lead to a significantly expanded fishery. The potential for squid fisheries in the eastern Caribbean is almost undeveloped and deserves investigation, for both human consumption and as a bait for large pelagic and sport fisheries.

Ciguatera poisoning continues to slow down development of demersal fisheries in the northern Lesser Antilles. Outbreaks of the disease are fairly localized but higher demand is increasing the pressure to exploit ciguatera-prone areas and therefore increases the chance of landing ciguatoxic fish (Vernoux, 1988).

Some countries of the region have moved to full-scale shrimp aquaculture using wild fry. This has led to concern with the destruction of shrimp nursery habitat (mangroves and coastal marshes) as a result of pond construction. There is also a problem in some areas with the effects of runoff of agricultural chemicals on to shrimp nursery areas.

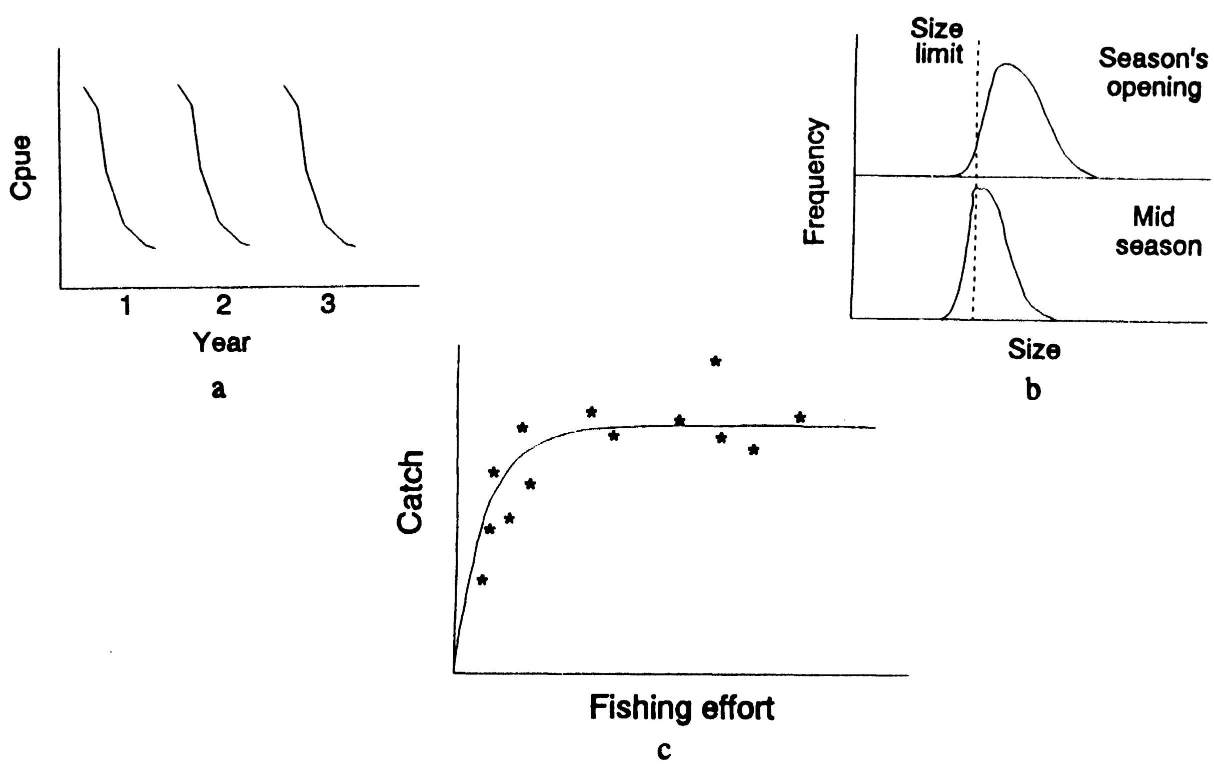
This area offers great contrast in terms of management of fish stocks, from some of the highly managed US fisheries to the completely unmanaged fisheries of countries like Haiti. This partially reflects the difference between industrial and artisanal fisheries but also shows dissimilar approaches to management of fish resources by individual countries. The only limited entry fishery within the region is the shrimp fishery off northern Brazil but other forms of control such as closed seasons and gear restrictions are used by several countries (Dias-Neto, 1991; Valentini et al. 1991). Most US fisheries are managed through output controls by imposition of catch quotas and/or bag limits, however there are instances (e.g., Florida lobster) where a form of input control (limits and progressive reduction of the total number of traps) has recently been agreed to by the fishing industry. Size limits are also used throughout the region and may reflect biological, economic and marketing considerations.

The very low yields recently obtained from reef fisheries due to overexploitation, has lead to policies focusing on development of new pelagic resources at the expense of improvements in the management of reef demersals. There is certainly a lot to be gained by attempting to maximize the overall bio-economic yield of all reef species. But this strategy would certainly lead to overexploitation of some stocks and underexploitation of others, and measures should be put in place to prevent population collapses of individual species. Careful consideration needs to be given to the interdependency between the artisanal reef fishery and the seasonal fishery for coastal pelagics. Agreements have to be reached on separate access rights for these two fisheries, if the coastal reef resources are to recover.

BOX: Caribbean spiny lobster: a fishery for annual recruits

Spiny lobsters are distributed over the entire Caribbean and as far south as Northern Brazil; however no major fishery occurs within the Gulf of Mexico. Juveniles and adults do not move much beyond their settlement area but larvae have the potential to mix throughout the whole Caribbean basin. Stocks are close to full exploitation and the annual crop of recruits is depleted each season. For any given stock high catch rates are evident at the beginning of each fishing season followed by a decline in catch per unit of effort through the season (Figure a).

Lobsters over the minimum legal size are only common in the landings at the opening of the season and thereafter landings become dominated by recruits (Figure b). Given this situation it is critical to ensure that the minimum legal sizes allow for sufficient escapement to spawning by adults every year to replenish the annual crop of recruits (see, eg, Burnett-Herkes et al., 1986). Annual yield in the fishery seems largely independent of fishing effort once the annual recruits have been harvested (Figure c). This effort pattern has lead to considerable overcapitalization of fishing fleets (e.g., Aiken and Haughton, 1987). Only recently Florida fishermen have agreed to a scheme to reduce the number of traps in the fishery to increase economic viability. The main goals of management should be to reduce excess fishing effort, enhance survival of prerecruits and ensure sufficient spawning. Although the first two goals may be achieved through local management the third may require Caribbean-wide cooperation (Snead, 1987).



Box Figures: Showing the rapid fishing down of larger lobsters during the season both in (a) catch rate (CPUE), (b) sizes, and (c) how overall landings do not go up significantly with continued increases in fishing

Many of the resources of the region are shared by several countries and there is growing recognition of the need for cooperation in fisheries management. Countries with isolated island shelves could contemplate independent management based on socio-economic considerations. Larval dispersal and adult migration characteristics of some stocks may still mean that biologically oriented management will have to be coordinated at the regional level.

Investigations on the marine resources of the area fall within the terms of reference of the Western Central Atlantic Fisheries Commission (WECAFC), except for tunas, which are covered by the International Commission for the Conservation of Atlantic Tunas (ICCAT). The WECAF Commission and its two working parties (on Marine Resources and Economics and Planning) meet in alternate years, as does its Committee for the Development and Management of Fisheries in the Lesser Antilles.

EASTERN CENTRAL ATLANTIC (Area 34) (Table 8)

Catches in this region rose to 3.8 million t in 1977, fell to 2.9-3.0 million t in 1985-86, and recovered to 3.7-4.0 million t in 1989-90. The magnitude of changes in landings illustrates the large fluctuations of the small pelagic resources such as horse mackerel and sardine which are usually influenced by changes in climatic and fishing pressure, characteristic of this region.

Catches were recorded by 21 coastal countries and more than 18 non-coastal countries, giving a markedly international character to many of the region's fisheries and the share of landings by non-African long-range fleets remains high. It has decreased from 67% of the catch during the period 1970-74 to 43% in 1975-79, and was 58% in 1980-84. This share remained at 58% in 1989 and 1990, partly reflecting policy decision by coastal states, but also the current difficulty of some African countries in fully exploiting the resources themselves, especially given the large fluctuations of pelagic offshore resources which are of principal interest to foreign fleets.

Changes in the economies of Eastern Europe may soon result in a reduction of catches in Area 34 as their distant water fleets begin to operate under market forces. For example, the former USSR caught 40% of the catch, primarily small pelagics, off West Africa in 1990. This represents an opportunity for coastal States to benefit by replacing the foreign operations. However, care should be taken as the investment risks and costs are high and the prices of small pelagics are low.

Northern Sector

In the northern sector from Cap Spartel (Gibraltar Strait) to the north of Cape Timiris (Mauritania), the demersal stocks are almost fully exploited or overexploited, both economically and biologically. These include cephalopods, hakes and sparids; the one possible exception being the stocks of black (Senegalese) hake found to the south of Cape Juby. Fishing effort should be significantly reduced for cephalopods and for European hake, which also needs adequate protection as small fish. Recent management measures taken in Morocco (closed seasons) have proved to be beneficial (FAO, 1992c;d).

The coastal stocks of seabreams are heavily exploited to the north of Cape Juby and markedly overexploited to the south of Cape Bojador. The recovery of the stock is threatened by the rapid expansion of the cephalopod fishery, which produces a high incidental fishing mortality on juvenile seabreams (FAO, 1992d). The large stock of Moroccan sardine seems to have returned to historical levels with improved accessibility by coastal fleets off northern Morocco.

In the Mauritania-Senegal sector the fishery has undergone major development in the last ten years, due to increases in fishing by foreign fleets and development of national fishing capacity. Catches have not increased, and all the stocks traditionally exploited are considered at least fully fished. The levels of abundance of demersal stocks have been seriously reduced since the early seventies and the future of the resources is a matter of concern. Pink spiny lobster stocks, which were slowly recovering after several years of serious overfishing, are again subject to highly intensive fishing with pots and gillnets. Green lobsters were probably underexploited in the north, but fishing is intensifying on southern stocks. An unexploited clam stock with a potential of about 300 000t has been discovered off the coast of Mauritania (FAO, 1992d).

Shrimp stocks of Senegal are fully exploited and the overall potential seems to have increased significantly compared to earlier studies. This, and the fact that octopus abundance has also increased while that for traditional species has decreased, may be an indication that the ecosystem is under severe fishing pressure.

The large stocks of sardine, mackerel and horse mackerels of this region are highly variable, and their assessment difficult. They are periodically subjected to high variations in abundance due to climatic changes, to large variations in fishing effort, or both. Because foreign fleets tend to shift from one species to another, trends in catch rates are difficult to interpret. The stock of mackerel seems to be fully fished, while the stock of sardine north of Cape Blanc has apparently experienced a period of increased abundance leading to unusually large catches, especially by foreign fleets. Recent acoustic surveys in northwest Africa show that the school density of sardinellas is very high particularly off Mauritania, with biomass estimates of around 4 million t. The state of the deep sea resources on the slope is unknown. Fishing is intensive on shrimps, hakes and seabreams, either directly or through "incidental" mortality resulting from by-catch in the horse mackerel fishery. Research effort is insufficient and recent attempts to assess the resources were unsuccessful (FAO, 1992d).

Southern Sector

Recent trawl surveys in Guinea have shown that coastal resources inside 20 m depth (roughly at 15 nautical miles, offshore) offer a potential of 45 000t for the development of the artisanal fishery, of which 15 000t could be exploited by small sized trawlers. The traditional offshore stocks have been very heavily fished by foreign fleets for years. The potential of demersal resources is estimated to be around 84 000t of which 32 000t are of high commercial value and 52 000t are of medium value. The pelagic stocks represent more than 50% of the marine resources of Guinea but their potential is unknown. At present, the pressure from foreign vessels is low. Recent estimates showed that pelagic and demersal resources have a potential of some 65 000 t. Increased fishing intensity of bottom trawlers and small-scale artisanal fisheries has led to major problems for the traditional artisanal fishery. In zones shallower than 20 metres the biomass has decreased and the catch rate of sciaenids has increased significantly (FAO, 1992g).

In the Sherbro area (Sierra Leone and Liberia) the state of the stocks is not well known. They have been heavily fished by foreign fleets in recent years, but biological data and statistics are still inadequate for a detailed scientific analysis (FAO, 1992d;e). From data collected by an acoustic survey in the Sherbro area, it appears that the large stock of triggerfish, Balistes carolinensis, which developed in the seventies (Caverivière, 1991) has practically disappeared, possibly because of fishing pressure, but more likely due to a reversal of the earlier change in climatic conditions. This change also occurred along the western coast of the Gulf of Guinea where landings of the globefish (Lagocephalus laevigatus) and of the high value cuttlefish (Sepia officinalis) increased significantly.

Throughout the sector, the most common commercial fish species in depths of less than 50 m seem to be fished at high levels of exploitation. Demersal stocks, further offshore in 50 to 200 m, are still not fully exploited. However, it is unlikely that their exploitation rate will increase because the fishery is not economically attractive due to the lower density of fish and catch rates, and higher fishing costs. The pink shrimp (Penaeus notialis) present in small concentrations from Senegal to the Congo, seems to be heavily exploited. Competition exists between artisanal inshore and industrial offshore fisheries. As catch rates increase, shrimpers are keeping larger amounts of fish by-catch for marketing, and better use is being made of fish which used to be discarded.

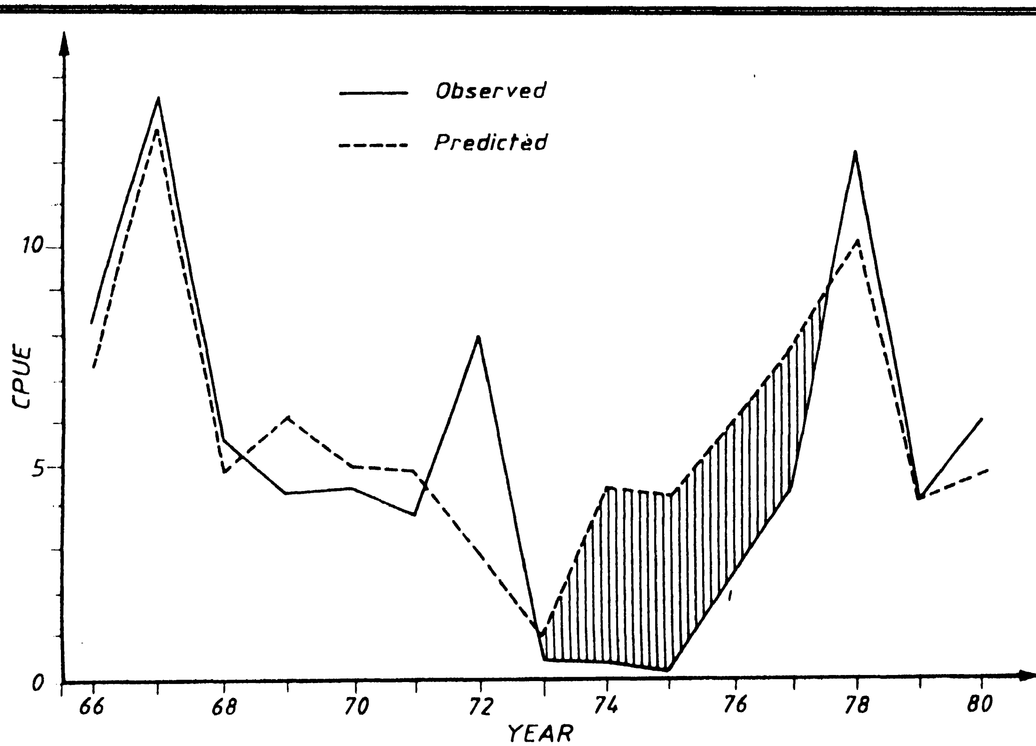
The important and unstable stocks of small pelagics of the Côte d'Ivoire-Ghana-Togo-Benin area, which collapsed in the past due to both high fishing pressure and unfavourable climatic conditions (Binet et al., 1991; Cury and Roy, 1991), have returned to record and steady high levels since the beginning of the mid-1980s with landings of Sardinella aurita of 80 000 to 106 000t/year (Freon, 1991). The stock of sardinellas seems to be in good shape. However, low catches of Sardinella maderensis which ranged from 20 000 to 48 000 t/year during the same period, are of concern. Very little is known about the stocks of anchovy and mackerel. The catches of the former species are extremely high while those of the latter appear highly variable (FAO, 1992f).

Little is known about pelagic and demersal resources in the whole southern Gulf of Guinea, where many countries have not yet developed the appropriate data base and research structure. Fishing effort on demersal stocks has been concentrated on the inshore zone and on juveniles. The demersal stocks of the deep shelf and slope, especially on hard bottoms, still seem to be underfished in most of the southern Gulf of Guinea. They may offer some potential for modern artisanal fishing with gillnets or longlines.

BOX: Effects of upwelling on a West African fishery

A small pelagic fishery off the coast of West Africa provides a good example of the effects that environmental conditions can have on the abundance of a fishery resource. Sardinella aurita, is mainly exploited by the artisanal fishermen from Ghana and to a lesser extent from Togo and Côte d'Ivoire, and by the semi-industrial fishery from Ghana and Cote d'Ivoire. The success of this fishery depends not only on the amount of fishing effort but also on environmental conditions in previous years in the area, i.e., the intensity of the seasonal upwelling.

The solid line in the Figure shows the highly variable catch rate (CPUE) in the fishery from 1966 to 1980. Conventional fishery models utilized to assess the potential of a fishery are based on stable fish populations and do not account for environmentally-induced fluctuations such as was evident in this fishery. The intensity of upwelling in the previous years was inserted in the model in order to make it more realistic (Freon, 1991). The dotted line in the Figure is the projected catch rate which results from adjustments made for different values in intensity of upwelling. The results show a highly unstable fishery which collapsed in 1974 due to high fishing pressure and unfavourable upwelling conditions. However, it recovered in 1978 and the catch rate (not shown) has stabilized since the mid-1980s. The modified model is a useful approach for the efficient management of a fishery provided that the influence of climatic variables is known and is restricted to the years preceding exploitation or where they can be adequately predicted.



Box Figure: Observed and predicted catch rates for small pelagics (sardinella) of West Africa, predicted by a production model with climatic inputs

Research programmes in Cameroon have demonstrated that coastal resources are subject to very high levels of fishing mortality, particularly in the estuary where small trawlers operate part of the year. Since the early 1980s, fish catches decreased while those for shrimp, Penaeus notialis, increased slightly. There appears to be a need to increase mesh size and possibly reduce fishing effort.

The assessment and elaboration of biological advice for management of the resources in this region are undertaken in the framework of the Committee for the Eastern Central Atlantic Fisheries (CECAF) by the national research laboratories, bilateral assistance programmes, and the FAO regional projects dealing with fisheries management. Important initiatives have been taken at sub-region level by the coastal countries to promote collaborative assessments on shared stocks through working groups and it is the objective of CECAF to promote and support these initiatives as far as possible. With a few exceptions, most stocks extend beyond the coastal countries EEZs and are occasionally shared, as in the case of horse mackerel, by as many as seven countries. This characteristic compounds the difficulties of stock assessment and the subsequent adoption and implementation of the management measures necessary for a rational use of the resources.

In 1988 the CECAF Sub-Committee on Management (FAO, 1989b) went through a process of overall review of all stocks in the area and the overall conclusions were: (a) most large stocks are fully fished or overfished; (b) pelagic stocks are highly variable and difficult to evaluate: their future management must be flexible and take this instability into account; and (c) the rate of updating of the evaluations is not satisfactory. In fact, the frequency of the assessment working group meetings has decreased considerably during the past few years, because of the termination of the Regional FAO/CECAF Project, and due to insufficient development of research at the national level in many countries. Despite this, the willingness to increase collaboration between coastal countries in the northern CECAF area is very encouraging.

Some 43 stocks and groups of stocks of importance need to be evaluated regularly in the whole CECAF area, many of which are shared by several of the 21 coastal States in the region. The data available since 1980 show that the CECAF project and the countries together produce new information (often still insufficient) on 20 stocks on average, i.e., 2.5% of the number of available stocks. Because these updatings are largely concentrated on the northern CECAF area, the shortage of information in the rest of the region is clearly evident.

During the last biennium, prospects for fisheries research in West Africa and new solutions for strengthening national research capacities through regional cooperation have also been considered. The main priorities in research items which could be developed at the regional level concern resources assessment and monitoring, population dynamics, ecosystem dynamics, typology of fisheries, bio-economic analysis and improved support of fisheries research. The CECAF Sub-Committee on Management (FAO, 1992c) recommended the continued evaluation of the principal pelagic and demersal stocks, the realization of bio-economic analysis of fisheries and the creation of a Geographical Information System for oceans and fisheries.

MEDITERRANEAN AND BLACK SEA (Area 37) (Table 9)

Total landings in the Mediterranean and Black Sea combined varied from 1.9 to 2.1 million t from 1982 to 1988 but declined to 1.7 and 1.5 million t in 1989 and 1990. Most of this decline is from landings in the Black Sea where the catch dropped from 833 000t in 1988 to 489 000t in 1989 and 428 000t in 1990. Preliminary figures for 1991 (GFCM, 1991) suggest an even steeper decline in small pelagic catches from the Black Sea.

Mediterranean resources have a long history of biological investigation, but for many countries, research specifically in support of fish stock assessment has only been carried out relatively recently, and the application of research to management of marine fisheries is still low (Caddy, in press). The pace of ecological change in the Mediterranean and Black Sea Basins (Caddy, in press), has accelerated over the last decade, both due to early growth in fishing intensity, and progressive anthropogenic effects such as nutrient runoff in this semi-enclosed sea, and continues to do so at a rate that is of concern to Mediterranean countries, and this is particularly evident with respect to fishery resources (Caddy and Griffiths, 1990; GFCM, 1993).

Advice and recommendations for the management of the resources are elaborated through the General Fisheries Council for the Mediterranean (GFCM) and the Joint Commission on the Fisheries of the Black Sea. Since 1980, some resource evaluations have been updated within the framework of GFCM in a series of technical consultations held regularly in the Western and Central Mediterranean area, the Adriatic Sea and the Eastern Mediterranean.

Although national management authority over demersal resources is limited to territorial seas with extensions of from 6 to 30 nautical miles, problems of shared fisheries management have, until recently, been relatively limited in the Mediterranean. Shared stock problems for the demersal resources are, actually or potentially, for the Gulf of Lions and the Gulf of Gabes, the demersal resources of the Adriatic Sea, and some (e.g., the hake) resources of the Ionian/Aegean Sea. These problems are now being tackled at a sub-regional level through GFCM. The main shared stock problems relate however, to the large pelagic fish resources, and to the small pelagic stocks of the Aegean, Gulf of Lions, Adriatic and the Sea of Alboran.

Fishing by some vessels from northern Mediterranean ports along the southern Mediterranean shelves historically has occurred, and is still frequently reported (Caddy, 1990a). Countries along the southern shores of the Mediterranean in the 1970s and 1980s have already been, or are still now, building their fleet and governmental fisheries infrastructure. Problems involving shared stocks have been more serious in the Black Sea (Ivanov and Beverton, 1985), where formerly the lack of a common framework for management contributed to a degree of overexploitation of a number of resources.

In the western Mediterranean, stocks are fully exploited with the possible exception of mackerel and horse-mackerel and, in some areas, sardines, while in the Adriatic and Gulf of Lions there is evidence of overfishing of most of the highly valued demersal species such as hake, red mullet and clams (vongole). In the central Mediterranean, the demersal resources generally are also fully exploited to heavily overexploited, particularly off Italy where demersal stocks are very heavily fished. Despite this, landings of demersal species for the whole continental shelf of the

Mediterranean increased for most species by some 3-8% per year between 1975-76 and 1985-86. This included overall reported landings of Mullus spp. and hake both of which rose by 5-7% per year. Similar rises were reported for prawns and shrimps, but landing trends for Pagellus spp. and cephalopods were more modest, at 3-5% per year. A few species, such as Maena spp. registered small overall declines (Caddy, 1990a). In inshore Spanish waters, an increase in the proportion of octopus in the catch has been suggested as a response to declining bottom-fish stocks.

It may be possible to explain some of this earlier increase as a result of the higher fishing effort exerted, and/or improvements to the statistical data base. However, other factors such as an increase in productivity of previously nutrient-limited demersal and pelagic food chains due to increased nutrient runoff (UNEP/UNESCO/FAO, 1988), seem to be indicated as a strong candidate (see Box: "Productivity estimates for the Mediterranean: evidence of acceleratig ecological change"). These increases seem to progressively favour pelagic food webs as bottom anoxia becomes permanent (Caddy, 1990b; 1993), but the food web is drastically modified and simplified with further nutrient enrichment, as has happened in the Black Sea (see Box: "Fishery induced and anthropogenic effects on the Black Sea ecosystem"), where dramatic declines in pelagic fish production have been registered over the last two years.

History of management in Mediterranean fisheries

The overall effects of very high local fishing intensities have been long understood, and declining catch rates and small sizes at first capture were soon evident after the second world war, particularly in the northern Mediterranean (Caddy, in press). Fishing capacity for demersal resources also increased for most of the southern and eastern Mediterranean as a result of fleet construction in the 1970s and 1980s, and as a consequence of demersal fish prices which tend to be higher than in most other parts of the world (Caddy, 1990a).

Past heavy fishing effort in Cyprus has reduced catches of formerly abundant species, and led to a fishery dependent on smaller species. In response to this situation, typical of a number of Mediterranean fisheries, a seasonal closure of the trawl fishery in order to protect the young fish stocks was enacted in the 1970s. This measure roughly doubled the fish landings, and increased profitability for artisanal and trawl fisheries (Garcia and Demetropoulos, 1986). It also led to dramatic rises in fishing effort by both trawl and artisanal fleets, with the result that increased profits for individual fishermen are still not being generated by the fishery (Hannesson, 1989). Fisheries economists have recommended that in the event of increases in catches due to improved management, dissipation of the resultant profits by investment in excess vessels should be avoided by licence limitation of both artisanal and industrial fleets.

BOX: Productivity estimates for the Mediterranean: evidence of accelerating ecological change

Despite generally high exploitation rates, the overall Mediterranean landings for all species continued to rise in the 1970s and 1980s (GFCM, 1991). This is not easily explained in terms of steady state fisheries theory, given that landings might have been expected to decline as effort further increased and stocks were depleted. An examination of man-induced environmental trends over the last few decades, pointed to the likely importance of nutrient enrichment for increasing fishery productivity within the Mediterranean and Black Sea basins, seas where biological and fishery productivity were formerly considered to be strongly limited by low nutrient levels. This hypothesis seems compatible with pollution studies carried out under the Mediterranean Action Plan, and with remote sensing imagery available (*Figure a* from NSF/NASA, 1989).

It seems from GFCM statistics that increases in fishery production in the 1970s and early 1980s were particularly evident for semi-enclosed basins such as the Black Sea and Adriatic, where nutrient-enrichment from land and river runoff has been more pronounced, than for the generally nutrient-poor regions of the eastern Mediterranean and around Sardinia. The effects of large inputs of nutrients, as for the Aegean Sea (receiving nutrient-rich water from the Black Sea outflow), and the Gulf of Lions (from the Rhone river), also appear to be reflected in recent landings trends; as well as where there is a more diffuse discharge of nutrients from human activities, as from the Nile delta (since construction of the Aswan Dam). The still largely oligotrophic nature of water masses in the southern Mediterranean as shown in Figure a, appears reflected in the significantly lower productivities in terms of tons of fish production per shelf area shown in Figure b.

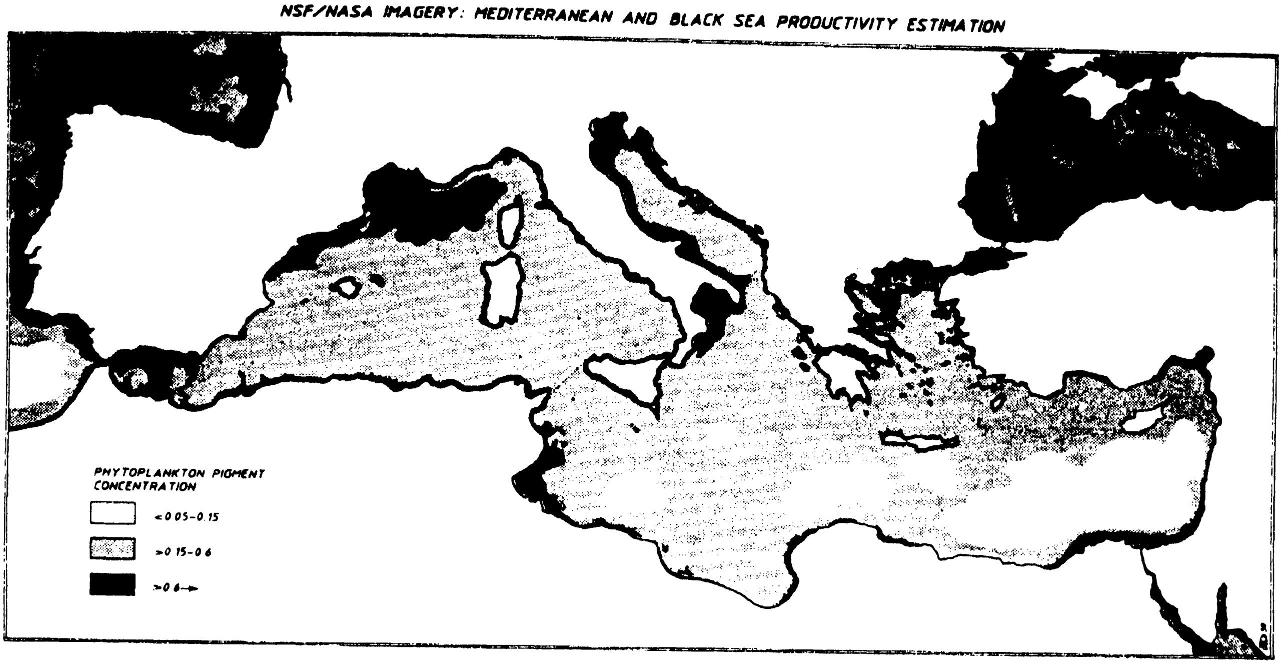


Figure a: Distribution of phytoplankton concentrations in the Mediterranean and Black Seas, based on 30 NSF/NASA (USA) images in May 1980.

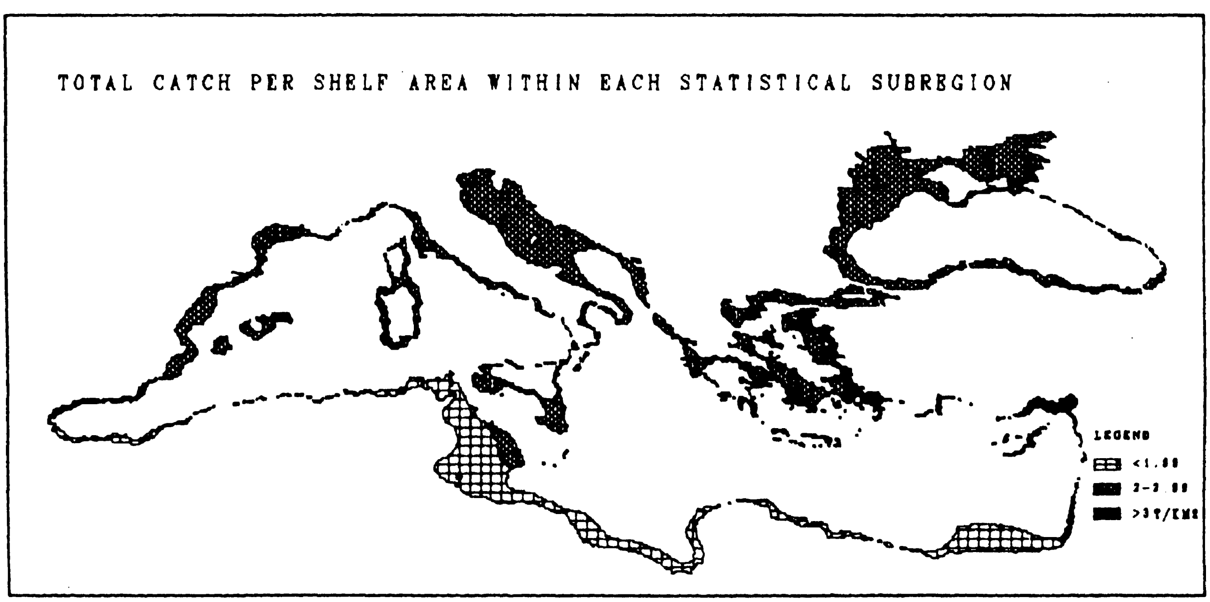


Figure b: Total production of pelagic and demersal fishes (1989) expressed per shelf area inside 200 m depth.

BOX: Fishery induced and anthropogenic effects on the Black Sea ecosystem

A general deterioration of the marine environment of the Black Sea has occurred (Balkas et al., 1990), and apart from largely contemporaneous events in the Aral Sea, represents the first example of the collapse of fishery productivity for a large inland sea. This situation has been particularly pronounced in the Sea of Azov, which has been affected by strongly reduced inflows from northern rivers (VNIRO, 1979), diverted for industrial and agricultural purposes, and on the northwest shelf of the Black Sea, where the effects of eutrophic runoff, particularly from the Danube, first had a strong influence. Uncontrolled fishing, nutrient inputs from other rivers and the littoral zone, and the introduction of exotic species, have combined with heavy fishing to change the ecosystem of this enclosed water body (Caddy and Griffiths, 1990).

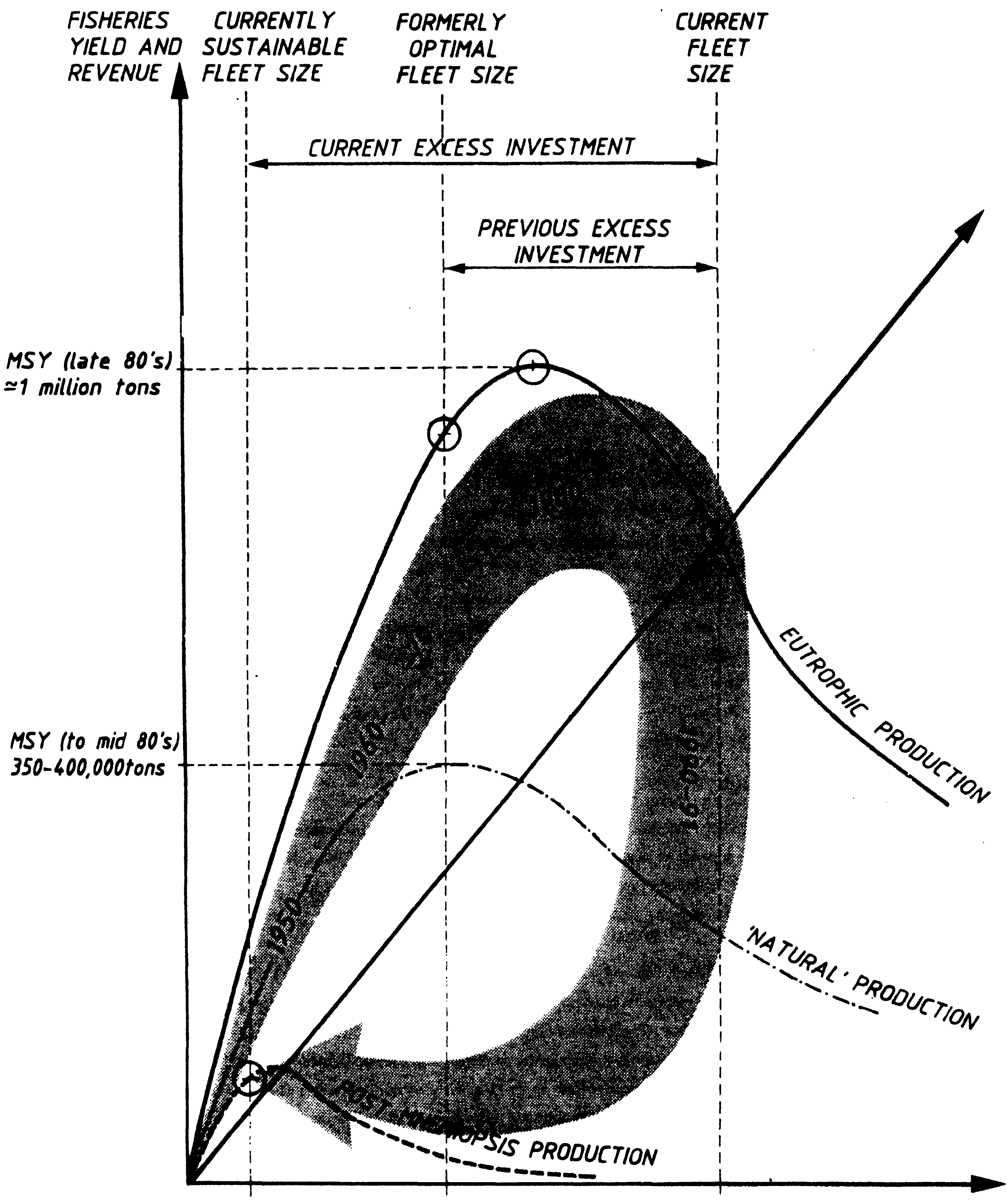
These anthropogenic effects were felt earliest on the demersal, benthic resources, on anadromous and migratory fish species and marine mammals, but have extended through the ecological chain, including the phytoplankton and zooplankton. The first two groups were most severely affected by widespread anoxia of bottom waters on the northwestern and western shelves of the Black Sea, and in the Sea of Azov, as for wild stocks of turbot and other bottom fish and shellfish, and sturgeons and river herring (Zaitsev, 1993). Problems of environmental degradation, plus overfishing, are also relevant to the Sea of Marmara (Kocatas et al., 1993), which prior to the 1980s, was an essential migratory route for many pelagic species such as bonito, blue fish and mackerel, moving between the Mediterranean and Black Seas, but which are rarely encountered now in the Black Sea.

The first effects of nutrient enrichment and the decimation of stocks of fish predators, appear to have been an increase in small pelagic biomass (Ivanov and Beverton, 1985). Biomasses and landings in the Black Sea rose in the late 1970s: landings, particularly of anchovy, from a previous level of around 350-400 000t to just short of 1 million t (Box Figure). This was accompanied by a significant decline in species diversity, and increases in phytoplankton production. Recent evidence suggests that a collapse in the anchovy stocks occurred in 1988-89, with estimates of landings in 1991 of less than 150 000t.

The introduction of an exotic, non-commercial species of coelenterate into the Black Sea, the ctenophore Mnemiopsis, which is a predator on fish eggs and larvae, may have acted in combination with heavy fishing and environmental changes, and appears to have been a key factor in the collapse of Black Sea anchovy and other pelagic fish (Zaitsev, 1993). This situation has preoccupied the international community, and a programme for rehabilitation of the Black Sea environment and living resources is now underway.

Experience from the Black Sea suggests that under nutrient enrichment, heavy fishing of stocks of small pelagics may make space for alternative invertebrate planktivores, such as medusae and ctenophores, which compete with, and feed on fish eggs and larvae. The effects of nutrient enhancement (bottom up effects) and heavy fishing on predators (top down effects), seem to be synergistic in changing the ecological balance towards short-lived planktophagic species. If these types of mechanisms apply in heavily exploited marine ecosystems, overfishing could reinforce the effects of eutrophication already mentioned above, and appear to provide warning signals to other enclosed seas such as the Baltic, Caspian and Yellow Sea (Caddy, 1993).

The situation with respect to fisheries statistical reporting and joint management of the Black Sea fisheries and environment is likely to radically change in future years, now that there are six coastal States which have signed a joint Convention for protection of the Black Sea Environment. There is also the possibility of revival of the Black Sea Fishery Commission, with participation of all coastal States.



Box Figure: A biological scenario for stock increases and subsequent collapse of small pelagics in the Black Sea, and its consequences for fishery investment

Relatively few countries have taken management action to control increases in fishing effort despite the repeated recommendations of GFCM. Allowing for changes in fishing power, catch rates of demersals in inshore fisheries are still generally low, and present levels of landing are achieved by exerting a high fishing effort by generally over-capitalized fleets. The top priority is still therefore to correct the serious overfishing that exists immediately offshore from most Mediterranean littoral zones. It seems likely also, that effort control is a precondition to the success of other management measures, such as increasing the size at first capture and, more importantly, increasing the spawning biomass and spawning success. At the same time, urgent measures need to be taken to protect inshore nursery areas from the adverse impacts of fishing and pollution.

Italy has recently introduced the use of seasonal closures to protect their young fish stocks, and this appears to have been effective in the Adriatic in increasing recruitment of red mullet. Separate fishing areas in Israel are now allocated for different types of gear in order to reduce conflict between trawlers and inshore fishermen.

The small mesh size used in trawling in many countries continues to be a problem, and the need to enforce the 40 mm mesh size regulation has been supported by the Adriatic and Western Mediterranean Consultations of GFCM, but not in the Aegean and eastern Mediterranean. Here, other measures such as inshore closures and direct bans on landing small fish are in effect, which are also applicable to gear other than trawls. From the perspective of mesh size regulation of cod ends, three categories of demersal resources exist (Caddy, 1990c):

(a) Fish with large sizes at first maturity, many of which are also the apical predators of the demersal system. These include the common hake (Merluccius merluccius), the Angler fish (Lophius piscatorius), the small elasmobranchs (especially the Squalidae, Scyliorhinidae and Rajidae), the larger Scorpaenidae, the ling (Molva spp.), Conger conger and the larger flatfish (including Lepidorhombus spp. and the common sole, Solea solea). For these species, the trawl cod-end stretched mesh sizes that would be needed to postpone capture until the size at first spawning, would have to be of the order of 80-100+ mm.

(b) A group of species of considerable importance, such as many seabreams, the common pandora, poor cod, the red mullets, Norway lobster and cuttlefish, would require a stretched mesh size of at least 40 mm to achieve the same result as for group (a).

(c) Small species such as small shrimp and cephalopods, gobies, solenettes, and other "forage" species, can be taken only with smaller mesh gear, but have considerable local importance. For these, a cod-end mesh size of less than 40 mm is required if these species are to be available for harvesting. This requirement apparently also applies for mixed catches of small demersals and small pelagic fish.

The effect of a 40 mm or smaller mesh size without effort regulation, risks decimating group (a) if spawning fish are fully available to fishing. On the other hand, a mesh size of 40 mm or over would capture few of category (c), even if this mesh size is close to optimal for category (b). Mesh size regulation appears to be no substitute for protection of sensitive nursery areas, e.g., eel grass beds, from the effects of trawling, and the general priority remains with control of excessive fishing effort, pollution, and prevention of degradation of the coastal zone. A "passive" approach to reducing destructive inshore fishing on inshore Posidonia beds (important as nursery areas for young fish) has been tried in some areas: the location of concrete blocks as obstacles to inshore trawling.

Red coral is one of the more valuable Mediterranean resources, being used with similar precious corals from Indo-Pacific waters, for production of jewellery. In the past, this species occurred in commercially exploitable concentrations off Spain, Algeria and Sardinia, and at lower densities elsewhere. Fishermen and industry have been greatly concerned with the declining returns to an ever more sophisticated harvest sector (GFCM, 1989), which has exchanged primitive dragging equipment for diving equipment capable of operating at a hundred metres depth. A rotating harvest scheme was seen by the industry and scientists as one of the few realistic options for a heavily exploited resource, which in absence of management is likely to be placed on the CITES list of species for which export of the organism or its products is restricted or prohibited.

Molluscs support some of the more valuable fisheries, with the explosive development of mussel culture acting as an indication of enrichment in the Gulf of Lions and Adriatic. Mechanized clam ("vongole") harvesting in the Adriatic was one of the single most valuable Mediterranean fisheries, but suffered from overexploitation in the 1980s (see Froglia, 1989), and probably also from the effects of pollution. Control of licences has recently been introduced.

Industrial scale development occurred somewhat later for the small pelagic resources and, apart from anchovy fisheries, many of these resources are less heavily exploited; reflecting the generally high differential in prices received in the region for demersal versus small pelagic resources. Large fluctuations in stock size for the small pelagic stocks of the Mediterranean, are documented in the fisheries of the Sea of Alboran and the Adriatic. Sardine stock size for several areas has been shown to be influenced by primary production (e.g., Vucetic and Alegria-Hernandez, 1988), itself responding to levels of nutrient runoff (e.g., in the Adriatic and off the Nile delta (Wahby and Bishara, 1981)) which have been generally increasing in coastal waters (Pucher-Petkovic et al., 1988; Degobbis, 1989; Friligos, 1989). Uncontrolled enrichment processes and larval predation, in combination with heavy fishing, have however had serious negative impacts on small pelagic resources in the Black Sea (see Box "Fishery induced and anthropogenic effects on the Black Sea Ecosystem").

The sardine stock appears to be rather underexploited in the northwestern Mediterranean, judging from hydro-acoustic surveys, although growing use of high opening trawls in some countries has increased utilization of small pelagics, while this gear still maintains pressure on demersal stocks. The sardine stock in Morocco appears to be fully exploited, and has declined recently relative to the anchovy stock. Small pelagic stocks in Algeria appear to be underfished, especially for anchovy, and Mediterranean stocks of horse-mackerel, in general, appear under-exploited. Landings of small pelagics have been variable, but an overall increase of roughly 4% per year was recorded for all small pelagics combined, over the decade preceding 1985-86 (Caddy, 1990a).

Management measures to control fishing have been relatively limited for small pelagic fish, apart from restrictions on pelagic trawling in some countries. Few stock assessment recommendations have been made, except for the Gulf of Lions stock of sardines. The problem for most small pelagics, except for anchovy, seems related more to difficulties in achieving effective utilization and marketing rather than overfishing. In fact, there is evidence that some pelagic resources may have increased in recent years (e.g., Marasovic et al., 1988).

Increased interest in large pelagic resources in the Mediterranean has led to heavy pressure on the bluefin tuna and swordfish resources, using fishing techniques such as large-scale surface drift nets. This is of special concern in the vicinity of straits and along migration routes. Many local swordfish fisheries in the Mediterranean appear to now be operating on very young, small fish (GFCM, 1990).

Bonito, Sarda sarda, and swordfish, Xiphias gladius, have shown landing increases averaging over 8-10% per year from 1975 to 1985 - figures almost equalled by bluefin tuna. Local increases in fishing effort, or new or expanded fisheries, such as those for swordfish in Greece, Malta, and the Ionian Sea, appear to account for increased landings, but although local increases in fishing effort are implied, there appears to be a real increase in recruitment of small swordfish to these fisheries. This may be related to the increase in abundance of their prey, notably the small pelagic fish referred to earlier. The need is apparent for some coordination of research and statistics gathering, not only for swordfish but also for bluefin tuna. Bluefin tuna is considered by ICCAT as in serious need of conservation measures, as are swordfish, bonito and dolphin fish. These matters were discussed in a joint ICCAT-GFCM workshop in 1990, which will be repeated later in 1992 (Ivanov and Beverton, 1985). Possible problems with other highly migratory species may be indicated by the effective termination of mass migrations of bluefish, bonito and mackerel into the Black Sea since the 1970s (Ivanov and Beverton, 1985).

The complex of problems faced in many Mediterranean countries with fishery management, are most clearly focused on the coastal zone, where critical habitats for fisheries (nursery areas, sites for aquaculture development), often encountered uncontrolled expansion in the use of the same areas for other human activities, such as tourism, domestic waste disposal and runoff of chemicals from industry and agriculture, and are subject to fishing pressure by artisanal fleets using a wide range of gear types.

SOUTHWEST ATLANTIC (Area 41) (Table 10)

Total catches in this area increased almost continuously from one million t in the mid-1970s to 2.4 million t in 1987, then decreased to 2.0 million t in 1990, to raise slightly to 2.2 million t in 1991. Most of the recent changes are due to the year to year changes in the catches of squids, hakes, and other demersal stocks in the Patagonian Shelf and Slope area, and of the sardinella catches off Brazil.

One of the most important fisheries in terms of total landings and value continues to be that for hake. Two species of hake are reported in the commercial catches in this area: the common hake (Merluccius hubbsi) which is the most abundant and found mainly in the northern Patagonian Shelf off Argentina and the continental shelf off Uruguay and southern Brazil, and the Patagonian hake (M. polylepis) which is found farther offshore in the southern Patagonian Shelf, around the Falkland (Malvinas) Islands, and along the Patagonian Slope. The areas of distribution of the two species tend to overlap, particularly offshore, where it is difficult to distinguish between these two species in the commercial catches. However, it is certain that more than 95% of the hake catches correspond to the common hake (Merluccius hubbsi), which is also the one that attracts most of the research efforts and is best known in the area (Otero et al., 1982; Otero and Verazay, 1984; Arena et al., 1986; Bezzi et al., 1986; Otero et al., 1986; Rey and Grünwaldt, 1986; Verazay and Otero, 1986; Angelescu and Prenski, 1987; Arena et al., 1987; Ubal et al., 1987; Otero and Verazay, 1988; Podestá, 1990; Bezzi et al., 1993). After being stable at around 350 000t for several years in the early 1980s, total hake catches dropped to 260 000t in 1984, to increase again with some year to year fluctuations to a new record of 520 000t in 1991.

Hake is mostly exploited by Argentinean fleets that operate over the entire area of distribution of the species, by a Uruguayan fleet operating in the Argentinean/Uruguayan Common Fishing Zone, and to a lesser extent, by a small Brazilian fleet fishing in southern Brazil. Offshore catches of hake by long-range foreign fishing fleets, mainly from Spain, Japan, Portugal and the former USSR increased for several years, but are now greatly reduced. Long-range foreign fleets were reporting less than 2% of the total catches of hake in this area until 1985, their share increased to 16% in 1988, but it is now back to less than 4%. Most of the off-shore catches are suspected to be Patagonian hake. Judging from the current exploitation levels and the assessments made in the past (Otero et al., 1982; FAO, 1983; Csirke, 1987; Bezzi et al., 1993), it is most likely that these two species of hake are fully exploited.

No major changes are noted in the catches of croakers and weakfishes. Most of these stocks are moderately to fully exploited (Otero and Ibañez, 1986; Haimovici, 1988; Arena, 1990). The stocks of weakfish in the Argentinean and Uruguayan Common Fishing Zone are now stable, after having recovered from a collapse in the early 1980s. Some limited possibility for further expansion of this fishery exists in northern Brazil.

Catches of sardinella (Sardinella brasiliensis), taken exclusively by Brazil, declined to 65 000t in 1988 and 32 000t in 1990, after being relatively stable at 100 000t for several years and in 1991 the total catch increased to 64 000t . This stock is considered to be fully to heavily exploited, and the drop in total landings may be a result of a combination of heavy fishing and biomass fluctuations due to natural causes. During the last two years there has been a reported increase in the abundance of anchoita (Engraulis anchoita) off central Brazil. This is the northernmost area of distribution of this species as well as the main fishery grounds of sardinella (Saccardo, 1983; Matsuura et al., 1985; Matsuura, 1989; Bakun and Parrish, 1990;1991).

Besides the sardinella, other clupeoids and other small pelagics are lightly fished in this area. The stock of anchoita (Engraulis anchoita) off southern Brazil, Uruguay and northern Argentina is virtually unexploited, with an estimated potential of a few hundred thousand t per year. Total catches of this species seldom exceed 20 000t, mostly reported by Argentina. Although it shows some wide year to year fluctuations in its overall abundance, all the assessments made in the past (Ciechomski and Sánchez, 1988) clearly indicate that the anchoita has high abundance levels and is a key element in the marine food chain in the area. This stock can easily sustain increased levels of exploitation, but so far, further development of this fishery has been limited by technological and economic factors, and the difficulties to overcome various problems associated with type of distribution and behaviour of the species, and the quality and cost/value ratio of possible products.

As reported in past assessments (Boschi, 1989), major changes continued to occur in the stock of shrimp (Pleoticus muelleri) in the central part of the Patagonian Shelf. After increasing from 2 600t in 1981 to 23 000t in 1984, catches dropped to 10 000t in 1985, 7 000t in 1986, and 2 500t in 1987. However, catches of this species increased to 17 800 t in 1988 to then decline steadily to 8 200t in 1991. The wide fluctuations in the total catches of this species are almost certainly associated with year to year changes in the overall abundance of the stock, affected by heavy fishing and annual environmental changes.

After a continuous increase from 31 000t in 1980 to 350 000t in 1986, and a peak catch of 750 000t in 1989, catches of squids in this area declined to 552 000t in 1990 to peak up again to 674 000t in 1991. Most of these catches are short-fin squid (Illex spp.) and common squid (Loligo spp.) caught by Argentina and by long-range fleets from Japan, Republic of Korea, the former USSR, Poland and Spain on the southern Patagonian Shelf and Slope. Several studies have been conducted on those stocks, particularly on short-fin squid in the Patagonian Shelf and Slope area (Koronkiewicz, 1980; Brunetti, 1981; Otero et al., 1982; Hatanaka et al., 1985; Hatanaka, 1986; Koronkiewicz, 1986; Csirke, 1987; Hatanaka, 1988; Haimovici et al., 1990), and after a period of great uncertainty regarding the state of these stocks, and the fear of overexploitation, several management measures were introduced to reduce the fishing effort in some of the main fishing grounds. This helped to keep fishing effort under control, although fishing pressure continues to be very high. The overall abundance of these stocks is reported to vary widely from year to year due to natural causes, and close monitoring is needed for adequate protection. These stocks are considered to be fully to heavily exploited in the Patagonian Shelf and Slope, and lightly exploited elsewhere, particularly in the northern coastal areas.

The other important fisheries in the southern Patagonian Shelf and Slope are for southern blue whiting (Micromesistius australis) (Zukowski and Liwoch, 1977; Inada and Nakamura, 1978; Perrotta, 1982; Liwoch, 1986a;b; Csirke, 1987), mostly caught by the former USSR and Polish fleets. After being virtually unexploited in the late 1970s, catches of this species increased rapidly to a peak of 240 000t in 1983, to decrease and remain more or less stable at around 100 000t per year from 1984 to 1988. Catches have increased in recent years to 130 000t in 1989 and to 190 000t in 1990, and decreased slightly to 150 000t in 1991. The stock is considered moderately exploited, although it would be closer to the level of full exploitation if the recent rate of increase is maintained. Other demersal fish stocks in the Patagonian Shelf include the grenadiers (Macrourus spp.), tadpole mora (Salilota australis), pink cusk eel (Genypterus blacodes), toothfish (Dissostichus eleginoides), sharks, rays and notothenids. Total catches of these species increased steadily from less than 20 000t in the early 1980s to 125 000t in 1988, but decreased to 77 000t and 70 000t in 1989 and 1990. Although there is little specific information, most of these stocks are considered to be moderately exploited.

Several management measures have been in force in the area for some years. These include restricted licensing of national vessels to control fishing effort on hake, and mesh size regulations to reduce capture and discarding of juvenile hakes. Restrictions on pair trawling, and on in-shore fishing operations have probably contributed to the recovery of some croaker and weakfish stocks.

Some measures have also been adopted to limit the access and control the operations of long-range foreign fleets in the area.

Argentina and Uruguay continue to maintain close cooperation within the framework of the Joint Technical Commission for the River Plate Maritime Front, particularly regarding the research and management of fisheries in the Argentinean/Uruguayan Common Fishing Zone. In Brazil, ten permanent working groups, responsible for providing advice on the management and development of fisheries along the Brazilian coast, continued to update information and data on the assessment of the fish stocks of Brazil, although they have been less active in recent years.

An issue of serious concern for the conservation and long-term management of the fish stocks in this area was the rapid development of the offshore fishing in the southern Patagonian Shelf and Slope by long-range fleets. Some important fish stocks are being exploited both within the 200 nautical mile limit where national jurisdiction can be exerted, and in the area beyond where no national jurisdiction is recognized. After the re-establishment of diplomatic relationships between Argentina and the UK, the two countries are cooperating to improve the research, monitoring and control of fishing in the region. Management measures have been adopted to restrict access and regulate fishing effort in some fishing grounds, including voluntary restrictions in fishing grounds located beyond the 200 mile limit.

SOUTHEAST ATLANTIC (Area 47) (Table 11)

The Southeast Atlantic area, particularly off southern Angola and Namibia, has an exceptionally high biological productivity principally because of the upwelling of nutrients resulting from the Benguela current which flows northward along the coast. The total fishery potential of the Benguela current system is not well known.

Relatively few species account for the greater part of the total fish biomass: hake (Merluccius) are present both inshore and offshore, horse mackerel (Trachurus) and, to a lesser extent, chub mackerel (Scomber) are the major offshore species. Pilchard (Sardinops) and anchovy (Engraulis) are the most abundant inshore pelagic species of the coastal upwelling system. In addition, there are less abundant but economically significant resources of snoek, kingklip, sole, rock lobster, dentex and squids (Wysokinsky, 1986).

Total catches in this area have remained relatively stable at about 2.1 to 2.7 million t per year between 1980 and 1989, only to decrease to 1.5 million t in 1990 (FAO, 1992j). Most of the fluctuations in recent years are due to changes in the total catches of anchovy (Engraulis capensis) and to a lesser extent, cape horse mackerel (Trachurus capensis). These two species together with the hakes (Merluccius capensis, M. paradoxus, and M. polli), sardinellas (Sardinella aurita and S. maderensis), pilchard (Sardinops ocellata) and Cunene horse mackerel (Trachurus trecae) made up 58% of the total catches in 1989.

A large share of the catches (43%) was formerly taken by distant water fleets operating mainly off Namibia and Angola (ICSEAF Fishing Divisions 1.2, 1.3, 1.4 and 1.5). This situation arose because there was no coastal State control over fishing off Namibia while Namibia's independence was pending, and therefore this area became one of the few free fishing grounds left in the world after the United Nations Convention on the Law of the Sea (UNCLOS) went into effect. In the same area, Angola which became independent in 1975, is now emphasizing the development of its small-scale coastal fishery; previously there had been intense offshore fishing effort by foreign vessels operating in its 200 mile zone.

Upon independence in 1990, Namibia requested all foreign fleets to cease their fishing activities off the Namibian coast, pending the approval of a national fishing law, the declaration of a 200 mile exclusive economic zone, and the definition of a national policy regarding fisheries in the newly independent coastal State. Several options are currently being considered, and further studies on the state and potential yields of fish stocks are now being undertaken to help in the decision-making process regarding the future exploitation of Namibian fishery resources. Fishing by large distant-water fleets in the 200 mile zone off Namibia ceased, at least temporarily, in the third quarter of 1990. This caused a reduction in total catches in ICSEAF Divisions 1.3 to 1.5 in 1990, and hopefully will contribute to the recovery of some of the fish stocks that have been severely reduced due to heavy fishing in the past.

Hakes are the main and most abundant demersal stocks in this area. There are two species, Merluccius capensis and Merluccius paradoxus, which are not reported separately in the fishery statistics (FAO, 1992j). The stock off northern Namibia (ICSEAF areas 1.3-1.4) differs from that of the southern part (ICSEAF area 1.5) and is the most important of the two. The northern stock is shared with Angola while the southern stock is shared with South Africa. These stocks are exploited by foreign long-range fleets in the north (ICSEAF areas 1.3 to 1.5) and by coastal South African fleets south. After removal of more than 800 000t per year in the early 1970s, catches of hake decreased to about 445 000t in 1989. All the stocks have been overexploited, although the most southern stock seems to show some sign of recovery.

Of the several pelagic stocks of commercial importance in this area, the most abundant are the cape horse mackerel (Trachurus trachurus capensis) and the anchovy (Engraulis capensis). The cape horse mackerel yielded a catch of almost 500 000t in 1989, and is considered to be moderately to fully exploited, although this stock is known to be highly variable and is mostly fished by foreign long-range fleets. The anchovy stock is exploited almost entirely by coastal South African fleets, and yielded almost 452 000t in 1989. These stocks are considered to be fully exploited.

Another important pelagic stock in this area is the sardinella, which is currently exploited by the former USSR and Angola. The catch of this species was of 106 000t in 1989, and the stock is moderately exploited. The Cunene horse mackerel was intensively exploited by the former USSR and Angolan fleets, with total reported catches of 159 000t in 1989. The chub mackerel stocks are heavily exploited, and the pilchard (Sardinops ocellata) stock which collapsed off South Africa in the 1960s and off Namibia in the mid-1970s continues to be depleted, showing no sign of recovery. A high biomass of round herring (Etrumeus whiteheadi) exceeding 1 million t in ICSEAF Divisions 1.6 and Sub-area 2, was reported at the Standing Committee on Stock Assessment during the Tenth ICSEAF Regular Session held in Palma de Mallorca, Spain, in November-December 1989 (ICSEAF, 1989). Total catches for this species are of the order of 60 000t per year, and the perspectives for further development are promising.

Due to the lack of suitable stock assessment data, little can be said about the state of other fish stocks being exploited in this area, such as soles, kingklip, monkfish, dentex, rock lobsters and squids.

Until 1989 the exploitation of the stocks of this region was monitored through the activities of the International Commission for the Southeast Atlantic Fisheries (ICSEAF) which was mainly concerned with the international assessment, monitoring and management of fisheries in the then unclaimed waters off Namibia. This regional organization decided to cease its operation early in 1990 following the declaration of independence by Namibia in April 1990. Namibia is now managing fisheries within its exclusive economic zone as of July 1990.

WESTERN INDIAN OCEAN (Area 51) (Table 12)

Total recorded landings in the area were 3.4 million t in both 1989 and 1990, having increased from 2.9 million t in 1988 and 2.7 million t in both 1986 and 1987. The major coastal countries with their total catches in brackets in thousand tons, were: India (1 653), Pakistan (366), Iran (209), Sri Lanka (134), Oman (120), UAE (95), Yemen (89), Maldives (78) and Madagascar (75). Spain (107) and France (79) also reported major catches in the area.

Landings in India exceeded 1.6 million t in both 1989 and 1990. This is compared to landings of 1.2 million t in 1988 and 1.1 million t in 1987. These increases in Indian landings have accounted for the major part of the increase for the total Western Indian Ocean area. Much of the increase was for pelagic species, Indian oil sardine, Indian mackerel and anchovy. Mackerel landings increased in 1989, more than doubling the level of recent years but declined in 1990. The decline was offset by increased catches of oil sardine and anchovy. The demersal finfish catch in India consists of a large number of different species, with croakers, Bombay duck and catfish being the most important. Catches of croakers contributed substantially to the overall increased landings. The total landings of shrimps have remained relatively stable, but a shift in species towards smaller, less valuable species has been observed. The shrimp stocks appear to be heavily exploited.

Accompanying the large increases of Indian landings are the more gradual increase in landings in other countries in the region. Pakistan's total landings have been slowly increasing in recent years. Landings of shrimps have remained at around 28 000t from 1982 to 1988, declined in 1989 but returned to the former level in 1990. The shrimp resources appear fully exploited or overfished. Attempts have been made to encourage the fishery to move to underexploited resources in deeper waters.

Omani landings increased from around 100 000t from 1983 to 1986 to 166 000t in 1988; the main catches being pelagics (tunas, kingfishes and small pelagics) caught by gillnets. However, landings decreased to 118 000 and 120 000t in 1989 and 1990 respectively. The Norwegian research vessel DR FRIDTJOF NANSEN surveyed Omani waters (1983-84) and found these to be very productive areas. This survey gave an estimate of biomass for small pelagics (scads, mackerels and sardines) of 1.2 million t and a demersal biomass of 345 000t (seabreams, catfish, croakers, grunters and emperors). The MSY has been estimated at 270 000t of pelagics and 77 000t of demersal fish.

Landings by Iran have steadily increased. The 1989 and 1990 landings of 210 000t and 200 000t respectively are more than double those of years prior to 1986. Shrimp landings have doubled over a similar period to reach a level near 10 000t per year. Tuna and other large pelagics yield more than 20 000t per year. Landings in the United Arab Emirates have also increased from a level near 72 000t through the first half of the 1980s to 95 000t in 1990.

Shri Lanka's marine landings have dropped from 180 000t in the early 1980s to 140 000t in 1985-86, recovered to 166 000t in 1989, but fell back to 134 000t in 1990. Tuna and small pelagic species (sardines) caught by gillnets are the largest components of their catches, and there has been an offshore expansion in recent years, especially in shark fisheries. To some extent the restriction in coastal fisheries has been due to civil disturbances in the country. Pelagics (tunas, kingfishes, scads, sardines) form the main catch. A second important group is the demersal fishes (emperors, groupers, snappers). The recorded landings by Yemen reached 89 000t in 1990, up from 73 000t over the previous several years. Pelagics comprise the major part of the catch. Landings by the Maldives, primarily of tuna and tuna-like species caught by the traditional pole and line fishery, rose to 78 000t in 1990. Considerable resources of reef fish (groupers, snappers, etc.) are virtually unexploited.

Countering the general rising trend in the region are the landings in the countries most directly affected by the Gulf War. Shrimp landings by Kuwait dropped from 5 000t in 1988 to less than 2 000t in 1990. Total marine fish landings have dropped by a similar amount (See Box: "Recent fisheries and environmental findings from the Gulf"). Saudi Arabian shrimp landings declined from 7 000t in 1984 to less than 5 000t in 1990, and total fish landings of 45 000t in 1990 are also down from the level of the previous several years. Marine fish landings by Iraq also declined from previous years. The magnitudes involved in these reductions are not large enough to have changed the rising trend of landings for the northern zone of the Western Indian Ocean as a whole.

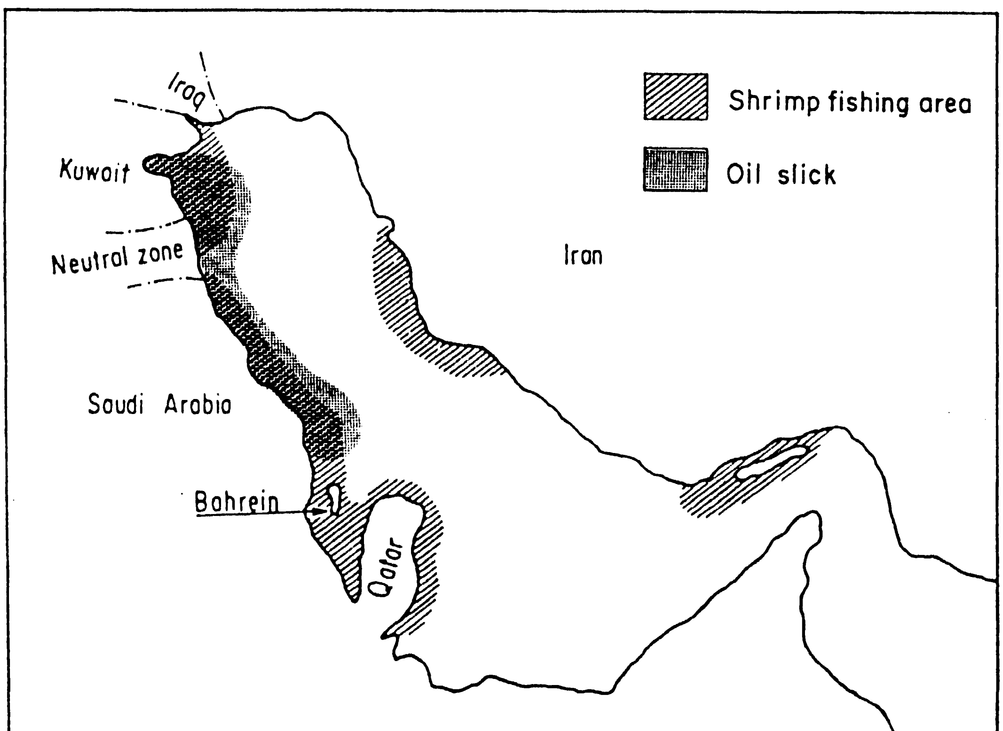
Total landings in countries bordering the Southwestern Indian Ocean, including Somalia but excluding landings by foreign fleets, have gradually increased from 131 000t in 1981 to 290 000t in 1990. Most of this is accounted for by a continuing large annual increase in landings reported by Madagascar and the Maldives, from 51 000t in 1981 to 153 000t in 1990. The major shrimp catching countries in the Southwestern Indian Ocean in 1990 were Madagascar (9 000t) and Mozambique (6 000t). The state of exploitation of artisanal fisheries in the Southwestern Indian Ocean is unknown, and the extent to which they interact with the industrial trawl fisheries is also unknown.

The main opportunities for increased catches are in fishery development for small pelagic stocks off Mozambique and Somalia, expansion of fishing for demersal trawl fish off Mozambique, Madagascar and Tanzania, increased utilization of by-catch from shrimp trawlers and some further expansion of artisanal fisheries off Madagascar and Somalia (Ardill and Saunders, 1991). The potential for development of fisheries for small pelagics (anchovies, scads, Indian and Japanese mackerel, and round herring) in the Southwestern Indian Ocean needs to be assessed to see whether harvesting of these resources is economical.

BOX: Recent fisheries and environmental findings from the Gulf

Following the 1991 Gulf War, international concern as to the environmental effects of the war led to a number of rehabilitation and research initiatives in the region. These included a major UN interagency effort coordinated by UNEP, the establishment of a reserve and research station supported by the EEC in the area of the oil spill in Saudi Arabia, and an extended research cruise by a vessel of the US National Oceanographic and Atmospheric Administration. All of these activities were supported by the countries in the region and complemented by national research and rehabilitation initiatives. These actions largely cleaned up the major oil spill and provided valuable environmental information.

Fisheries in the Gulf appear to have been directly and indirectly affected by the war (Carpenter, 1992). During the first half of 1991, there was very little commercial fishing in the Gulf, because the most valuable shrimping grounds are in the northern part of the Gulf near the war zone and the area of the oil slick (Box Figure). Small scale fisheries did however operate south of the war zone. The shrimp catch in late 1991 and early 1992 was very low compared to previous years, presumably because of the disruption of fishing operations, but an apparent stunting of growth of shrimp in the Gulf was noted. It is not known if this stunting was due to reduced sea water temperatures caused by the smoke from burning oil wells in Kuwait, water and sediment pollution from the war, or some other natural factor. Although oil spills from the war affected the rich fishing grounds off Kuwait and northern Saudi Arabia, otherwise there are reports of an overall reduction in oil pollution in the Gulf, probably due to decreased tanker traffic.



Box Figure: Distribution of major oil slicks during the Gulf war in relation to shrimp fishing areas

Several countries (Tanzania, Madagascar, Somalia) are expecting increased catches from artisanal fisheries for demersals on the basis of differences between the estimated potential yield, and the reported catch. However, because of the difficulty of collecting good landing information, real catches may be much closer to the potential yield than present statistics suggest. The strengthening of fishery data collection is very important in order to provide a sound data base for development and management advice.

Several resources in the Southwestern Indian Ocean are fully exploited (Ardill and Saunders, 1991) and most coastal countries recognize that some form of management is required to prevent overexploitation. This is the case of the demersal trawl fishery in Somalia, shallow water shrimp fishery in Mozambique and Madagascar, and the handline fishery for demersal stocks on offshore banks between Mauritius and Reunion. In general, there is a great need for stock assessment work in the Southwestern Indian Ocean, which should be focused on several priority resources, such as those for valuable crustaceans and fish, and for those stocks with developmental prospects. A need also exists to focus research on assessment and management problems of artisanal fisheries, given that substantial increases in yield can be expected if these fisheries are properly assessed and managed. The area could benefit from more effective management of shrimp fisheries where in some cases a 75% reduction in effort could maintain the harvest at the present level, and greatly increase the profitability of the fishery.

Many countries rely on a system of licensing national and international vessels as their main tool for controlling fishing effort of their industrial fisheries (FAO, 1986). In practice however, it seems that this system is not sufficient to ensure that effort reductions take place when they are needed. It is important that countries understand that there has to be a managerial and legal mechanism which allows administrations to use the licensing system as a fishery management tool.

France, Spain, Taiwan (Province of China), Korea and Japan were the principal foreign countries fishing for tuna and tuna-like species in the area. This fishery started in 1981 and recorded a catch of 277 000t in 1990. The state of the stocks of oceanic tuna are covered in Table 21 and in the chapter on tunas.

Large unexploited resources of mesopelagic fish (lantern fish) have been detected by the Norwegian research vessel DR FRIDTJOF NANSEN, but no economic way of catching these fish has been devised. In most cases the concentrations are not high enough for economic exploitation by purse seines or midwater trawls. It remains an open question whether the mesopelagic stocks might represent potential fisheries for the area.

The Indian Ocean Fishery Commission (IOFC) (Marashi, 1993) is the regional organization for the Indian Ocean (Area 51 and Area 57) that assists and coordinates national programmes in fisheries development, promotes regional research activities and examines management problems relating to offshore resources. Special committees are set up for the management of fish stocks in the Gulfs, Southwest Indian Ocean, Bay of Bengal and the Indian Ocean tuna. These committees do not regulate fisheries but act as advisory bodies in the management of the fishery resources in the various countries in the region.

EASTERN INDIAN OCEAN (Area 57) (Table 13)

Statistical area 57 (Eastern Indian Ocean) covers the waters of the Bay of Bengal, northern part of the Malacca Strait and Eastern Indian Ocean proper. The countries bordering the area include India, Bangladesh, Myanmar, Thailand, Malaysia, Indonesia and Australia. The shelf area of the Asian continent stretches from the eastern part of India over the coast of Bangladesh, Myanmar and down to the Malacca Strait, with an extensive shelf area found off Myanmar and east India. Freshwater runoff greatly influences the northern part of the region, where large rivers enter the Bay of Bengal from northeastern India (Ganges River), Bangladesh (Brahmaputra River) and Myanmar (Irrawaddy and Salween Rivers). Estuarine resources are important here; for example the toli shad, an estuarine species, dominates the marine catch in Bangladesh.

This area is subject to the seasonal influence of the southwest monsoon (May-September) when the sea is relatively rough. Myanmar fish abundance fluctuates according to this monsoonal cycle, and in the pre-monsoon period, fish are found in more abundance than during the post monsoon. A special characteristic of this area is that it is subject to destructive cyclones that form over the open ocean and head for shore in a generally westward direction. The northeastern coasts of India and Bangladesh are the most vulnerable to cyclones.

Reported landings in area 57 reached 2.8 million t in 1990, a slight increase over the previous year's catch of 2.7 million t (Table 13). Catches come mainly from inshore, from the small-scale fishery. The five countries contributing 85% of the catch in 1990 were India, Indonesia, Malaysia, Myanmar and Thailand. Increases in the catch were noted for most demersal and pelagic species. However, some inshore resources, in particular shrimp, have experienced intensive exploitation in coastal waters off east India, Myanmar and Thailand.

Small-scale and industrial trawl fisheries, fish the same coastal grounds off the Indian coast, and user conflict and intense fishing pressure have been reported in coastal waters. To reduce the conflict commonly arising between artisanal and trawl fishermen inshore, some countries are deploying artificial reefs which provide new fishing grounds for artisanal fishermen, but also discourage trawl fishing in these areas. Thailand and, to a certain extent, Malaysia, have considered this activity to be one of the programme priorities.

Under-exploited fish resources may still exist in this region, particularly in the shelves of the Andaman and Nicobar Archipelago. Deep sea resources (groupers, snappers, pomfret, etc.) have a potential of about 73 000t a year on the shelves of the Andaman and Nicobar Archipelago, and offer alternatives for the deployment of large Indian deep-sea trawl fleets (Sudarsan, 1990). A deep water lobster (Puerulus sewelli) and penaeid shrimp of the genus Aristeus are believed to be abundant in the southern part of the continental slope of Myanmar (FAO, 1984), but there are no indications that commercial trawling has occurred there.

A large shrimp by-catch, estimated to be about 120 000t in 1990, is discarded off the east coast of India by the trawl fishery (Gordon, 1991). In Thailand, however, most of the by-catch are used by the fishmeal industry which supports a growing aquaculture industry.

A longline fishery for tuna which targets for sashimi consumption in Japan has developed in the Indian Ocean off Indonesia, and although this fishery was initiated by foreign fleets, local fishermen are taking over the foreign boats.

Off northwestern Australia, the demersal fishery is now exclusively in Australian hands. The resources are considered fully exploited and all foreign fishing has ceased. A large number of species are taken in the southeast demersal trawl fishery, but catches in recent years have been dominated by orange roughy at a depth of 800-1 200 m. These stocks are near full exploitation.

Fishing by foreign vessels in Area 57 has grown less intense. Japan, the Republic of Korea, and Taiwan (Province of China) have traditionally fished for tuna employing long-lines but landings by these countries amounted to 17 000t or less than 1% of the overall catch in 1990.

Scientific management of fisheries resources is not yet well established in some areas of this region, although development of fisheries has reached a point where this is necessary. Fishery management involving effort control is better established in Malaysia than in the rest of the region, except in Australia, where resource management is well established. Countries in this area are members of the Indo-Pacific Fisheries Commission (IPFC) and the Indian Ocean Fishery Commission (IOFC). Both of these bodies are only advisory and thus do not have any regulatory power. Countries presently exploiting tuna resources in the Indian Ocean are in the process of establishing the Indian Ocean Tuna Commission which will be responsible for the management of the regional tuna resources. The Bay of Bengal Project (BOBP), a regional project funded by multidonor agencies (DANIDA, ODA, SIDA, UNDP), has also assisted development of marine fisheries, particularly in providing assistance to fishing communities.

NORTHWEST PACIFIC (Area 61) (Table 14)

Reported landings from the Northwest Pacific have decreased slightly from a record 26.7 million t in 1988 to 25.7 million t in 1990 (FAO, 1993a). The decrease was primarily from the decline in landings of Alaska pollock and the Japanese pilchard. The total annual landings remain among the highest in the world: 31% of the total world marine catch. The production is also distinct, being supported by the environmental diversity in the area with its well-balanced composition of demersal and pelagic species.

Salmon stocks in the area, once depleted during the 1960s especially in Russia, began to recover since the late 1970s, and appear to have stabilized in recent years. These include odd- and even-year class pink, chum (Russian origin), sockeye, coho and Chinook salmons. Catch of chum salmon around Japan accounts for more than half of total salmon catch from the entire area. Artificial breeding and releasing techniques, along with rehabilitation and enhancement of natural conditions in ascending rivers in northern Japan are believed to be partially responsible for this.

The fishery for Alaska pollock continues to land the highest catch for any single demersal fish stock in the world. The catch was over 5 million t from 1986 to 1988 but declined to 4.8 million t and 4.2 million t in 1989 and 1990. All the stocks are considered to be fully exploited and there has been a significant increase in the proportion of undifferentiated (low value) fish in the catch. A second important demersal fish in the northern part of the area is Pacific cod. Landings have increased from around 80 000t in the early 1980's to over 200 000t in recent years. Most cod stocks are fully exploited. Other demersal fish in the north are considered fully exploited, and several stocks have been depleted, including bastard halibut, plaice and flounder, tonguefish and rockfish. Landings of demersal fish in the south are stable at a low level with the exception of largehead hairtail, filefish and sandlances.The catch of largehead hairtail has varied from 531 000t to 650 000t annually since 1985.

The demersal stocks in the East China Sea and Yellow Sea are seriously depleted and are estimated to be at one-fifth to one-tenth of their highest levels (Yu, 1991). There is little sign of recovery in these fisheries. Overfishing in these cases may be due to serious losses of post-larvae and juvenile fish to the fine mesh fishing gears used in the coastal fisheries. The coastal pelagic fish stocks in this area are very productive. They exhibit large fluctuations in abundance and change dramatically in dominance from one species to another. These features are most noticeable in the stocks around Japan, involving the Pacific herring, Pacific saury, Japanese pilchard, Japanese chub mackerel, Japanese anchovy and Japanese jack mackerel. An example of this has been the change in abundance of the Japanese pilchard around Japan. The catch in the mid-1960s was around 9 000t, but exceeded 5.4 million t in 1988, making it one of the world's largest single species catches. The catches in 1989 and 1990 were 5.1 and 4.7 million t. A recent analysis of the age structure of the stock suggests that a decline in abundance may be forthcoming in the future. Management of such unstable pelagic fish stocks is quite difficult, and requires frequent monitoring of the population. Clear causes of these changes are unknown; it has become generally accepted that they are probably natural causes and there is little evidence of a direct link with fishing pressure.

Landings of Pacific herring have continued to decline from over 200 000t in 1985 to 1988 to 109 000t in 1990. Catches of Pacific saury have increased from 274 000t in 1985 to 331 000t and 416 000t in 1989 and 1990. Another coastal pelagic fish, the chub mackerel, has declined in catch from 1.5 million t in 1986 to 1.0 and 0.7 million t in 1989 and 1990. The total catch of all pelagic fish in the area in recent years has continued to be from 6 million to 8 million t. Due to the major changes in relative abundance of the different species, it is difficult to establish long-term sustainable yields for the individual species. The catch of scads (Decapterus spp.) reached 0.4. million t in 1990. The catch was taken by China from the coasts bordering the South China Sea and southern East China Sea.

The annual landings of the Japanese flying squid fishery declined from over 400 000t in the early 1970s to 200 000t in 1988 but have recovered somewhat to 287 000t and 298 000t in 1989 and 1990. The cephalopod stocks around Japan are considered fully exploited, but the oceanic squids in the northern region, along with neritic cephalopods in the southern region, could provide substantially larger catches (Chikuni, 1985). Prawn and shrimp stocks are considered fully exploited, and little change in the landings is expected.

At present, there is no functional multilateral organization to cover the entire area, although such an organization would be helpful in the assessment and management of shared fish stocks. Present research and management are the responsibility of the individual coastal countries. Five bilateral fishery agreements between individual countries currently exist in the region through which management of the shared stocks is partially conducted.

NORTHEAST PACIFIC (Area 67) (Table 15)

The environment: Inter-annual variability in the marine environment of the northeastern Pacific Ocean appears to be strongly linked with El Niño phenomena originating in the tropical Pacific (Wooster and Fluharty, 1985). This results in an intensification of anti-clockwise wind circulation over the Gulf of Alaska and Bering Sea, and increased northward transport of water properties and organisms within the eastern boundary zone of the ocean. Thus warmer conditions and incursion of southern species have generally coincided with El Niño events. The entire period of the late 1970s and early 1980s generally exhibited enhanced "El Niño"-like characteristics: especially marked in 1976 and in 1982-83 (Norton et al., 1985; Wooster and Hollowed, in press).

El Niño conditions appear detrimental to resident fish populations in the southern parts of the area (Pearcy, 1992), but favour successful recruitment in some important stocks of the northern Gulf of Alaska and Bering Sea (Beamish and Bouillon, in press). For example, better than average reproduction in many North Pacific groundfish stocks in the late 1970s, coinciding with the extended "El Niño"-like conditions, appears to have been important for sustaining the populations through the following decade.

Fisheries commissions: The Pacific Salmon Treaty, enacted in 1985 between Canada and the USA, enables the benefits to be obtained from their management and enhancement efforts. A Pacific Salmon Commission establishes general fishery management objectives for international conservation and harvest sharing of intermingling Canadian and US salmon stocks. The International Pacific Halibut Commission (IPHC), established in 1923, with membership of Canada and the USA, deals with research and management of the Pacific halibut resources in the entire area (Marashi, 1993).

The International North Pacific Fisheries Commission (INPFC), established in 1952 with Canada, Japan, and USA as members, coordinates collection, exchange and analysis of data on high seas fisheries. A very recent development is the North Pacific Marine Science Organization (PICES), established in 1992 to coordinate and promote scientific research on the environment and resources of the northern North Pacific Ocean (Marashi, 1993). Early membership is expected to include Canada, China, Japan, Russian Federation and the USA. Several other countries are considering membership.

Management measures: Much of the 200-mile exclusive economic zone (EEZ) within the region is under US jurisdiction and in US waters, within the purview of the Magnuson Fishery Conservation and Management Act of 1976. This act requires formal fishery management plans which are designed to achieve sustainable yield and are implemented through regional councils. Regular resource surveys are undertaken for fishery-independent stock assessment. Annual assessments of status of stocks incorporate fishery statistics and catch-at-age data with survey results to project biomass estimates for each coming year. All of the major fishery stocks of the region are managed by catch quotas or harvest guidelines, including the stocks off the British Columbia coast of Canada which follows limited entry policies. In many cases resources are shared with the USA. Fishing areas have occasionally been allocated for conflicting harvesting methods (e.g., pots and longlines versus trawl fisheries in Alaska). By-catches are tabulated and analysed as a component of yield.

Over the past decade or so, fisheries in this region have shown a transition from dominance by salmon resources, king crab and halibut, to a growing importance of groundfish and other species, i.e., more recently exploited resources such as Alaska pollock and other crabs and shellfish. Catches in the directed longline fishery for halibut are controlled by a USA-Canada agreement and Commission. Strict limits on allowable by-catch of halibut and king crab (now severely depressed, but a still valuable but over-capitalized fishery), once attained, result in other fisheries being closed even if their own quota allocation has not been reached. This feature may have had a positive impact in slowing exploitation, and many fisheries meet criteria. High levels of exploitation in new fisheries are discouraged by a requirement that fishing targets not aim for an exploitation rate more than 80% of the calculated MSY level. However, although pressure to exploit once underexploited groundfish resources has increased sharply, some resources, notably large populations of flatfish, can be only lightly exploited under the allowable trawlfish by-catch limit for halibut. A search is underway for a new set of "rules" for the mixed species fisheries that maximize the net total revenue from the fisheries as a whole. One such working rule that is being suggested in US groundfish fisheries is to aim for an exploitation rate that is equivalent to that also giving a spawning biomass of 35% of that for the virgin stock.

The requirement that natural resources be exploited under criteria leading to sustained yield is built into the constitution of Alaska, and applies to both commercial and the very important sport fisheries. Risk evaluation has been assigned a specific role in the management process. In order to avoid strategies leading to stock collapse, fixed escapement policies have been applied. However, threshold policies, where the fishery is pursued at a fixed level of exploitation but closed when biomasses drop below some preset value, are being explored.

Catches and stock status: The total fish catch in Area 67 has remained in the neighbourhood of 3.2 to 3.5 million t for the five-year period 1986-90, following a steadily rising trend through the early 1980s. Alaska pollock, presently the largest fished stock in the world, has by itself rather consistently accounted for slightly less than half of the total catch in this region. In the Alaska pollock fishery, a transition from a formerly foreign fishery for surimi to joint ventures with US enterprises and then to a wholly domestic fishery has occurred, except for high seas areas such as the "Donut Hole" where an international fishery has been carried out under agreements of the parties concerned. Large catches in this international zone have led to concern for impacts on the eastern Bering Sea population, and in August 1992, China, Japan, the Republic of Korea, USA, Russian Federation, and Poland agreed to a two-year moratorium on fishing for Alaska pollock in the "Donut Hole" (an area beyond 200 mile limits lying within the Bering Sea).

The burst of good recruitment years in the late 1970s and early 1980s built the Alaska pollock stocks to very high levels. Presently, the biomass of this stock in the eastern Bering Sea appears to be at a moderately high level but a decreasing trend appears to be underway (NPFMC, 1992b). In the Gulf of Alaska, the pollock stock has likewise tended toward a gradual decline (NPFMC, 1992a) (but there are indications of an increase in 1992).

Total landings of the major salmon stocks during 1989 and 1990 are estimated to be 446 000t and 437 000t, respectively. This represents a high level of catches relative to previous years. Preliminary reports for 1991 indicate a further increase. The recent abundance of salmon in the world market has resulted in depressed prices and some economic distress to Alaskan fishermen, alleviated in part by the high biomass available. In contrast to the Alaskan situation, stocks of salmon off Washington, Oregon and California have undergone a major decline since the mid-1980s. Some of this decline is attributed to degradation of the freshwater habitat resulting from urbanization and long-standing drought conditions.

Recent halibut landings were quite stable from 1986 to 1988, with catches ranging from 41 000 to 43 000t, close to the record landings in 1962. Landings have decreased slightly in 1989 and 1990 to 39 000 and 37 000t, respectively. Stock biomass appears to have increased during the 1970s, and probably peaked in 1986-87. Although stocks are still considered healthy, a decline in biomass seems to have begun. Management strategies have restricted the commercial harvest and have been set at about 75% of the estimated annual surplus production. Problems with regard to restricting the amount of fishing effort continue. For example, Canada has instituted a new system of individual vessel quotas (IVQ) on a two-year trial basis.

Landings of flatfish have been affected by early closures due to halibut by-catch restrictions. The catch of yellowfin sole in the Bering Sea declined sharply in 1989 and 1990 to around 150 000t after a long period of increasing catches starting in the early 1970s and culminating in 1988 at 219 000t. The landings of "other flatfish" also peaked in 1988, and also dropped sharply in 1989 due to early by-catch closure but then rebounded substantially in 1990.

Pacific cod catches also dropped slightly in 1989 after a continued rise since the mid 1970s. Pacific cod also followed the pattern apparent in many of the stocks in the region of a strong rebound in 1990, in this case to a new record annual catch. However, recent surveys indicate Pacific cod stocks, like the pollock stocks, to be declining. North Pacific hake is another large population that now seems to be declining. However, there are indications that the 1990 year class may turn out to be large.

Stocks of Pacific Ocean perch (a long-lived fish, taking 16 years to mature) remain at a depleted level, with recent landings of less than one-third those of the early 1970s. Several strict management measures have been imposed for some time now, and Pacific Ocean perch is presently landed only as by-catch. Recent evidence suggests that the condition of the stocks of this very long-lived species has shown limited improvement.

Sablefish resources in the Gulf of Alaska are considered to be in good condition but, like many other important stocks of the region, appear to be in a state of decline. Landings in the region in 1989 and 1990 totalled 45 000 and 43 000t respectively, down from their 1988 peak of 52 000t. Pacific herring is the only coastal pelagic fish resource being exploited in the area. There are believed to be a number of separate stocks, and recent declines in some have appeared to be at least partially offset by increases in others. The total landings have been quite steady in the 1980s, usually in the neighbourhood of 80 000t, largely reflecting market demand for roe. King crab stocks are in a depressed state, with landings continuing to be only a fraction of those of the 1970s and early 1980s. Pacific snow crab landings have been steadily increasing, with a particularly sharp increase occurring in 1990.

In summary, the effect of the burst of good recruitment years in North Pacific groundfish stocks in the late 1970s and early 1980s, which apparently acted to sustain the growth of the fisheries through much of the 1980s, now appears to be fading and many of the most important populations (e.g., pollock, halibut, Pacific cod, North Pacific hake, sablefish) seem to be in gradual decline. The effects of natural trends and fluctuations in the ocean-atmosphere system remain beyond human control. Apparently, the recent environmental situation has not been such as to produce a high frequency of strong recruitments in these populations. Clearly, even well-posed, conservative fishery management plans and procedures can be disrupted by unforeseen long-term trends in recruitment frequency patterns. On the other hand, salmon stocks have recently been so productive that oversupply has been a problem.

At this time there is major interest in the region in limiting effort in order to improve the economic yield of the fisheries and economic well-being of the fishermen. For the king crab, lack of limited entry has generally resulted in very short seasons, substantial overcapitalization, and difficulties in rationalizing product extraction and monitoring. Pressures are now growing for the institution of individual transferable quotas (ITQ) or, alternatively, community development quotas (CDQ), which take into account the needs of native peoples and coastal communities.

Concern over potential effects of the squid driftnet fishery on salmon and other marine populations in this region led to adoption in 1989 of a United Nations resolution calling for a moratorium on all large-scale driftnet fishing on the high seas by 1992. Taiwan (Province of China), Republic of Korea, and Japan, the major nations involved in this fishery, have each announced intentions to abide by the UN moratorium.

WESTERN CENTRAL PACIFIC (Area 71) (Table 16)

This area extends from the tropics to the subtropics and covers the main continental shelf of Southeast Asia, stretching south and east. Oceanic waters are the dominant influence on the climate of small island countries. Freshwater runoff from monsoons obviously impacts the western part of the area, with freshwater input from the big rivers in Thailand, Cambodia, Vietnam and Indonesia influencing the major shelf area. Another shallow water shelf lies between Indonesia and Australia as an extension of the Australian continent, forming an extensive trawling ground between the two countries.

The development of fisheries in the region has intensified since the 1960s, particularly in Southeast Asia. Small-scale fisheries contribute the most to the total catch. Landings reached a record of 7.3 million t in 1990 (Table 16) with more than 85% of the catch taken by Indonesia, Malaysia, Philippines, Thailand and Vietnam. Demersal and small pelagic fish comprise most of the total catch. Shrimp and tuna are the major export fisheries. Fisheries of Papua New Guinea remain undeveloped. Small islands are very much dependent on the tuna fisheries.

Total catch of the region has continuously increased over the last 20 years, but the rate of increase has slowed. Certain demersal fish species: including slipmouth (Leiognathidae), catfish (Ariidae) and croakers (Sciaenidae) show signs of overexploitation, particularly in the Gulf of Thailand and the Malacca Straits. Local pelagic stocks, including mackerels and round scads, are heavily exploited in the Malacca Straits, the Java Sea, the inner part of the Gulf of Thailand and inner parts of the Philippine waters, while sardines are heavily exploited in the Bali Strait (RAPA, 1989; SCORRAD, 1990; Silvestre, 1990).

The increase in total catch in the region is attributed primarily to the extension of fishing onto new grounds. Some Thailand catches were reported to have originated from outside their waters in the late 1970s. Indonesia had also increased its catch in the mid-1980s through further development of fisheries in the eastern part of the country. Recent development of industrial fishing in eastern Malaysia also contributed to an increase in catches. Some of the overall increases in catches are attributable to the increased catch of species such as the squid fishery in the Gulf of Thailand in 1980s. Some scientists believed that the increased abundance of squid was a result of heavy exploitation on its predators, the demersal fish.

Few countries in the region have formulated fisheries management plans, integration and those measures implemented have not been fully successful in reducing fishing pressure and, as a consequence, some of the excess fleet (e.g., Thailand's fleet) have had to compensate by fishing in the waters of neighbouring countries through various bilateral agreements. Indonesia provides fishing access to foreign fleets 12 miles off its archipelago, primarily in the South China Sea and on the Pacific side (CDMSCS, 1991).

Most stocks of coastal shrimp in Asian waters and in northern Australia are fully exploited. Trawl fishing has been banned in the western part of Indonesian waters since 1980 but a recent trammel net fishery has continued pressure on the coastal shrimp stocks. Total catches have levelled off during the past decade at 200 000 to 300 000t. The catch of the northern Australia prawn has increased but this was believed to be more related to seasonal variability than to management (Anon., 1991). Over-capitalization of the industry has caused recruitment overfishing of the tiger prawn.

Development of new fisheries in the region has certainly been responsible for the increase in overall catch. However, fisheries development, particularly in Southeast Asia, has been hampered by increased fishing effort on some of the depressed stocks and conflicts among fishermen using various fishing gears. Some countries have deployed artificial reefs which serve as barriers for inshore trawl fishing (Pauly and Chua, 1988).

The degradation of coastal environments in the region is a major problem due primarily to growth in the human population, movement of people to coastal cities and coastal development in the regions. This leads to increased discharge of municipal and industrial effluents, landfill and mangrove clearing. Increased agriculture also increases the amounts of herbicides and pesticides in rivers which may reduce survival of juvenile fish and shrimp in coastal areas. Other human induced activities include increased terrestrial runoff of silt due to land reclamation and deforestation as well as recent development of coastal aquaculture which contribute to changes in the aquatic environment. These factors are of key importance since a high percentage of marine fish production comes from stocks which pass their early and most vulnerable stages in coastal waters.

Management of fishery resources by small island countries in the eastern region, particularly for tuna, has been successful through cooperative work of the Fisheries Forum Agency (FFA). This organization serves as the focal point for the island States for access of fishing agreements with distant water fishing nations. FFA has developed a register of foreign fishing vessels enabling member countries to monitor foreign vessels.

The Southeast Asian Fisheries Development Center (SEAFDEC) has, with limited success, initiated the improvement in the collection of statistics of multispecies fisheries in the countries in the region for stock assessment purposes. Regular monitoring surveys by Thailand have been directed towards aquatic resource evaluation, the results of which, unfortunately, still do not play a major role in management decisions. Therefore, the main priority of fisheries development in the region revolves around the question of strengthening fisheries management. The International Center for Living Aquatic Resources Management (ICLARM), SEAFDEC and the Association of Southeast Asian Nations (ASEAN) are fisheries organizations not directly involved in regional management. The Indo-Pacific Fisheries Commission (IPFC) and its subsidiary body, the Standing Committee on Resources Research and Development (SCORRAD) are fisheries advisory organizations and do not have authoritative power. The ASEAN/US Coastal Resources Management Project, coordinated by ICLARM, is playing a significant role directed toward integrated coastal area development, including fisheries, in the region.

EASTERN CENTRAL PACIFIC (Area 77) (Table 17)

Fisheries in this area are strongly influenced by the California Current System, which is one of the major eastern boundary current systems in the world (Bakun and Parrish, 1980; Parrish et al., 1981; Bakun and Parrish, 1982; Parrish et al., 1983). The shelf along the western coasts of the Americas is also relatively narrow in this area, and coastal areas support important fish stocks, which are dominated by small pelagics in the upwelling areas off southern California, northern Mexico and Panama, tunas and other large pelagics offshore, and highly valuable shrimp stocks inshore.

Total catches in this area have fluctuated between 1.5 and 1.8 million t per year since 1985. In 1990 and 1991 the total catch was 1.5 million t, down from 1.8 million t in 1989. Fisheries are dominated by pelagic species in terms of volume of catches, and by shrimp species in terms of value. The abundance and total catch of some fish stocks in the area tend to fluctuate from year to year due to environmental changes, mostly associated with the "El Niño" (Sharp and Csirke, 1984; Lluch-Belda et al., 1992). During 1991 and 1992 the area was affected by a mid-intensity "El Niño" that is expected to affect fisheries in this region.

Total catches of Californian sardine (Sardinops sagax caeruleus) were 440 000-480 000t per year from 1986 to 1988, increased to 510 000t in 1989, declined to 400 000t in 1990 and increased again to 470 000t in 1991. This fishery collapsed in the USA in the 1950s and although there is a recovery of the stock, the overall abundance is below the previous levels. The stock is considered to be moderately to fully exploited, but is subject to wide natural fluctuations, and currently is only being exploited by Mexico. Changes in the area of distribution and duration of the fishing seasons have been reported during 1991 and 1992, and the sardine has almost disappeared from the Gulf of California.

Total catches of Northern Pacific anchovy (Engraulis mordax) dropped sharply from 110 000t in 1989 to only 6 000t in 1990 and 21 000t in 1991, after being at around 120 000-170 000t per year for several years. Most of the anchovy is caught by Mexico to produce fish meal, but small quantities are caught in California for live bait. The low catches during recent years seem to be a consequence of a reduced overall abundance of the stock due to recruitment failure and a northern shift in distribution which has affected the Mexican fishery.

Catches of Central Pacific anchoveta (Cetengraulis mysticetus) continue to fluctuate off Panama. After a maximum of 240 000t in 1985, catches were 40 000t in 1988, 120 000t in 1989, and 60 000-65 000t in 1990 and 1991. Most of these fluctuations are due to natural annual changes in overall abundance and distribution. The stock is probably fully exploited. Catches of Pacific thread herring (Opisthonema spp.) continue to fluctuate in the area. It is mostly caught off Panama and annual landings ranged from 10 000t to 40 000t in the last five years. Several stocks of thread herring are present in the area, and most are moderately to fully exploited.

The chub mackerel (Scomber japonicus) is moderately exploited in this area, and total catches have been maintained at around 50 000-80 000t per year. The Pacific jack mackerel (Trachurus symmetricus) is lightly exploited. Catches have remained slightly above 10 000t per year until 1989, and dropped to 4 000t and 2 000t in 1990 and 1991.

Catches of tuna have also been relatively stable since the decline in 1982-83, and have recovered slightly. Landings of skipjack tuna (Katsuwonus pelamis) have been in the range of about 40 000-80 000t since 1986, after a catch of 130 000t in 1985. Catches of yellowfin tuna (Thunnus albacares) increased from 130 000t in 1983 to 276 000t in 1986 and 282 000t in 1988, to decrease to 212 000t in 1991. This stock seems to be fully exploited. The albacore (Thunnus alalunga) and bigeye tuna (Thunnus obesus) are moderately exploited and their total catches are relatively stable at about 20 000t and 90 000t per year, respectively.

Shrimp stocks (mostly Penaeus spp.) are fully to heavily exploited almost everywhere in the area. The stocks off Nicaragua were lightly to moderately exploited, but fishing pressure is building up rapidly also there. Catches of squat lobster (Pleuroncodes planiceps) declined from almost 12 000t in 1987 to slightly over 3 000t in 1988 and 2 000t in 1989 and 1990. This stock seems to be lightly exploited and good concentrations have been reported by the R/V DR FRIDTJOF NANSEN which surveyed the area in 1987. These surveys, conducted as a part of a UNDP/NORAD/FAO Project, also confirmed a total biomass of more than 1 million t of small pelagic stocks in the area, and another 250 000t of demersal stocks (IMR, 1988). An increase in the catches of squids has also been reported with 77 000t in 1988 and 83 000t in 1990. These stocks are lightly exploited and offer some potential for further development, although they are highly variable.

There are no FAO regional bodies in the area. At the moment research and management on tuna in the area are coordinated by the Inter-American Tropical Tuna Commission (IATTC) based in La Jolla, but not all the countries in the area are members of this body. FAO and the Organización Latinoamericana para el Desarrollo de la Pesca (OLDEPESCA) promoted further subregional cooperation within the framework of a working group on fisheries research for Central America and Panama, of which Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama are members.

SOUTHWEST PACIFIC (Area 81) (Table 18)

This area includes waters off southeastern Australia (namely off New South Wales), New Zealand, the EEZs of several island countries, and a large area of deep ocean water. Total catches for the area have levelled off for 1988-90 at around 1 million t, after a rapid increase in the early and mid-eighties (FAO, 1992j).

New South Wales is the major centre for oyster farming in Australia, and prawns dominate trawl fisheries catches in the north (NSW Fisheries, 1992; Kailola et al., 1993). Over 60 species of fish are taken in the demersal fish catch off southeastern New South Wales, but catches tend to be dominated by only a few species. Total catch in this region reached 38 000t in 1990-91; gemfish, redfish and ocean perch stocks are probably overexploited, and a number of other species, most recently orange roughy, are fully exploited. Recently gemfish has suffered a collapse in recruitment which suggests that abundance may decline for several years even in the absence of fishing. The major demersal stocks off New Zealand are probably fully exploited (Baird, 1992; Annala, 1993; New Zealand Fishing Industry Board, 1993). Unfortunately, recent statistics on catch and fishing effort for many species are considered inadequate for satisfactory stock assessments.

Landings of blue grenadier increased rapidly from 43 000t in 1985 to 392 000t in 1990. The increased catches of grenadier account for most of the recent increase in landings in this area. Stocks of blue grenadier are currently being fished down, and the New Zealand TAC was reduced from 250 000t in 1989-90 to 200 000t in 1990-91 (Annala, 1993), and will almost certainly be brought down further. The snapper is New Zealand's most valuable coastal finfish fishery. Snapper stocks have shown signs of overfishing for at least a decade, and catches and quotas in most areas have been progressively reduced. Most stocks are still under stress and their TACs are being held down to promote rebuilding.

Rock lobster is the second most valuable inshore fishery off New Zealand (Baird, 1992; Annala, 1993; New Zealand Fishing Industry Board, 1993). Concern has recently been expressed over the status of this resource. The fishery is believed to be fished beyond its full potential and the resource is declining because of high fishing effort. Biologists are predicting seriously diminishing catches unless there is some reduction in fishing effort. The New South Wales rock lobster fishery is also showing signs of overexploitation (NSW Fisheries, 1992; Kailola et al., 1993). Landings of cephalopods, which had levelled off over the last ten years at just over 100 000t, are starting to show large fluctuations with a record of 228 000t landed in 1989 but only 92 000t in 1990.

The New Zealand Ministry of Agriculture and Fisheries is responsible for the management of fisheries under New Zealand jurisdiction (Annala, 1993; New Zealand Fishing Industry Board, 1993). In 1986 the Ministry adopted a market-driven system of ITQ within a quota management system which has been able to stabilize a number of fisheries at more appropriate economic levels. Recently ITQ have been changed from a fixed tonnage to a proportion of a variable overall TAC. This new system should be more effective for those stocks that face substantial reductions in their TAC in the near future, such as orange roughy.

TACs are determined periodically (yearly for all ITQ fisheries) with the help of scientific fishing surveys (Baird, 1992; Annala, 1993). Orange roughy was the most valuable fishery for the New Zealand fleet in the late 1980s, but has since been overtaken by blue grenadier (Annala, 1993). Unfortunately present orange roughy harvest levels will only be obtainable for a few years unless new major stocks are discovered (see Box "Orange roughy: A sustainable fishery from 100 year old fish?). Present assessments suggest that many stocks are at a level below 50% of their virgin spawning biomass and some are at 10-20%. Given these parameters, present TACs will not ensure sustainable catches in the medium or long term nor will they allow stocks to rebuild. This is the reason why significant decreases in TACs are predicted for several orange roughy stocks. In fact, TACs of orange roughy off New Zealand have been reduced in the past three years for the two largest of the six stocks.

Because of the imposition of the ITQ system, New Zealand has put considerable effort into ensuring their indigenous people receive a fair share of fishing rights. In 1991 a special legislation was passed to give Maori people certain special privileges and to promote their access to those fisheries where they previously did not participate.

Australia is adopting a system of Individual Transferable Quotas (ITQ) for some selected fisheries, notably the southeast trawl fishery which includes most catches made in New South Wales (NSW Fisheries, 1992; Kailola et al., 1993). Most other Commonwealth fisheries are managed by TACs, but few State fisheries are managed that way. New South Wales for example has unlimited entry for its prawn trawl fishery (Annala, 1993), whereas Queensland, which fishes part of the same stock, does have limited entry for their trawl fisheries. The northern prawn fishery and South Australian prawn fishery have had significant experience with limited entry and with seasonal closures to increase landings and landed prawn size in order to maximize revenues and reduce fishing costs (South Australian Department of Fisheries, 1992). These differences occur because of the agreement between the Australian Commonwealth and the States which gives jurisdiction of most coastal stocks to the States and most offshore and some shared stocks to the Commonwealth (Department of Primary Industries, 1992; NSW Fisheries, 1992; Kailola et al., 1993).

SOUTHEAST PACIFIC (Area 87) (Table 19)

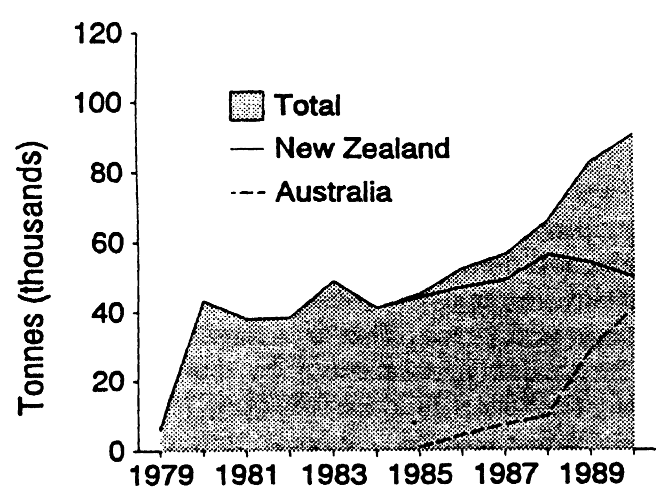
The northern boundaries in this statistical area now include the coastal zones of Colombia and Ecuador, and Peru and Chile. The species and area totals have been revised accordingly. The area borders the western coast of South America, with a narrow continental shelf. The central and southern part off Chile and Peru is dominated by an eastern boundary current system which generates a cold, nutrient-rich upwelling. The northern part off Ecuador and Colombia has a tropical climate and is less productive. The central and southern part of this area is dominated by small pelagic stocks which sustain its main fisheries while further north, the main fisheries are inshore those for shrimp and offshore for tuna. This area is greatly affected by the periodic arrival of "El Niño", with the most noticeable impact being on the catches and overall abundance of pelagic fish stocks (FAO, 1976; Guillen, 1983; Parrish et al., 1983; Jordan, 1985; Cucalón and Maridueña, 1989; Flores, 1989; Yañez, 1989).

BOX: Orange roughy: a sustainable fishery from 100 year old fish ?

Although present in most deep water temperate oceans, orange roughy only currently supports a commercial fishery off New Zealand and Australia. Some scientist claim that these fish may reach 100 years of age and mature at an age of 20-25 years. The fishery started in the early eighties and was initially confined to New Zealand (Annala, 1993), but since 1986, substantial catches have been made off Australia (Kailola et al., 1993). The fishery targets large spawning aggregations which occur in very localized areas. Catch rates at the spawning site remain high as long as there are fish spawning, but drop dramatically thereafter. The high catch rates obtained by individual boats tended to mask the rapid decline that occurred in the spawning population, and were an incentive to increase fishing effort every year. In spite of the significant depletion of the presently known spawning aggregations, overall catches in the region have continued to increase (Box Figure) as new spawning sites and new fishing grounds have been found.

The rate of depletion of some of these spawning aggregations has been very high (Annala, 1993), with some of the early concentrations having decreased to 10% of their virgin biomass. It is estimated that the St. Helens concentration off eastern Tasmania has been reduced to about 50% of the virgin biomass in five years (Kailola et al., 1993). The longevity and slow growth of this fish suggests that the maximum harvest rates that a stock can sustain are around 1-5% of the virgin biomass. Early harvest rates and present TACs are both higher than these levels, indicating the fishery will not be sustainable unless new stocks or concentrations are found.

A serious management problem this fishery shares with other fisheries harvesting long-lived species, is that any effects of fishing pressure on the spawners will affect recruitment up to 20 years later. Assessments are also complicated because of the unknown interchange of individuals between the various spawning concentrations, and between the non-spawning and spawning adults. There is the temptation from an economic perspective to harvest such slow-growing resources by "pulse fishing". However, management should set conservative TACs because the very low natural mortality of orange roughy ensures that fish which are not caught today will remain in the stock for many years to come and stability in landings could quite readily be achieved.



Box Figure: Trends in orange roughy catches in the Southwest Pacific

After the major decline in catches in the 1970s and early 1980s following the collapse of the Peruvian anchoveta, total catches in this area have recovered, and since 1985 they have always been above 10 million t per year. They increased to 15.3 million t in 1989 but dropped to 14 million t in 1990. These totals are above the record catches of 13.8 million t in 1970, when the anchoveta fishery was at its peak and dominated the landings.

The species composition of the catches is now more diversified, although small pelagics are still dominant and represent around 90% of the total landings (see Box: "Pelagic catches off western South America"). The most important pelagic stocks in this area are the sardine (Sardinops sagax), the Peruvian anchoveta (Engraulis ringens) and the jack mackerel (Trachurus murphyi) (Arana, 1986; Mathisen and Tsukayama, 1986; Pauly and Tsukayama, 1987; Tsukayama and Palomares, 1987; Espino and Wosnitza-Mendo, 1989; Parrish, 1989; Pauly and Palomares, 1989; Pauly et al., 1989; CPPS, 1993). These three species made up almost 85% of the total catch in 1990. Other small pelagic fish stocks of relative importance in the area are the Pacific breams (Seriolella spp.), the eastern Pacific bonito (Sarda chiliensis), and the chub mackerel (Scomber japonicus). The most important demersal fish stocks are the Chilean hake (Merluccius gayi), the Patagonian grenadier (Macruronus magellanicus) and the Patagonian hake (Merluccius polylepis). After the record catch of 6.5 million t in 1985, total catches of sardine decreased to 5.4 million t in 1988, 4.3 million t in 1990 and 4.2 million t in 1991. This stock is mainly exploited by Peru, where catches have fluctuated between 1.7 and 3.5 million t per year, and Chile, where catches have declined from 2.9 million t in 1985 to 0.7 million t in 1991. The stock is considered to be fully exploited, with some concern for overexploitation.

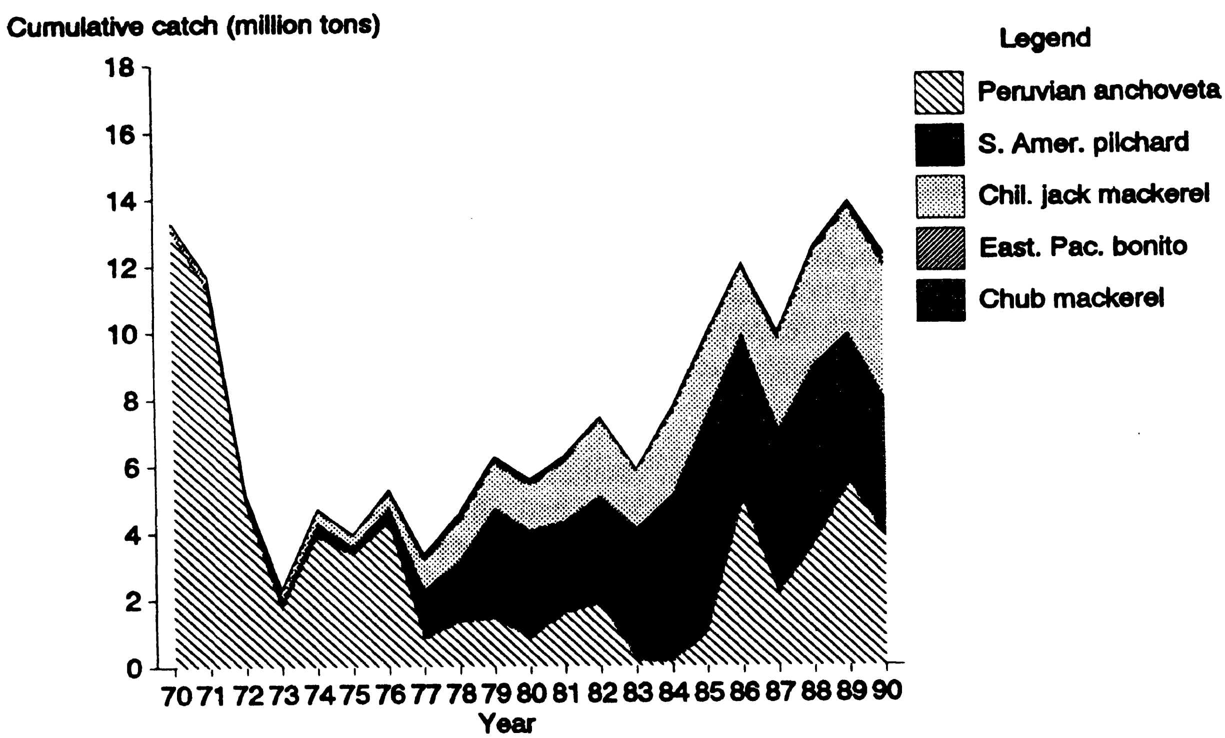
Catches of Chilean jack mackerel continue to increase with record catches of 3.8 million t reported in 1991. This species has a very wide distribution in the southeast Pacific. Chilean and Peruvian fleets fish along the coast and the former USSR and Cuba fish offshore. Catches by the Chilean fleet have increased consistently, reaching a record 3.0 million t in 1990. Catches by the coastal Peruvian fleet have been variable with 136 000t reported for 1991, after a maximum of 504 000t in 1977. The stock is also actively exploited by foreign fleets beyond the 200 mile zone, and the catches by the former USSR, the main offshore fishing country, increased to more than 1.1 million t in 1990, but changed to 640 000t in 1991. The offshore catches by Cuba were of the order of 40 000t in 1990 and 31 000t in 1991. The abundance of this stock seems to have increased over the past years, and the expansion in its distribution makes it very difficult to assess the long-term potential. It is still considered to be moderately exploited although catches are relatively high.

After its dramatic collapse in the 1970s, catches of Peruvian anchoveta were less than 1 million t in the early 1980s, almost 5 million t in 1986 and since then have fluctuated between 2.1 million t in 1987, and 5.4 million t in 1989, with 4.0 million t being caught in 1991. It is exploited primarily by the Peruvian purse seine fleet off northern Peru, and by the Chilean purse seine fleet off northern Chile. This stock is highly variable, and under the present conditions is estimated to have a potential annual yield of 2 to 5 million t. It is considered to be fully to heavily exploited, and although the purse seine fleets off Peru and Chile are also targeting other small pelagic species, they maintain a heavy pressure on the Peruvian anchoveta. Catches of the eastern Pacific bonito and the chub mackerel have been increasing over the last few years. Captures of other small pelagic species, such as the South Pacific breams (Seriolella spp.), and the Chilean herring (Strangomera bentincki) have been more or less stable.

BOX: Pelagic catches off western South America

One of the most productive areas for fisheries in the world is the upwelling region off the west coast of South America. Here the pelagic fish stocks exhibit large fluctuations in abundance and change in dominance from one species to another. For example, the catch of the Peruvian anchoveta peaked in 1970 at 13.8 million t (19.7% of the world's marine catch) and had collapsed to only 126 000 t by 1983. There is still not complete agreement on the relative contribution of fishing and environmental changes to the collapse.

Although the anchoveta stocks have recovered somewhat in the late 1980s, other pelagic species have filled part of the vacuum created by the decline of the anchoveta population (Figure). These include South American pilchard, Chilean jack mackerel and chub mackerel. Catches of eastern Pacific bonito are also increasing, after collapsing in the 1960s. The total landings of all species in 1989 (13.9 million t) just exceeded the total landings in 1970.



Box Figure: Trends in landings of small pelagic fish of western South America

Landings of the Patagonian grenadier increased consistently from 20 000t per year in the early 1980s to almost 230 000t in 1989, but then declined to 130 000t in 1990 to raise to 165 000t in 1991. Catches of Patagonian hake have also increased from around 20 000t in the early 1980s to almost 70 000t in 1988, have remained above 50 000t in 1989 and 1990, to drop to 40 000t in 1991. These two stocks are exploited off the coast of southern Chile. Catches of Chilean hake dropped to less than 50 000t in the early 1980s, but then increased steadily to almost 150 000t in 1988 and 225 000t in 1990, to decrease to 140 000t in 1991. This stock is being exploited off northern Peru and central Chile.

Landings of squid have varied widely from 19 500t in 1985, 4 800t in 1987, 7 200t in 1988, and 11 000 and 22 000t in 1989 and 1990, with a sharp increase to 130 000t in 1991, which is believed to be much closer to the potential yield of these stocks. After being considered as virtually unexploited in this area, squid fishery had further developed in the area, particularly the one targeting on the population of flying squid (Dosidiscus gigas). The management and development of this type of fisheries poses some problems, due to the high variability of the stocks which make it difficult to plan long-term investments based on the exploitation of a single, highly variable stock.

Regional research activities regarding fisheries and other marine-related research activities, are coordinated by the Permanent Commission for the Southeast Pacific (CPPS), of which the four coastal States in this area are members. This area is not covered by an FAO regional body, but very good relationships and cooperation are maintained between FAO and the CPPS.

SOUTHERN OCEANS (Areas 48, 58 and 88) (Table 20)

The total catch in the Southern Oceans was 429 000t in 1989/90 compared to a range of 458 000-503 000t from 1985/86 to 1988/89 (FAO, 1992j). Most of the catch is krill (Fischer and Hureau, 1985; CCALMR, 1992a), accounting for 89% of the total in 1989/90. The major krill and finfish catches taken in the Southern Oceans comes from the waters around the islands of South Georgia and South Orkney in the Atlantic Ocean (Area 48) (CCAMLR, 1992a;c).

The major catch of finfish consists of lanternfishes (Myctophidae), mackerel icefish (Champsocephalus gunnari) and Patagonian toothfish (Dissostichus eleginoides) (Fisher and Hureau, 1985; CCAMLR, 1992a). The history of exploitation of fish resources in the Southern Oceans is one of continuous shifting from one overfished stock to another less exploited one. The fish resources are very limited and their yield too small for them to sustain high catches.

The krill catches were 395 000t in 1988/89 and 381 000t in 1989/90 (FAO, 1992j). Most of the catch was taken by the former USSR fleet and Japan (Fischer and Hureau, 1985; CCAMLR, 1992a;c). Because the annual net production of krill is believed to be low compared to the available biomass, the resource could be vulnerable to overfishing. Therefore, there is a need for precautionary management measures. This need becomes very obvious when considering the present degree of depletion of the other more economically viable resources of the Antarctic, and the failure of their international management.

The Antarctic fisheries are managed by the Convention for Conservation of Antarctic Marine Living Resources (CCAMLR) (CCAMLR, 1992b). Areas north of 60°N are theoretically under the responsibility of relevant regional fisheries bodies, but there is no effective fisheries management policy in any of these bodies regarding Antarctic resources. The concept of ecosystem management followed by CCAMLR is unique to this resource management body, which has wider terms of reference than fisheries. The failure to achieve sustainability of important Antarctic fish resources, given a primary focus on the interactions among species, combined with the very difficult problem of enforcement of an entirely distant water fleet, means that there are serious problems in addressing the issue of the interaction between men and the valuable, but fragile, harvestable resources.

TUNA AND TUNA-LIKE SPECIES (Table 21)

Tuna and tuna-like species belong to the sub-order Scombroidei, which is composed of tunas, billfishes, swordfishes and other related species (Collette and Nauen, 1983; Joseph et al., 1988). They occur in the tropical and temperate zones. Species of albacore, bigeye tuna, northern and southern bluefin tuna, skipjack tuna and yellowfin tuna are referred to as the principal market tuna species because of world-wide demand for sashimi and/or canning (Saran, 1991).

The northern bluefin tuna occurs in commercial quantities in the Atlantic and Pacific Oceans, from 70°N to 25°N and, to a smaller extent, south of the equator in the Pacific (Bartoo, 1987). The southern bluefin tuna is found also in these two Oceans and the Indian Ocean, but from 10°S to 50°S (Bartoo, 1987). The bigeye tuna, yellowfin tuna and albacore occur throughout the Atlantic, Indian and Pacific oceans between 40-55°N and 40-45°S (Bartoo, 1987). The skipjack tuna, of relatively lower commercial value, is also distributed in the three oceans from 50°-60°N to 50°S (Bartoo, 1987). Some principal market tuna species undertake long migrations and are considered as highly migratory under the Law of the Sea (Hey, 1989). Two other oceanic species (slender tuna and butterfly kingfish) occur in the Southern Ocean with a circumpolar distribution between 15°S and 50°S (Collette and Nauen, 1983). Despite their lower value, they offer significant potential and are now incidentally caught by the Japanese fishery targeting at southern bluefin tuna. Slender tuna are also a significant by-catch of driftnet fisheries (FAO, 1990a; Northridge, 1991).

Other important tunas have more neritic distributions; they live on or close to continental shelves and around islands and archipelagos. In this category are found less commercially important species such as the longtail and blackfin tunas (Collette and Nauen, 1983). The first species occurs in the eastern Indian Ocean, the Pacific off Southeast Asia (mainly in the Gulf of Thailand and the South China Sea) and off Australia (20°N to 35-40°S), and the second in the western Atlantic (40°N to 25°S). The billfishes include marlins, sailfish and spearfish (Nakamura, 1985). The swordfish includes one species only. With the exception of two spearfish species, these fish have wide geographical distributions, but do not necessarily occur in all oceans. The other species of importance to fisheries include wahoo, bullet, frigate tuna, kawakawa, black skipjack, little tuna, bonito, Spanish and king mackerels, seerfish and sierra (Joseph et. al, 1988; FAO, 1992j). These represent a significant potential for some coastal countries, being frequently subject to artisanal and/or recreational fishing.

Most tuna and tuna-like species are commercially caught with purse-seine, longline and pole and line methods (Joseph et al., 1988; Joseph, 1990). The first and third methods are used for fish swimming close to the surface (e.g., skipjack and small to medium yellowfin, albacore and northern and southern bluefin tuna), whereas the last method targets fish at greater depths (e.g., large northern and southern bluefin tuna, bigeye tuna, yellowfin tuna, albacore, billfish and swordfish; the last two species, especially billfish, being by-catch). Most of purse seine and pole and line catches are canned, while longline catches with the exception of those of albacore, are mainly sold for the sashimi market.

The use of pole and line and longline methods has been generally declining, while purse seining is becoming more popular (Joseph, 1990). This has resulted in increased catches of skipjack and small to medium yellowfin, while catches of big yellowfin and the other principal market tuna species have remained relatively stable. The other gears used are troll lines, hand-lines, driftnets, traps and harpoons. Natural or artificial fish aggregating devices (FADs) are often utilized in conjunction with purse-seining, pole and line fishing or hand-lining.

Trends in Catches and Fishing Operations: The total annual catch of tuna and tuna-like species has been steadily increasing from an average catch of about 1.9 million t in the early 1970s to 4.2 million t in 1990 (FAO, 1992j). During the same period, the catch of the principal market tuna species increased from 1.4 to 2.8 million t (FAO, 1992j). With a more than two fold increase in the annual catch of skipjack and yellowfin catches, these species made up 45% and 35%, respectively, of the 1990 catch of principal market tunas. The catches of the other principal market tuna species remained steady (albacore and bigeye tuna) or decreased (southern and northern bluefin tuna).

A total of 71% of the skipjack, 66% of the yellowfin, 58% of the bigeye and 53% of albacore were taken in the Pacific in 1990. The Indian Ocean catch of skipjack was 1.6 times higher than that in the Atlantic, but that for yellowfin was comparable in the two Oceans. The bigeye and albacore catches in the Atlantic were, respectively, 1.5 and 1.7 times higher than those in the Indian Ocean. The northern bluefin tuna is taken mainly in the Atlantic (79%) with the remainder in the Pacific. Most southern bluefin tuna are taken in the Indian Ocean (61%) and the remainder in the Pacific and Atlantic.

Approximately 63% of the 1990 catch of the principal market tuna species was taken by the traditional tuna fishing countries: Japan (649 000t), Taiwan (Province of China) (278 000t), Spain (262 000t), Republic of Korea (233 000t), USA (233 000t) and France (144 000t) (FAO, 1992j). Between 1985 and 1990, the combined catch of these countries increased by 30% mainly due to increased catches by the Republic of Korea, Taiwan (Province of China), Spain and France. The catches of the first two countries more than doubled mainly in the Indian and Pacific Oceans. The landings of the remaining, mostly developing countries increased by 36% during the period (FAO, 1992j). Off Southeast Asia in both the Indian and Pacific Oceans, tuna fisheries are growing, including the artisanal sector catching mostly small tunas, skipjack and yellowfin (FAO, 1992h;k). This sector's growth was also significant in the entire Indian Ocean. In addition to traditional tuna fishing countries, Indonesia, the Philippines, Mexico, Venezuela, Maldives, Ecuador, Panama, Ghana and the Solomon Islands contributed most to the 1990 catch. In fact, the catches of Indonesia and the Philippines have exceeded that of France.

In the early 1980s (mainly in 1983 and 1984), part of the Spanish and French purse-seine fleets shifted from the Atlantic to the Indian Ocean, significantly contributing to the increase in Indian Ocean catches of tuna and tuna-like species (more than doubled between the early 1980s and 1989, with a slight decrease in 1990), while in the Pacific and Atlantic, these catches increased by 41% and 6%, respectively. Now, some of the purse-seiners have moved back to the Atlantic. Most US purse-seiners have stopped operating in the eastern Pacific because of incidental catches of dolphins (see further text); some have now moved to the western Pacific. The Republic of Korea and Taiwan (Province of China) have also started substantial purse-seine operations in the western Pacific. Coastal countries, including island countries in the Indian and western Pacific Oceans are entering the tuna fishing through the purchase of purse-seiners and longliners (Lawson, 1992). This trend is expected to continue to grow in the near future.

Because the catches of non-principal market tuna species other than billfish and swordfish are mostly taken by developing countries, where the system of collecting and processing fishery statistics still needs improvement, catch statistics for these species may be less reliable and few, if any, management measures control their exploitation. Also, some catches of these species are discarded and not reported by industrial fisheries. The very rapid catch increase from 1970 to 1990 may partly reflect an improvement in the statistics (FAO, 1992j). Also, the catch composition of the secondary species is frequently not accurate, because of likely misidentification of species. The 1990 catch was composed mainly of Japanese Spanish mackerel (247 000t) frigate and bullet tuna (215 000t), longtail tuna (141 000t), narrow-barred Spanish mackerel (115 000t), kawakawa (98 000t), swordfish (77 000t), eastern Pacific bonito (54 000t), seerfish (46 000t) and Indo-Pacific king mackerel (43 000t) (FAO, 1992j).

The catch of tunas other than the principal species, also rose from about 0.5 million t in the early 1970s to 1.5 million t in 1990 (FAO, 1992j). Only a very small portion of this catch is composed of billfish and swordfish (10% in 1990), taken mainly in the Pacific and Atlantic.

Status of Stocks: (The areas mentioned in this section encompass the assumed natural boundaries of stocks, which are not necessarily FAO's statistical areas.) Many stocks of the principal market species appear to be heavily to fully exploited and some stocks are overfished (northern bluefin tuna in the western Atlantic and southern bluefin tuna). Skipjack in all Oceans is an exception. Also, recent studies indicate that the present catch of yellowfin in the western Pacific can be more than doubled without adversely affecting the stock. Yellowfin tuna in the central and western Pacific and albacore in the Atlantic are moderately exploited. In the Indian Ocean, fisheries for tunas and tuna-like species operated at relatively low intensity until the early 1980s, but the status of these stocks is not well-known (FAO, 1990b). The status of yellowfin tuna in the western Atlantic, albacore in the Indian Ocean and northern bluefin tuna in the Pacific is largely unknown.

The stock of albacore in the North Atlantic is moderately exploited (ICCAT, 1993). In the South Atlantic, MSY for albacore was estimated at 20-28 000t, and there is some evidence of a decline in the stock to 20-30% of the unexploited level (ICCAT, 1993). In the Indian Ocean, the stock of albacore seems to be heavily exploited, but its assessment is uncertain (FAO, 1990b). In the North Pacific, the albacore stock at present is, at least, one third smaller than that in the mid 1970s, but the stock seems to be in a stable condition (Shomura, et al., in press). In the South

Pacific, the deep water strata of the resource (older age groups) is presently heavily fished (South Pacific Commission, 1992b). On the basis of data from that fishery, MSY was estimated at 31 000-37 000t, but might be increased by surface fishing, though this could affect longline catch-rates. The 1988/89 combined driftnet, longline and troll catch might be unsustainable, but the driftnet fishery ceased in response to United Nations resolution on this fishery (FAO, 1990a).

In the Atlantic, bigeye tuna are fished at a level close to MSY, which is estimated at 67 000-76 000t (ICCAT, 1993). In the Indian Ocean, bigeye tuna are heavily fished, but probably they are in a healthy condition (FAO, 1990b). In the Pacific, the stock of bigeye tuna is exploited at a level close to MSY (139 000-170 000t) (Shomura et al., in press). In the Atlantic, skipjack are only moderately exploited. In the Indian Ocean, the stock of skipjack seems to be in a healthy condition, but its potential is largely unknown (FAO, 1990b). Catches of skipjack can probably be further increased both in the eastern, central and western Pacific (South Pacific Commission, 1992a; IATTC, 1992).

The 1989 abundance of medium sized (five to nine years old) and large (over ten years old) northern bluefin tuna was two thirds and just over a half, respectively, of the 1970 levels for the eastern Atlantic and the Mediterranean Sea (ICCAT, 1993). Small fish (two to four years old) have been increasing in abundance with large fluctuations since 1970. In the western Atlantic, the stock is considered significantly overfished and the biomass of adults is now only 10-23% of the 1970 level. In the North Pacific, the status of northern bluefin tuna is uncertain and recruitment seems to be highly variable (IATTC, 1992). It is probable that the yield-per-recruit could be increased by increasing the minimum age of capture to 2.5 years. The southern bluefin tuna in the Indian, Pacific and South Atlantic Oceans is overexploited; its parental biomass has been in a continuous decline, at least until 1990. Recent analyses have suggested a decline in recruitment from 1975 to 1983, but subsequent recruitment levels could not be determined.

The eastern Atlantic stock of yellowfin tuna is exploited at about the MSY level (ICCAT, 1993). The 1990 catch of 147 000t was above the estimated MSY of 132 000t due to strong year classes, but fishing effort seemed to be slightly below that associated with MSY. The status of the western Atlantic stock is uncertain (ICCAT, 1993). In the Indian Ocean, yellowfin tuna do not seem to be threatened by overexploitation, despite the tremendous increase of catch during the last ten years (FAO, 1992i). However, more research is needed before their status can be precisely determined. In the western and central Pacific, most analyses suggest that a doubling of the present yellowfin catch is sustainable (South Pacific Commission, 1992a). In the eastern Pacific, the stock declined between the 1970s and 1982 and then increased due to targeting at larger fish (improving the yield-per-recruit) and due to increased recruitment, which has stabilized since 1985 (IATTC, 1992). The stock now appears to be slightly underexploited.

Fishery statistics for billfish and Indian and Pacific Ocean swordfish, are incomplete and even basic biological information is limited (FAO, 1990b). Some concern has been expressed about blue and white marlin in the Atlantic (ICCAT, 1993). Swordfish in the North Atlantic has been intensively fished close to the MSY level if not already exceeding it (ICCAT, 1993). There are indications that sailfish are moderately exploited in the western Atlantic and less so in the eastern Atlantic (ICCAT, 1993). Very little is known about the status of billfish and swordfish in the

Indian Ocean, but the last species seems to be underexploited. Similarly, Pacific swordfish appears to be moderately exploited (FAO, 1990b).

Fisheries Management Concerns: The overall potential yield from the tuna and tuna-like resources depends on the combination of fishing techniques used because different methods have different ability to target the various age groups. Improvements in the yield can be achieved in some cases (e.g., albacore and yellowfin in the Atlantic and northern and southern bluefin tuna) by protecting small or immature fish and targeting more precisely older age-groups. Problems occur with compliance to the present size regulations (e.g., within the framework of the International Commission for Conservation of Atlantic Tunas (ICCAT), especially for northern bluefin tuna in the Mediterranean Sea (FAO, in press). In general, small fish frequently aggregate at their nursery grounds along the coasts, and large fish occur offshore where they are only available to industrial fisheries. The need to protect dolphins in the eastern Pacific may lead to smaller catches of large yellowfin usually associated with dolphins, leading to sub-optimal tuna fishing (National Research Council (U.S.). Committee on Reducing Porpoise Mortality from Tuna Fishing, 1992). Protection of small sizes may be ineffective for stocks with high natural mortality like skipjack, or are locally ineffective in areas with intense emigration.

Bio-economic interactions among fisheries need to be scientifically addressed for the resolution of fisheries management problems. Coordinated effort in this direction is being made. For example, FAO has initiated a Japan-funded Trust Fund project: "Cooperative Research on Interactions of Pacific Tuna Fisheries". Its activities are carried out within a framework of the "TUNET" network of ten Working Groups. In 1991, the project sponsored the First FAO Expert Consultation on Interactions of Pacific Tuna Fisheries hosted in Noumea, New Caledonia by the South Pacific Commission (SPC) and in cooperation with the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM).

Dolphins caught incidentally by purse-seiners are one area of concern, primarily for yellowfin in the eastern Pacific (National Research Council (U.S.). Committee on Reducing Porpoise Mortality from Tuna Fishing, 1992). Research and monitoring have been aiming at reducing the incidental mortality of dolphins. Also, some management restrictions have been imposed. Recently, many canneries have stopped accepting tuna that are caught with dolphins. This has implications on the fishing operation in the eastern Pacific, where the fishing intensity has decreased (some boats moved to the western Pacific) and less large yellowfin, which are usually associated with dolphins, are being caught.

WHALES AND DOLPHINS

Whales: Cetaceans are traditionally classified as either large or small. The first group is composed of baleen (with the exception of pigmy right whale) and sperm whales, while the second includes small toothed whales and dolphins. Cetaceans exist in all oceans, from the Arctic to the Antarctic (FAO, 1978; Watson, 1981). Some species including those of major, or formerly major, commercial importance (blue, humpback, fin, sei, minke, sperm whales and killer whale) are cosmopolitan.

Marine mammal resources are among the most vulnerable to overfishing because of their slow growth, low fecundity and, possibly also through the link between social behaviour and reproductive success. In particular, unrestrained whaling severely reduced many stocks in the 18th and 19th centuries and nearly all species of large whales early in the 20th century, giving one of the best examples of non-sustainable development in fisheries. With the exception of minke whale (Kasamatsu, 1990; Oeien, 1991), Gray whale in the eastern North Pacific and Bryde's whale in some oceans, the large cetaceans have been seriously depleted, in some cases perhaps beyond the level of recovery.

Early concern about unrestricted whaling resulted in the signing of the Convention for the Regulation of Whaling in 1931 and the consequent creation of an International Whaling Commission (IWC) in 1946 (Gulland, 1990). This did not prevent the serious decline in the abundance of important species like the blue and humpback whales. At that time, quotas did not differentiate among different species and geographical areas (Lamkester, 1988). Quotas were reduced by more than 90% between 1937 and 1969, partly, because of scientific advice given by the IWC Scientific Committee and, certainly, because quotas were not able to be filled. Finally in 1965, the IWC reduced catch limits towards levels which it was hoped the stocks could sustain. At the same time, blue whale fishing was banned. In 1972, quotas were set by species and specifically for sperm whales by sex. However, they applied to whole ocean areas without taking into account possible stock boundaries. By 1976, 13 years after scientists' recommendations to introduce such a system, all major whale stocks were placed under individual quota regulations. The Indian Ocean Sanctuary was established in 1979.

In 1982, the cessation of commercial whaling was approved pending a Comprehensive Assessment. This important decision was based largely on political considerations, despite the opinion of some parties that some species, such as southern and northern stocks of minke whales, were able to sustain some controlled exploitation. The actual phasing out of fishing was very gradual but, by 1988, whaling was de facto limited to aboriginal subsistence fishing by Greenlanders, Alaskan Eskimos and Siberian Aleuts. Limited additional catches were taken for scientific purposes by some whaling nations, despite doubts on this procedure forcefully expressed by other members of the IWC Scientific Committee.

In conjunction with the Comprehensive Assessment process, the final Revised Management Procedure was adopted in 1992, taking into account existing uncertainties in information and data and calling for protection of stocks reduced below 54% of the pre-exploitation level. This coincided with the completion of the Comprehensive Assessment for the Southern Hemisphere and North Atlantic minke whales. It is planned to assess the other baleen whales in the Southern Hemisphere and North Atlantic minke whales very soon. Some traditional whaling countries now hope to overturn the moratorium in the context of the Revised Management Procedure, and to re-open the minke whale fishery. This clashes with the opposing view of other countries concerned principally with conservation, and is leading to a crisis within the IWC. The conservation and management of whales was also considered at the meeting of UNCED's Preparatory Committee and by the Conference itself in Rio de Janeiro (June 1992). The central role of IWC was re-confirmed, but the proposal for a new moratorium did not receive conclusive support.

Small Cetaceans: The knowledge of the biology, stock structure, and status of small cetaceans is generally more limited than for large cetaceans. In fact, for some of them, very little is known. The populations of some species have a wide geographical distribution and they could be considered as highly migratory. However, many other species form local stocks. Small cetaceans have been targeted mainly by coastal fisheries (Harwood and Hembree, 1987; Goodall et al., 1988; van Waerebeek and Reyes, 1990) even though they also occur on high seas. They have also been incidentally caught by many fisheries operating on high seas as well as in EEZs (Peltier et al., 1992), but there is frequently little or no information available on these catches. Large scale gillnet and purse seine fisheries, both coastal and on high seas take incidental catches of small cetaceans. The operation of these fisheries on the high seas is subject to Resolution 44/225 of the General Assembly on Large-Scale Pelagic Driftnet Fishing and Its Impact on Living Marine Resources of the World's Oceans and Seas, which recommends that a moratorium be imposed on these fisheries by 30 June 1992 unless effective conservation and management measures are taken, based upon statistically sound analysis.

The management of small cetaceans resources leaves a lot to be desired. During UNCED's process in 1991/92, there was a debate on whether small cetaceans should be managed on a global basis (e.g., through IWC with an enlarged mandate) or regionally (through regional fishery bodies). No agreement was reached. Fortunately, IWC as well as the Programme and Coordinating Committee (PCC) of the FAO/UNDP Marine Mammal Action Plan have recently paid more attention to small cetaceans, which are not often considered by traditional fisheries management bodies.

ENVIRONMENTAL ISSUES IN MARINE FISHERIES

In recent years, an important change in perception has been gradually emerging in fisheries science. Traditionally, the point of view has been that fish population dynamics operate within a stable environmental context. However, environmentally-induced fluctuations in the 1970s changed our views on the validity of steady-state models. Environmental variation often has overwhelming effects on fishing success, on fish populations, and on the ecosystems that support them.

Anthropogenic effects, including effects of runoff from land and possible climate change, also now require that stock assessments be preceded by a broader evaluation of the likely nature and direction of such change. The importance of reconciling ecological, economic and biological criteria in setting management goals needs to be specifically recognized early in the assessment process.

The most dramatic effects of nutrient runoff have involved semi-enclosed systems (Caddy, 1993) such as the Black Sea and Baltic Sea. However, river runoff entering coastal waters is under the influence of Coriolis and other dynamic forces (Mann and Lazier, 1991), and tends to remain discrete and close to the coast. Thus, even in more open bodies of water such as the North Sea and Adriatic, river plumes may run parallel to the coast for hundreds of kilometres; hence the effects of successive rivers may be additive. Other types of rather stable hydro-dynamical structures, gyres, etc., also contribute to local retention of water masses (Sinclair, 1988). Eutrophication resulting from input and retention of nutrients in coastal waters has resulted in changes in biological community structure. For example, it has been implicated (Mellegaard and Nielson, 1990) in periodic formation of anoxic bottom conditions in the open North Sea off the Danish coast (see also, boxes for the Mediterranean and Black Seas).

Natural Environmental Perturbations

Establishing impacts of fishing and other anthropogenic effects is complicated by the wide natural variations which characterize the dynamics of our planetary system and its coupled oceans and atmosphere. A well known example is the El Niño phenomenon which had devastating effects on a number of marine populations, particularly in the eastern Pacific (Glantz and Thompson, 1981; Wooster and Fluharty, 1985). El Niño episodes appear at irregular frequencies of generally two to ten years, but particularly strong El Niño events may arise only once or twice a century. Because the ocean-atmosphere system of the Pacific is so large and so dominant over global weather patterns, El Niño events are a major source of climatic variability world-wide (Angel and Korshover, 1984). For example, fluctuations in the annual monsoon cycle in the Indian Ocean and western Pacific Ocean regions are strongly linked with El Niño occurrences. Apparent connections have also been reported to rainfall patterns in such widely-separated regions as northeastern Brazil, southern Africa, central North America and Russia (Glantz et al., 1987). At the time of preparation of this document, the global system has been undergoing an El Niño episode of substantial intensity (see "Pelagic catches off western South America" box). This event will undoubtedly affect both the landings and the population dynamics of important fish populations in many regions of the world.

Another major recent event has been the volcanic eruption of Mount Pinatubo in the Philippines in June of 1991. Aerosols in the earth's stratosphere due to this eruption appear to have led to a recent global average cooling of 0.5°C, which is equivalent to the average global warming occurring over the past century. The amount of direct solar radiation reaching the earth's surface may have declined by as much as 20-30% since the eruption. These effects are expected to persist for several years (Anon., 1992).

Many of the world's commercial fish populations are dependent on estuarine environments at some stage in their life cycles. Of those that are not, many inhabit the large areas of the world's continental shelves which are affected by freshwater inflows. As noted, these inflows tend to spread along shore, rather than dispersing in the open ocean. In such areas, the processes of nutrient enrichment, larvae transport and retention, frontal formation, dispersion and concentration of larvae and larval food, to which life-cycles are adapted, all tend to be dependent on freshwater-seawater interactions. In the second half of the 20th century, global water use has been rising by 4-8% annually (IPCC, 1990). It is continuing to grow in the developing world, while it is stabilizing in industrial countries, withdrawals are nearly equal to locally generated runoff, and water quality has deteriorated markedly.

Moreover, major alteration of sediment loading in freshwater runoff is occurring. Roughly 30% of the world's freshwater outflow is contributed by the Amazon River system. However, Milliman (1981) has estimated that of the roughly 8 thousand million t of sediment carried to the sea by the world's 40 largest rivers, nearly 50% comes from the long-ago deforested Hwang-Ho and Ganges/Brahmaputra systems which together contribute only about 6% of the total freshwater outflow; a additional 24% of the total sediment discharge comes from four other major rivers draining the Indo-Asian landmass where population densities are high. Rapid development and deforestation of African and South American watersheds are leading to massive increases in river sediment burdens in these regions. Corresponding effects on anadromous, estuarine-dependent, and coastal species may be expected.

Global Climate Change

The same factors of human population growth, intensive agriculture, industrial development, and deforestation that affect freshwater, estuarine and near-shore ecosystems, also act to change the basic climatic context in which these processes operate. Recent decades have seen a continuing accumulation of carbon dioxide and other "greenhouse" gases in the earth's atmosphere, leading to predictions of global climate changes (Ramanathan, 1988). Although there is controversy as to the precise nature of these changes, the bulk of current scientific opinion is that substantial climate changes are likely to occur over a relatively brief time scale (i.e., decades). The effects on marine ecosystems and organisms would go beyond mere temperature change. Fish typically have complex life cycles in which certain stages are at the mercy of dynamic processes acting within the ocean-atmosphere system, which are ultimately driven by the pattern of global heating. This is the very thing that is altered by accumulation of atmospheric greenhouse gases.

The Intergovernmental Panel on Climate Change (IPCC) has assembled the best available consensus of views of the scientific community on the probable magnitudes of the expected changes (IPCC, 1990). These include an effective doubling of carbon dioxide in the atmosphere between now and 2025 to 2050 (for a "business as usual" scenario), with an increase of global mean temperature in the range of 1.5°C to 4.5°C. The direct impacts on the marine system would include a sea-level rise of about 20 cm by 2030 and about 65 cm by 2100 with an average rise in the temperature of the surface layer of between 0.2° and 2.5°C. Despite recent international agreements to limit production of ozone-destructive gases, depletion of the earth's protective layer of stratospheric ozone is expected to continue unabated at least through the 1990s.

The potential consequences to marine ecosystems, and to fish populations, are many and varied. Temperature has pronounced physiological effects on organisms, directly controlling physiological rates of cold-blooded organisms. Areas of temperature conditions appropriate for particular species will probably be altered substantially. Because the changes would be unprecedentedly rapid, biological adaptations to the new conditions would lag. Thus fish populations may lose access to ocean structures and interfaces vital to their reproductive strategies. Migratory navigation may be dependent on ocean temperature gradients and isotherm positions, and hence finely tuned migratory behaviours may be disrupted. There may be changes in overlaps among various predator and prey species, altering the viability of certain populations within them. One concrete effect, which is evident in response to normal climatic variation, is the latitudinal movement of the centre of stock distributions in relation to maritime boundaries: this effect, which has already been detected in some areas (e.g., the pelagic stocks in the Southeast Pacific), could be accentuated by climate change, and lead to de facto changes in allocation of fishery resources between adjacent coastal states.

Variations in wind conditions are among the most important environmental factors affecting reproduction of many fish species. One likely "greenhouse effect" is increased contrast in temperature between heated land masses and the oceans during the warmer seasons. This would amplify sea breezes and alongshore winds, enhance wind-driven offshore transport in the surface layer, and intensify upwelling and turbulence in coastal regions (Bakun, 1990). On the other hand, greenhouse effects will tend to lessen the tropical-polar gradient in global heating.

The potential effects of climate change on freshwater runoff are uncertain, but it appears that many land areas would experience increases in precipitation, while others may experience decreases. The IPCC Report (IPCC, 1990) estimates that in some limited areas, as much as a 40% to 70% reduction in annual runoff could occur. Increased winter temperatures will have important ramifications on seasonal runoff patterns. Marine ecosystems associated with mountainous drainage basins will likely be particularly severely impacted.

Sea level rise would flood shallow water habitat and nursery grounds. Inundation and erosion of coastlands could lead to increased marine ecosystem productivity, but also to eutrophication and pollution of marine habitats. Sea level is already rising at over one centimetre per decade (with regional variations due to local geological movements). Too rapid a rise due to climate change might drown coral reefs and reduce fishery production and biological diversity. In addition, the fishing sectors of low lying countries would suffer economic distress and dislocation caused by loss of coastal property and facilities by coastal flooding and erosion.

Reductions in the earth's ozone shield may affect both the health of fishermen and others involved in exposed outdoor activities and the resources on which their livelihood depends. The increased cell damage that affects all organisms exposed to increased ultraviolet radiation affects the viability of fish larvae, which are often concentrated very near the sea surface.

As the above patterns become apparent, it will be important to have already begun assembling the necessary information to correlate these to patterns of response of fishery resources. This requires collecting and assembling data in ways that will allow definition of sub-regional and inter-regional patterns of response, in a period of unprecedentedly rapid global environmental change.

LIST OF ACRONYMS

ACFM	Advisory Committee on Fisheries Management
ASEAN	Association of Southeast Asian Nations
BOBP	Bay of Bengal Project
CAFSAC	Canadian Atlantic Fisheries Scientific Advisory Commttee
CCAMLR	Convention for Conservation of Antarctic Marine Living Resources
CDQ	Community development quotas
CECAF	Commission for the Eastern Central Atlantic Fisheries
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora (IUCN)
COFI	Committee on Fisheries
CPPS	Permanent Commission for the Southeast Pacific
DANIDA	Danish International Development Agency
EEZ	Exclusive economic zone
FAD	Fish aggregating devices
FAO	Food and Agriculture Organization of the United Nations
FFA	Fisheries Forum Agency
GFCM	General Fisheries Council for the Mediterranean
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICJ	International Court of Justice
ICLARM	International Center for Living Aquatic Resources Management
ICNAF	International Commission for the Northwest Atlantic Fisheries
ICSEAF	International Commission for the Southeast Atlantic Fisheries
INPFC	International North Pacific Fisheries Commission
IOFC	Indian Ocean Fisheries Commission
IPCC	Intergovernmental Panel on Climate Change
IPFC	Indo-Pacific Fisheries Commission
IPHC	International Pacific Halibut Commission
ISSCAAP	International Standard Statistical Classification of Aquatic Animals and Plants
ITQ	Individual transferable quotas
IVQ	Individual vessel quotas
IWC	International Whaling Commission
MAP	Marine Mammal Action Plan
MSY	Maximum sustainable yield
NAFO	Northwest Atlantic Fisheries Organization
NASCO	North Atlantic Salmon Conservation Organization
NORAD	Norwegian Agency for Development Cooperation
ODA	Overseas Development Administration
OLDEPESCA	Organización Latinoamericana para el Desarrollo de la Pesca
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer
PCC	Programme and Coordinating Committee of the FAO/UNDP
PICES	North Pacific Marine Science Organization
SCORRAD	Standing Committee on Resources Research and Development
SEAFDEC	Southeast Asian Fisheries Development Center

SIDA	Swedish International Development Agency
SOFA	State of Food and Agriculture (FAO)
SPC	South Pacific Commission
TAC	Total allowable catch
TUNET	A network of ten Working Groups
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
Unesco	United Nations Educational Scientific and Cultural Organization
WECAFC	Western Central Atlantic Fisheries Commission
WHO	World Health Organization

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C. MARINE RESOURCE TABLES

Notes for all tables

Source of information for all tables: 1970-1990 Yearbooks of Fishery statistics (Catches and landings), FAO, Rome

Additional sources of information by individual area:

Eastern Central Atlantic (Area 34)

1970-1989: CECAF Statistical Bulletins
1990: Provisional FISHDAB (Fishery Data Base, Rome)

Mediterranean and Black Sea (Area 37)

1970-1989: GFCM Statistical Bulletins

Southeast Atlantic (Area 47)

1975-1988: ICSEAF Bulletins
1989: Questionnaires supplied by member countries

Main fishing countries: The main fishing countries are listed in ranking order by catch size

Country descriptions: The former USSR is listed as USSR in the tables since the reorganization of the States had not occurred by 1990

Catches and landings: All catches and landings are expressed in metric tons and are rounded to the nearest thousand tons

State of exploitation: The state of exploitation is for the latest information available and noted by the following abbreviations:

?	=	Unknown/uncertain
U	=	Under-exploited
M	=	Moderately exploited
F	=	Fully/heavily exploited
O	=	Over-exploited
D	=	Depleted
R	=	Recovering

NOTE TO READERS: If you have information that you believe will contribute to improving the accuracy of future revisions of this document, you are kindly requested to entitle it "C710 revision" and send it to The Chief, Marine Resources Service, FAO, Via delle Terme di Caracalla, 00100 Rome

Table 5

Northwest Atlantic (Area 21)

Stock a/	Main fishing countries (1990)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
Atlantic cod	Canada,Greenland,USA, Portugal,Spain,Germany	972	538	654	640	667	601	626	630	543	F-O
Red hake	USA, Portugal	45	15	3	2	2	3	2	2	2	D
Haddock	Canada, USA	34	42	67	50	55	35	35	30	25	D
Saithe (Pollock)	Canada, USA	34	43	54	66	78	75	62	58	50	F
Silver hake	USSR, USA, Cuba	270	136	71	99	103	78	91	106	91	U
Roundnose grenadier	Germany, USSR, Portugal	42	24	5	5	7	8	6	5	4	M
Atlantic redfish	Canada, USSR, Portugal	267	165	123	128	166	209	148	162	180	F-O
Flatfishes	Canada, USA, Spain	284	238	212	205	217	220	182	163	159	F-D
Other groundfish	USA,Canada,USSR,Spain	137	118	94	97	111	122	96	90	118	
Capelin	Canada, USSR	130	217	42	54	84	66	110	118	184	R
Atlantic herring	Canada, USA	612	320	199	220	223	287	284	275	314	R
Atlantic menhaden	USA	273	267	313	312	222	297	327	326	395	F
Atlantic mackerel	USA, Canada, Germany, USSR, Bulgaria, Poland	355	133	29	55	64	74	79	74	65	U
Other fish	USA, Canada, USSR	140	92	59	69	57	80	54	62	63	
Total fishes		3595	2348	1925	2002	2056	2155	2102	2101	2193	

Table 5 (continued)

Stock a/	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Crabs	USA, Canada	46	50	95	99	94	80	87	85	90	F
American lobster	Canada, USA	30	33	43	54	59	60	63	67	74	F
Northern prawn	Greenland	12	42	46	56	65	71	76	83	89	F
Other shrimp	Canada	13	8	11	14	15	18	19	20	23	F
Total crustaceans		101	133	195	223	233	229	245	255	276	
Amer. cupped oyster	USA, Canada	173	146	118	53	72	59	38	34	28	
Cupped oyster	USA	0	0	0	0	0	0	1	1	11	
Scallops	USA, Canada	73	182	152	108	129	190	191	205	219	F
Clams (quahogs, soft shell)	USA, Canada	231	232	325	435	418	395	382	414	420	F
Squids	USA	45	117	58	23	23	24	2	37	39	
Other molluscs		5	8	16	25	31	28	42	34	27	
Total molluscs		527	685	669	644	673	696	676	725	744	
Others		1	1	1	1	1	1	3	5	7	
Total area		4224	3167	2790	2870	2964	3081	3026	3086	3221	

a/ Part of stock occupies Western Central Atlantic (Area 31).

Management measures. All important stocks in Canadian, NAFO (Northern Atlantic Fisheries Organization) and northern areas are covered by catch quotas. These quotas are set by coastal states (Canada and EEC) for waters within 200 miles and by NAFO for waters beyond national jurisdiction. In addition to quotas, there are controls on effort, gear, area and season.

Table 6

Northeast Atlantic (Area 27)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Freshwater and diadromous	Norway, UK, UK Scotland, Finland	56	49	66	85	110	124	172	228	279	?
Plaice	Netherlands,Denmark, UK England Wales	184	167	147	203	182	185	192	192	205	F
Common sole	Netherlands, France, Belgium	31	23	29	34	28	30	28	29	32	F
Other flatfish	Iceland, Norway, Spain, France	159	127	147	143	140	157	171	180	155	F
Tusk	Norway, Faeroe Is.	32	34	42	44	44	41	34	43	40	?
Atlantic cod	Iceland, Norway, Denmark, USSR	1831	1714	1527	1314	1368	1468	1330	1145	956	O
Ling	France, Norway, Iceland, Spain	68	73	84	87	85	87	81	82	74	?
Haddock	Iceland,UK Scotland, Norway, Faeroe Is.	601	385	312	327	364	363	303	239	183	O
Saithe (Pollock)	Norway, Iceland, Faeroe Is., France	646	537	439	439	388	409	390	379	378	F
Polar cod	USSR	193	18	29	11	1	0	0	0	0	?
Norway pout	Norway, Denmark, [illegible]	523	541	500	391	285	339	277	352	296	M-F

Table 6 (continued)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Blue whiting (Poutassou)	Norway, USSR, Denmark, Faeroe Is.	41	410	729	651	804	693	661	651	566	M-F
Whiting	UK Scotland, France, UK England Wales	204	220	178	134	113	118	119	94	91	F
European hake	Spain, France, Portugal, Denmark	97	76	66	77	72	72	72	67	68	F
Other gadoids	France, Spain, USSR	42	52	53	45	67	55	53	47	45	?
Sandeels	Denmark, Norway, UK Scotland	358	643	681	657	973	857	1042	1134	753	F
Atlantic redfishes	Iceland, Norway, USSR	155	312	292	271	253	209	222	175	192	F
Monk (Angler fish)	France, Spain, UK Scotland	35	37	53	60	52	54	55	54	53	?
Other demersal fish	Denmark,France,Ice-land,Norway,Faeroe I	145	155	119	118	144	194	200	191	153	?
Capelin	Iceland, Norway, Faeroe Is.	1658	2921	2426	2132	1292	1022	1031	777	797	F
Atlantic horse mackerel	Norway, Denmark, Netherlands, Spain	279	234	169	206	229	261	357	384	405	M
Atlantic herring	Norway, Sweden, Denmark, USSR, UK Scotland,Netherlands Iceland, Finland	1373	784	849	1294	1307	1305	1401	1356	1225	M-D

Table 6 (continued)

Stock	Main fishing countries (1990)	1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
European sardine (pilchard)	Portugal, Spain	161	164	217	220	199	182	175	173	177	F
Sprat	Denmark, USSR, Poland	402	748	426	212	200	246	255	209	190	M
European anchovy	Spain, France	35	47	17	13	11	18	17	17	17	F
Atlantic mackerel	UK Scotland, Norway, Ireland, Netherlands	482	724	589	536	537	616	622	511	585	F
Tunas	Spain, Portugal	53	49	46	44	53	59	62	48	50	F
Other pelagic fish	Spain, Portugal	44	53	26	66	52	39	50	52	58	?
Sharks	France, Norway, UK Scotland	71	64	56	68	65	70	65	61	66	?
Skates	France, UK England Wales, UK Scotland	31	27	27	23	25	30	28	26	23	Some species: D Others: M
Other fish	Portugal, France, USSR, Norway	225	183	171	92	63	30	54	38	40	?
Total fishes		10215	11571	10512	9997	9506	9333	9519	8934	8152	
Crabs	France, UK England Wales	25	33	35	38	34	38	36	33	34	?
Norway lobster	UK Scotland, France	36	40	46	55	51	54	54	49	48	F
Northern prawn	Norway, Iceland	21	33	85	172	127	115	112	113	133	F

Table 6 (continued)

Stock	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
Common shrimp + Crangon	Netherlands, Germany	40	38	46	20	20	21	20	24	16	F
Other crustaceans	France, Spain	16	8	6	12	7	7	9	8	7	?
Total crustaceans		138	152	218	297	239	235	231	227	238	
Oysters	France, Spain	70	99	103	142	146	135	135	144	149	F
Blue mussel	Spain, Netherlands, Denmark, France	293	328	479	538	532	534	494	472	463	F
Scallops	Iceland,UK Scotland, Faeroe Is.	41	44	49	50	61	89	64	48	55	F
Common cockle	UK England Wales, France, Germany	30	28	17	12	26	50	34	28	33	M
Cephalopods	France,Spain,Portugal	36	25	39	38	26	44	42	49	54	U
Other molluscs	France,Portugal,Spain	41	32	27	21	30	37	50	45	38	?
Total molluscs		511	556	714	801	821	889	819	786	792	
Others a/		4	2	0	0	0	0	0	0	0	
Total area		10868	12281	11444	11095	10566	10457	10569	9947	9182	

a/ Including starfish, purple sea urchin and aquatic invertebrates n.e.i.

Management measures. The management regime of this region is in a period of transition, with the establishment of entalled jurisdiction by the coastal state, and the slow development of a common fishery policy by the EEC. A variety of measures, principally catch quotas, and controls on mesh sizes and sizes of fish have been set.

Table 7

Western Central Atlantic (Area 31)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Freshwater and diadromous fishes	Venezuela	10	7	10	16	11	13	11	8	8	F
Snappers	Venezuela, Mexico, Cuba, USA	21	19	22	22	24	26	23	23	36	M-F
Groupers	Mexico,Venezuela,USA	24	21	26	22	22	24	26	27	30	
Grunts	Venezuela, Cuba	29	23	8	9	9	9	7	8	8	O
Sciaenids	Venezuela,USA,Mexico	37	39	31	30	31	29	28	29	28	
Sharks and Rays	Mexico,Venezuela,USA	9	12	21	25	24	24	30	32	29	M
Other demersal fishes	Mexico, Venezuela USA, Dominican Rep.	36	38	51	32	28	33	34	37	36	O
Mullets	USA,Mexico,Venezuela	27	23	31	24	27	31	31	34	35	? a/
Atlantic menhaden	USA	51	80	83	47	34	26	34	31	34	F
Gulf menhaden	USA	571	636	803	884	829	907	639	583	520	F
Round sardinella	Venezuela	44	40	50	59	84	87	62	72	59	M
Other clupeoids	USA, Cuba	20	15	11	10	6	5	6	9	9	M
King and Spanish mackerels	Mexico, USA, Venezuela	21	22	23	20	20	21	19	21	22	M-F
Other tunas	Venezuela, USA	32	35	58	74	56	42	48	56	43	M

Table 7 (continued)

Stock	Main fishing countries (1990)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
Other pelagic fish	Venezuela, USA, Mexico, Barbados	22	25	27	25	24	25	33	29	37	M
Unidentified fishes	Mexico, USA, Guyana, Cuba	129	157	244	269	279	259	254	255	300	
Total fishes		1083	1192	1499	1568	1508	1561	1285	1254	1234	
Crabs	USA, Mexico	35	41	49	51	51	56	65	55	48	U
Spiny lobsters	Cuba, Bahamas	20	22	24	30	28	26	25	26	22	F-O
Shrimps	USA, Mexico	170	166	171	183	201	180	165	174	180	
Other crustaceans	St Kitts and Nevis, Virgin Is. Br.	1	1	0	1	1	2	1	1	1	
Total crustaceans		226	230	244	265	281	264	256	256	251	
Oysters	USA, Mexico	161	172	206	223	186	173	158	152	127	Culture potential
Cephalopods	Mexico, Venezuela	5	7	10	10	13	12	12	18	19	U
Calico scallop	USA	9	14	150	126	17	85	122	68	11	M-F
Other molluscs	Venezuela, USA	17	33	38	54	41	49	44	56	54	U
Total molluscs		192	226	404	413	257	319	336	294	211	
Others		1	1	1	2	1	1	1	1	1	
Total area		1502	1649	2148	2248	2047	2145	1878	1805	1697	

a/ Probably moderately to heavily fished if the discards by shrimp trawlers are taken into account.

Table 8

Eastern Central Atlantic (CECAF - Area 34)

CECAF Sub-areas	Stock	Main fishing countries (1989)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990a/	State of exploitation
NORTH												
All sub-areas	Cephalopods	Korea Rep., Spain	173	146	133	96	122	86	108	123		O
34.1.1+34.1.3	Octopus	Morocco, Spain	94	79	79	57	64	45	61	62		O
34.1.3+34.3.1	Cuttlefish	Spain, Senegal Korea Rep, Italy	30	25	24	16	22	15	17	18		O
34.1.1+34.1.3	Squids	Morocco	14	16	10	2	2	6	9	6		O
34.1.1+34.1.3	European pilchard	USSR, Morocco, Romania, Spain	392	630	484	299	316	633	769	972		F
34.1.3+34.3.1	Sardinellas	USSR, Senegal, Guinea, Romania	162	173	155	134	125	271	293	311		F-O
34.3.1	Bonga	Senegal, Gambia	27	17	16	12	16	7	15	24		?
34.1.3+34.3.1	Horse mackerels	USSR, Germany, Senegal	299	313	290	45	58	329	310	263		F highly variable
34.1.3+34.3.1	Mackerels	USSR, Romania	87	81	82	6	12	86	278	262		F highly variable
34.1.1	Hakes	Morocco, Spain	10	20	6	7	6	7	6	7		O
34.1.3+34.3.1	Hakes	USSR, Italy	52	39	22	2	3	7	7	8		O-?

Table 8 (continued)

CECAF Sub-areas	Stock	Main fishing countries (1989)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990a/	State of exploitation
			Catches ('000t)									
34.1.3+34.3.1	Sea breams	Senegal, USSR Mauritania	98	53	33	26	25	39	30	31		O
Others			869	611	486	337	564	444	508	516		
Total North			2307	2203	1820	1039	1127	1975	2411	2603		
SOUTH												
34.3.3+34.3.4+ 34.3.5+34.3.6	All prawns and shrimps	Cameroon, Gabon, Nigeria	4	11	20	19	19	21	22	25		F
All sub-areas	Demersal		155	181	173	126	142	158	112	127		F
34.3.4	Sardinellas	Ghana, Côte d'Ivoire	57	55	66	136	112	113	110	104		F-O-R
34.3.6	Sardinellas	Congo, Zaire	6	6	11	11	12	12	15	13		M
All sub-areas	Bonga	Nigeria, Sierra Leone, Cameroon, Côte d'Ivoire	46	51	86	95	84	101	100	107		F Côte d'Ivoire: D
Others			273	291	253	205	268	386	360	328		
Total South			541	595	609	592	637	791	719	704		

Table 8 (continued)

CECAF Sub-areas	Stock	Main fishing countries (1989)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990a/	State of exploitation
OCEANIC												
34.1.2+34.2.0+ 34.3.2+34.4.1+ 34.4.2			56	62	119	14	8	10	10	8		?
TUNA												
34.0 b/		Spain,France, Ghana,Japan	204	258	306	268	251	264	287	288		M-F
UNKNOWN AREA												
34.9.0				120	186	923	995	145	102	94		
Total CECAF Area				3238	3040	2836	3018	3185	3529	3697	4098	

a/ Breakdown by sub-areas for 1990 not yet avalaible.

b/ Catches in whole areas; see also Table 21.

Table 9

Mediterranean and Black Sea (Area 37)

Sector a/	Species groups	Coastal countries	Remarks	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990 b/
Balearic	Demersal	Algeria	Trawl only	26.9	37.0	43.5	44.2	34.7	34.8	24.0	34.8	
37.1.1	Coastal pel.	Morocco		93.2	132.4	154.2	146.1	158.6	156.6	173.9	171.6	
	Miscel. c/	Spain		10.2	22.7	29.0	22.7	21.9	14.9	18.0	17.4	
Gulf of Lions	Demersal		Finfish	4.1	7.2	8.9	5.5	5.9	12.2	9.2	8.8	
37.1.2	Coastal pel.	France	Sardine	19.7	18.5	25.5	23.9	21.3	43.5	34.7	35.5	
	Miscel. c/			9.4	4.8	2.2	2.7	2.5	6.0	8.3	8.0	
Sardinia	Demersal	France	Trawl only	33.3	22.8	23.5	31.2	29.2	32.9	31.0	22.0	
37.1.3	Coastal pel.	Italy		58.8	39.1	36.9	35.8	36.3	29.9	21.4	18.1	
	Miscel. c/	Tunisia		15.1	12.4	13.1	16.4	15.1	15.8	13.9	10.8	
Adriatic	Demersal	Italy	Trawl only	18.2	19.6	18.7	16.2	18.6	20.6	19.0	15.8	
37.2.1	Coastal pel.	Yugoslavia		80.2	91.7	122.4	119.8	91.7	92.4	80.3	84.3	
	Miscel c/			30.6	37.2	33.6	24.2	30.3	14.0	13.1	10.8	
Ionian	Demersal	Albania	Trawl only	30.8	42.2	49.7	87.9	74.3	66.2	70.2	67.8	
37.2.2	Coastal pel.	Italy,Libya		32.2	43.8	51.3	61.2	65.9	62.4	62.4	59.0	
	Miscel. c/	Malta,Tunisia		16.3	37.2	41.2	38.0	40.3	38.4	37.4	42.2	
Aegean	Demersal			16.3	22.2	26.9	32.3	39.0	38.8	47.1	55.0	
37.3.1	Coastal pel.	Greece		23.2	35.8	46.4	61.5	58.7	65.0	104.4	96.9	
	Miscel. c/	Turkey		7.5	10.2	9.2	7.7	8.2	8.1	10.9	11.0	
Levant	Demersal	Cyprus,Egypt	Finfish	9.7	12.0	13.2	12.1	14.1	15.4	20.1	23.3	
37.3.2	Coastal pel.	Israel,Lebanon		9.1	9.0	13.8	15.7	18.8	17.3	19.6	19.6	
	Miscel. c/	Syria,Turkey		4.1	3.1	3.7	6.0	5.3	18.7	15.8	12.7	
Whole	Demersal			139.3	163.0	184.4	229.4	215.8	220.8	220.6	227.5	
Mediterranean	Coastal pel.			316.4	370.3	450.5	464.0	451.3	467.1	496.7	485.0	
	Miscel. c/			93.2	127.6	132.0	117.7	123.6	116.0	117.4	112.9	
Total Mediterranean				548.9	660.9	766.9	811.1	790.7	803.9	834.7	825.4	

Table 9 (continued)

Sector a/	Species groups	Coastal countries	Remarks	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990 b/
				Catches ('000t)								
Black Sea 37.4	Demersal	Bulgaria, Romania		24.4	31.8	42.3	49.9	48.6	57.6	51.3	43.6	
	Coastal pel.	Turkey		293.9	369.0	682.8	655.1	740.3	628.5	735.9	398.0	
	Miscel. c/	USSR		98.6	73.1	99.2	135.9	104.9	105.3	46.2	47.1	
Total Black Sea				416.9	473.9	824.3	840.9	893.8	791.4	833.4	488.7	
Whole area 37.0	Tunas			22.9	30.1	54.2	62.3	55.4	59.0	69.9	51.8	
Whole area 37.0	Others d/			125.8	165.7	229.7	261.1	278.7	303.2	337.7	344.4	
Totals	Demersal			163.7	194.8	226.7	279.3	264.4	278.4	271.9	271.1	
	Coastal pel.			610.3	739.3	1133.3	1119.1	1191.6	1095.6	1232.6	883.0	
	Miscel. c/			191.8	200.7	231.2	253.6	228.5	221.3	163.6	160.0	
	Tunas			22.9	30.1	54.2	62.3	55.4	59.0	69.9	51.8	
	Others d/			125.8	165.7	229.7	261.1	278.7	303.2	337.7	344.4	
Total area				1114.5	1330.6	1875.1	1975.4	2018.6	1957.5	2075.7	1710.3	1489.0

a/ GFCM statistical divisions (boundaries given in GFCM Statistical Bulletins).

b/ Breakdown by sub-areas not available.

c/ Miscellaneous: diadromous, marine fishes n.e.i.

d/ Others: crustaceans, molluscs, other aquatic animals.

Table 10

Southwest Atlantic (Area 41)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Argentine hake	Argentina, Uruguay, Spain, Japan, Brazil	144	318	329	376	381	439	434	398	421	F
Southern blue whiting	USSR, Poland	0	11	131	95	104	85	101	132	194	U-M
Atlantic croaker	Brazil, Uruguay, Argentina	54	84	80	57	70	71	67	61	55	M-F
Weakfishes	Brazil, Argentina, Uruguay	40	56	77	69	66	60	58	56	50	M-F
Sardinella	Brazil	174	136	127	124	126	91	65	78	32	O
Anchoita	Argentina	28	20	18	12	16	20	21	21	14	U
Red shrimp	Argentina	0	0	11	10	7	3	18	12	10	F-O
Other prawns and shrimps	Brazil	48	54	52	69	57	57	49	50	51	F-O
Squids and octopuses	Korea Rep., USSR, Japan, Taiwan (Prov. of China), Spain	4	44	150	270	354	744	656	751	552	Patagonian shelf: F-O Elsewhere: U
Other demersal Patagonian shelf	Argentina, USSR, Poland	2	11	24	44	74	96	125	77	70	M
Others		324	333	360	575	592	701	698	619	580	
Total area		818	1067	1359	1701	1847	2367	2292	2255	2029	

Table 11

Southeast Atlantic (Area 47)

Species	Stocks ICSEAF divisions	Main fishing countries (1989)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990 a/	State of exploitation
Hakes	1.3+1.4	USSR, Spain	414	280	162	212	231	136	212	137		O
	1.5	Spain, USSR, S. Africa	231	162	116	173	150	163	97	174		O
	1.6	S. Africa	164	106	89	100	109	104	90	83		O-R
	2.1+2.2	S. Africa	55	53	43	56	51	41	45	52		R
Kingklip	All sub-areas	S. Africa, Spain, Japan, USSR	12	10	8	16	17	14	9	8		O
Large-eyed dentex	1.3+1.4	Bulgaria	15	23	6	1	1	0	1	1		D: mid 1970s R: no sign
Panga	1.6+2.1+2.2	Japan,S.Africa	8	6	2	2	2	2	2	2		F
Sardinella	1.1+1.2+1.3	USSR, Angola	92	125	205	211	165	108	133	106		M
Cunene horse mackerel	1.1+1.2	USSR, Angola		31	45	28	53	54	39	63		
	1.3	USSR, Angola	159	190	60	28	55	51	91	96		F-O
Cape horse mackerel	1.3+1.4+1.5	USSR, Romania, Bulgaria, S. Africa, Germany, Spain	161	386	283	428	448	518	539	440		M-F
	1.6+2.1+2.2	S.Africa,Japan	32	52	17	27	32	39	41	59		M-F

Table 11 (continued)

Species	Stocks ICSEAF divisions	Main fishing countries (1989)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990 a/	State of exploitation
Pilchard	1.3+1.4+1.5	S. Africa	462	279	47	57	53	67	66	79		D
	1.6	S. Africa	68	85	44	33	36	41	42	35		D
Anchovy	1.3+1.4+1.5	S. Africa	211	212	190	52	16	376	118	158		F-O
	1.6	S. Africa	233	244	315	273	300	593	565	294		F
Chub mackerel	1.1+1.2+1.3+ 1.4+1.5	USSR, Spain S. Africa	3	77	33	28	28	31	11	12		F
	1.6+2.1+2.2	S.Africa	58	2	3	4	3	5	8	17		F-D
Others			377	455	615	375	375	386	391	442		
Total area			2755	2778	2283	2104	2125	2729	2500	2258	1530	

a/ 1990 species breakdown not available.

Table 12

Western Indian Ocean (Area 51)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Shad (Hilsa)	Pakistan	11	9	4	2	2	2	2	1	1	
Giant sea perch	Pakistan	1	1	1	2	1	1	1	0	0	
Flat fishes	India	12	10	14	9	15	12	8	21	17	
Bombay duck	India	94	122	100	104	95	88	98	116	124	
Sea catfishes	India, Pakistan	60	58	52	33	45	45	57	48	49	
Lizard fishes	India, Egypt	2	8	9	6	6	8	7	10	10	
Pike congers	India, Pakistan	9	17	11	11	10	7	6	7	9	
Groupers	UAE, Saudi Arabia, Pakistan, Oman	4	4	12	19	20	20	25	22	23	M-F
False trevally	India	5	3	6	4	5	3	5	6	8	
Snappers	UAE, Saudi Arabia	4	5	7	8	9	10	10	10	10	
Ponyfishes	India	16	7	14	12	18	10	6	11	11	
Grunts	Pakistan	3	4	4	8	8	7	10	7	7	
Emperors (Lethrinids)	UAE, Tanzania, Saudi Arabia, Mauritius	6	12	18	27	34	34	42	38	38	
Croakers, drums	India, Pakistan	39	101	111	146	150	152	151	199	226	
Goatfishes	India	3	5	9	19	12	9	22	20	19	
Porgies, seabreams	Oman, Pakistan, Korea Rep.	8	10	14	15	17	21	21	15	14	
Threadfins	Oman, Yemen, Tanzania	1	1	1	2	3	2	2	2	3	
Other identified demersal percom.	India, Tanzania, UAE, Italy	14	26	26	20	28	31	44	43	43	
Demersal percom. n.e.i.	Oman, Egypt, Sri Lanka	32	44	51	39	36	20	18	31	33	
Black pomfret	Pakistan	4	5	3	4	4	1	1	1	1	
Butter fishes	India, Pakistan	23	28	36	28	23	25	29	31	14	
Carangids	India, Pakistan, UAE, Sri Lanka, Egypt	28	53	59	65	73	80	88	161	171	
Sardinellas	India, Pakistan, UAE	163	237	266	253	242	213	237	286	314	
Anchovies	India, Pakistan	31	40	53	48	40	34	55	56	94	U-M

Table 12 (continued)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Wolfherrings	India, Pakistan	7	11	16	19	12	12	12	17	24	
Mixed clupeoids	Pakistan, India, Sri Lanka	70	60	100	74	79	110	130	125	132	
Other identified pelagic percom.	India, Sri Lanka, Oman, Pakistan,	22	29	41	41	42	46	64	70	50	
Pelagic percom. n.e.i.	Yemen, Oman	188	143	115	86	79	88	85	77	85	
Seerfishes (kingfish)	India, Oman, Pakistan, UAE	22	27	44	76	72	82	77	66	61	
Skipjack	Maldives, Spain, France, Sri Lanka	35	28	51	125	137	156	191	219	201	
Yellowfin	Spain, France, Oman, Taiwan (P. China), Panama	25	28	45	89	107	115	166	136	162	
Longtail tuna	Iran, Oman, Pakistan	12	14	12	37	31	37	40	36	36	
Kawakawa	India, UAE, Maldives	2	3	15	26	25	20	30	17	17	
Big-eye	Taiwan (P. China), Korea R., Japan, France	12	20	24	31	35	37	40	33	33	
Albacore	Taiwan (P. China)	8	8	10	7	8	9	11	6	8	
Southern bluefin	Japan	5	3	5	3	2	2	3	3	1	
Billfishes	Sri Lanka, Korea, Oman	4	4	5	10	11	12	12	12	10	
Other tuna	Pakistan, India, Madagascar, USSR	24	26	25	20	32	45	36	50	58	
Hairtails	India	21	37	38	66	56	56	43	40	41	
Indian mackerel (Rastrelliger)	India	113	66	49	99	75	77	75	163	124	
Sharks, rays	Pakistan, India, Sri Lanka	101	107	97	86	89	92	96	96	96	
Other fish	India, Iran, Pakistan, Madagascar, Sri Lanka	250	343	349	565	587	606	621	761	668	
Total fishes		1494	1767	1922	2344	2375	2437	2677	3069	3046	

Table 12 (continued)

Stock	Main fishing countries (1990)	1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Crabs	Madagascar, Bahrain, Pakistan	0	1	2	2	2	2	2	3	3	
Lobsters	Yemen,Oman,Madagascar	4	5	3	5	5	5	5	5	6	
Shrimps	India,Pakistan,Iran, Madagascar,Mozambique	200	225	222	259	239	231	245	239	258	F-O
Other crustaceans	India, Sri Lanka	8	16	21	11	10	11	11	14	12	
Total crustaceans		212	247	248	277	256	249	263	261	279	
Cuttlefishes	Taiwan (P. China), Yemen, Korea R., Oman	10	13	7	8	8	5	4	6	10	
Other cephalop. and bivalves	India, Iran, Taiwan (P. China)	3	9	13	21	19	31	38	41	39	
Total molluscs		13	22	20	29	27	36	42	47	49	
Others		0	0	0	0	1	0	1	1	1	
Total area		1719	2036	2190	2651	2659	2722	2983	3378	3375	

Table 13

Eastern Indian Ocean (Area 57)

Stock	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990
Toli shad	Bangladesh	0	0	11	72	84	104	106	111	112
Giant seaperch	Indonesia	1	1	2	4	5	6	6	7	7
Flatfishes	India	2	2	3	4	5	5	4	9	6
Sea catfishes	India	17	20	29	31	40	34	33	45	45
Lizard fish	India, Malaysia	2	5	6	6	6	6	4	6	5
False trevally	India	3	4	4	2	2	3	3	3	2
Sillago-whitings	Australia	1	2	3	3	4	5	5	5	6
Ruffs	Australia	5	4	4	6	9	11	12	10	13
Snappers	Indonesia	2	4	6	7	7	9	9	12	14
Threadfin breams	Malaysia,Thailand,Indonesia	1	5	10	7	10	11	9	10	10
Ponyfishes	India, Indonesia	28	34	40	35	32	38	39	45	50
Croakers	India, Malaysia	21	29	40	42	51	53	55	51	44
Goatfishes	India	2	4	5	5	9	9	3	10	15
Halfbeaks,needlefish	India, Indonesia, Australia	1	9	8	10	11	15	14	7	8
Barracudas	India, Indonesia	2	3	6	7	7	8	9	9	10
Threadfins	India, Indonesia	4	11	8	7	9	10	11	13	12
Carangids	Indonesia, India, Thailand	15	26	60	78	81	91	115	94	93
Butterfishes	India	6	8	14	11	15	22	10	12	15
Sardinella, sardines	India, Thailand, Indonesia	4	66	89	95	115	135	98	101	103
Anchovies	India	15	24	36	24	28	26	17	15	17
Wolfherrings	India	5	8	11	16	21	17	16	17	16
Other Clupeoids	Indonesia,Australia,Malaysia	57	32	69	54	59	68	68	64	76
Kingfish, seerfishes	India, Indonesia	10	16	22	21	25	28	51	49	49
Skipjack	Indonesia	3	6	11	12	12	13	14	19	20
Yellowfin	Indonesia, Japan, Taiwan (Prov. of China)	5	10	10	12	12	14	13	18	18
Bigeye	Taiwan (Prov. China), Japan	4	12	13	12	12	12	14	8	10
Albacore	Taiwan (Prov. of China)	3	3	5	3	20	33	30	13	32
Southern bluefin	Australia, Japan	21	19	24	25	20	17	16	11	9
Marlins, billfishes, swordfish	Taiwan (Prov. China), Japan	2	3	5	6	5	4	3	3	2
Other tuna	Indonesia, India	8	16	38	42	38	57	52	66	72

Table 13 (continued)

Stock	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990
Hairtails	India, Indonesia	23	31	34	41	36	33	28	19	31
Mackerels (Rastrelliger)	Indonesia, Malaysia Thailand, India	15	37	108	124	105	109	107	107	111
Sharks and rays	India, Indonesia, Australia	31	38	50	47	53	59	78	65	64
Other, identif. fish	India, Malaysia, Indonesia, Thailand, Australia	35	60	101	105	121	151	189	190	199
Marine fishes n.e.i.	Myanmar, Thailand, India, Malaysia,Bangladesh,Indonesia	457	682	917	956	1049	1068	1066	1102	1150
Total fishes		811	1234	1802	1932	2118	2284	2307	2326	2446
Sand and mud crabs	Thailand, Indonesia	0	4	8	8	10	10	10	10	10
Lobsters	Australia	12	14	16	17	16	17	18	14	19
Penaeid shrimps	Malaysia, India, Indonesia, Thailand	3	30	67	61	67	67	98	107	113
Sergestid shrimps	Malaysia, Thailand	0	2	11	11	9	8	8	9	9
Other crustaceans	Bangladesh, India, Indonesia	29	44	70	83	97	115	89	89	98
Total crustaceans		44	94	172	180	199	217	223	229	249
Abalones	Australia	6	5	7	7	7	6	6	5	6
Oysters and mussels	Thailand, Australia	0	1	6	6	6	9	13	13	13
Scallops	Australia	4	4	18	15	12	9	7	5	6
Cockles and clams	Malaysia,Indonesia,Thailand	0	27	109	76	73	71	70	73	68
Cephalopods	Thailand, Malaysia, India	2	12	24	28	33	45	53	76	36
Other molluscs	India, Thailand	0	0	1	2	6	7	3	3	3
Total molluscs		12	49	165	134	137	147	152	175	132
Jelly fishes	Malaysia,Indonesia,Thailand	0	2	29	25	64	32	3	2	2
Total area		867	1379	2168	2271	2518	2680	2685	2732	2829

Table 14

Northwest Pacific (Area 61)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Salmon	Japan, USSR	186	230	239	334	250	287	258	386	361	D-R
Alaska pollack	USSR, Japan, Korea Rep., Poland	3014	3564	3618	4733	5154	5009	5108	4827	4225	F
Other demersal	Japan, China, Korea Rep., USSR, Taiwan (P. China), Hong Kong	1683	2072	1830	1999	2213	1994	1807	1852	1786	F-O
Pacific saury	Japan, USSR, Taiwan (P. China)	283	334	235	274	251	227	347	331	416	
Japanese jack mackerel	Japan, Korea Rep.	192	116	108	174	122	201	274	212	250	
Pacific herring	USSR	465	248	145	203	249	255	213	118	109	
Japanese pilchard	Japan, USSR, Korea Rep.	157	1433	3959	4723	5191	5321	5429	5143	4735	F
Japanese anchovy	Japan, Korea Rep.	441	356	349	349	412	308	304	316	442	
Chub mackerel	Japan,China,Korea Rep., USSR, Taiwan (P. China)	1554	1789	1354	1217	1479	1133	1138	981	673	
Largehead hairtail	China,Korea Rep.,Japan, Taiwan (P. China)	673	571	657	636	566	556	531	591	650	F
Tunas, billfishes a/	Japan, China, Taiwan (P. China)	384	419	449	423	481	454	534	542	617	F

Table 14 (continued)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
Other small pelagic	Japan, China, Taiwan (P. China), Korea Rep.	387	523	758	879	933	1002	910	987	1099	
Marine fishes n.e.i.	China,Korea Dem,Japan, Hong Kong, Korea Rep.	2844	3522	3809	3949	4234	4289	4661	4768	4946	
Japanese flying squid	Japan, Korea Rep.	425	285	267	192	143	264	231	287	298	F
Others		1872	2499	2957	3761	4031	4521	4926	4954	5081	
Total area		14560	17961	20734	23846	25709	25821	26671	26295	25688	

a/ Includes skipjack tuna, larger tunas, smaller tunas and billfishes.

Table 15

Northeast Pacific (Area 67)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Salmons	USA, Canada	197	219	354	435	396	318	340	446	437	F
Pacific halibut	USA, Canada	25	14	19	34	41	42	43	39	37	F
Yellowfin sole	USA	56	76	86	203	179	183	219	153	150	M
Other flatfishes	USA, Canada	172	112	118	134	166	126	179	110	154	M
Pacific cod	USA	79	62	112	138	172	208	245	222	261	M
Alaska pollack	USA, Korea Rep.	1063	888	1086	1399	1605	1714	1550	1494	1568	F
North Pacific hake	USA	169	163	95	99	186	298	199	241	184	M
Pacific ocean perch	USA, Canada	109	41	26	22	32	34	33	32	49	D
Sable fish	USA	47	28	24	30	40	48	52	45	43	M
Pacific herring	USA, Canada	114	101	78	83	68	85	84	85	82	
King crabs	USA	40	53	3	7	12	13	10	12	15	D
Pacific snow crabs	USA	31	52	39	39	50	52	66	75	97	F
Pacific oceanic shrimps	USA	54	67	22	14	28	32	33	36	26	F
Others		236	184	260	245	230	296	292	290	325	
Total area		2392	2060	2322	2882	3205	3449	3345	3280	3428	

Table 16

Western Central Pacific (Area 71)

Stock	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
Demersal fish	Philippines, Indonesia, Thailand, Malaysia	491	612	613	682	734	756	764	800	804	F
Coastal small pelagic fish											
Mackerels (Rastrelliger)	Thailand, Indonesia, Philippines, Malaysia	222	227	255	325	304	305	294	311	323	
Round scads	Philippines, Indonesia, Thailand, Malaysia	264	343	275	327	357	364	312	360	402	
Sardinellas	Indonesia, Philippines, Thailand	175	341	392	298	320	341	394	441	480	
Anchovies	Philippines, Indonesia, Thailand	148	166	209	307	252	264	289	289	274	M
Total coastal small pelagics		809	1077	1131	1257	1233	1274	1289	1401	1479	
Coastal larger pelagic fish											
King/Spanish mackerels	Indonesia, Philippines, Thailand	55	61	79	72	83	84	83	88	86	
Smaller tunas a/	Thailand, Philippines, Malaysia	62	94	160	203	194	260	324	346	296	M
Total coastal larger pelagics		117	155	239	275	277	344	407	434	382	

Table 16 (continued)

Stock	Main fishing countries (1990)	1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Skipjack tuna	Indonesia,Philippines	42	70	99	137	151	164	170	159	195	F
	Major oceanic countries c/	31	48	47	39	42	34	39	40	37	F
	Non-coastal countries d/	103	156	227	207	362	346	449	412	417	F
Total skipjack tuna		176	274	373	383	555	544	658	611	649	
Yellowfin tuna	Indonesia,Philippines	48	62	77	94	94	85	93	117	139	see
	Major oceanic countries c/	4	8	10	7	4	8	13	11	10	tuna
	Non-coastal countries d/	27	56	99	74	116	167	102	145	152	review
Total yellowfin tuna		79	126	186	175	214	260	208	273	301	
Penaeid shrimps	Thailand, Indonesia, Malaysia, Philippines	195	217	206	173	203	207	227	234	228	F-O
Other shrimps and prawns	Indonesia, Vietnam, Thailand, Philippines	83	135	140	152	153	162	180	177	179	
Total shrimps and prawns		278	352	346	325	356	369	407	411	407	
Cephalopods b/	Thailand, Philippines, Indonesia, Vietnam	95	134	152	159	185	186	184	188	184	U-M
Total area		4471	5118	5455	5909	6418	6840	6953	7248	7311	

a/ Bullet and frigate tunas, kawakawa and longtail tuna.
Nominal statistics are incomplete, only a few countries separated these species.

b/ Squids, cuttlefish and octopuses.

c/ Fiji, Kiribati, Solomon Islands, etc.

d/ Japan, Korea Rep., USA and Taiwan (Prov. of China).

Table 17

Eastern Central Pacific (Area 77)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t) a/									
Freshwater and diadromous fishes	USA	2	2	2	2	3	4	6	2	2	
Demersal fishes	Mexico, USA	79	68	91	71	61	65	70	64	73	U
Chub mackerel	Mexico, USA	1	15	38	47	50	47	52	60	78	M
Pacific jack mackerel	USA	19	27	38	10	11	12	10	13	4	U
Californian pilchard (sardine)	Mexico	58	142	353	372	471	477	446	509	399	M-F
N. Pacific anchovy	USA, Mexico	92	238	280	154	123	167	119	111	6	U
Central Pacific anchoveta	Panama	37	104	103	241	84	127	39	121	60	M-F
Pacific thread herring	Panama	17	19	19	2	5	11	41	18	34	M-F
Other coastal pelagic fishes	Mexico, USA	7	12	19	14	12	20	19	20	17	U
Skipjack tuna	USA, Japan, Mexico	58	119	108	129	62	52	86	80	45	M
N. bluefin tuna	USA	9	8	2	4	5	1	1	1	1	M
Albacore	Taiwan (P. China), Japan, Korea Rep.	15	20	24	34	33	24	26	21	17	M
Bigeye tuna	Japan, Korea Rep.	42	70	64	78	100	98	80	78	83	M

Table 17 (continued)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t) a/									
Yellowfin tuna	Mexico, USA, Venezuela, Japan	170	202	151	231	276	272	284	277	257	F
Other oceanic fish	Mexico, Japan, USA	37	34	32	30	33	43	40	41	45	U
Unidentif. fishes	Mexico	119	96	135	135	142	118	119	109	176	
Total fishes		762	1176	1459	1554	1471	1538	1438	1525	1297	
Dungeness and Pacific rock crabs	USA	2	1	0	1	1	2	2	0	0	U
Shrimps	Mexico,Costa Rica, Panama	68	58	75	84	82	85	78	83	67	F
Other crustaceans	Mexico,El Salvador, USA	2	3	11	9	13	18	10	10	10	
Total crustaceans		72	62	86	94	96	105	90	93	77	
Squids	Japan, Korea Rep., USA	11	14	23	25	36	68	76	81	83	U
Other molluscs	USA, Mexico	17	15	25	21	28	27	38	43	47	
Total molluscs		28	29	48	46	64	95	114	124	130	
Others	USA, Mexico	3	10	6	10	14	19	20	16	15	
Total area		865	1277	1599	1704	1645	1757	1662	1758	1519	

a/ Species and area totals have been revised because of boundary changes between areas 77 and 87, the latter now including Ecuador and Colombia, the catches of which were previously included in the former.

Table 18

Southwest Pacific (Area 81)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t)									
Blue grenadier (Hoki)	New Zealand, Japan, USSR	7	49	38	43	187	181	246	210	392	F
Southern blue whiting (Poutassou)	New Zealand, USSR, Japan	23	19	17	8	17	14	19	32	42	?
Orange roughy	New Zealand a/	0	1	42	44	47	49	56	54	50	F-O
Oreo dories	New Zealand	0	9	33	35	22	23	23	18	21	?
Other demersals		60	80	121	116	107	110	127	113	141	
Greenback horse, jack mackerels	USSR, New Zealand, Japan	13	13	23	42	133	135	96	94	111	?
Other small pelagics		12	25	15	20	21	20	21	20	24	
Snoek	New Zealand, Japan	17	21	30	18	18	36	30	27	29	?
Sharks and rays	N.Zealand, Australia	5	7	13	16	14	16	21	16	19	?
Unidentified fishes		14	29	17	54	20	142	190	158	25	
Total fishes		151	253	349	396	586	726	829	742	854	

Table 18 (continued)

Stock	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
Oysters	Australia, N.Zealand	19	20	18	17	15	13	18	17	13	F
Mussels	New Zealand	2	1	5	11	16	18	25	24	24	F
Squids	New Zealand, USSR Korea	8	37	116	123	101	104	135	228	96	?
Total molluscs		29	58	139	151	132	135	178	269	133	
Rock lobsters	N.Zealand, Australia	5	4	5	6	5	5	4	4	3	F-O
Others		62	58	56	25	32	30	36	48	45	
Total area		247	373	549	578	755	896	1047	1063	1035	

a/ Substantial catches of orange roughy, made by Australia since 1986, are reported to FAO as "other finfish", and are part of the group of "other demersal" in this table.

Table 19

Southeast Pacific (Area 87)

Stock	Main fishing countries (1990)	Catches ('000t) a/ 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation
Chilean hake	Peru, Chile, USSR	139	194	85	47	74	64	150	156	225	F
Chilean jack mackerel	Chile, USSR, Peru, Cuba	173	776	1845	2148	1961	2682	3246	3655	3828	M
Patagonian hake	Chile	0	9	37	32	39	57	69	57	52	
Patagonian grenadier	Chile	0	3	22	19	37	132	212	227	128	
South Pacific breams	Peru, Chile	16	18	20	20	41	48	30	22	17	
South American pilchard (sardine)	Peru, Chile, USSR, Ecuador	103	1512	3743	6509	4961	4950	5383	4530	4254	F-O
Chilean herring	Chile, Cuba	131	31	35	38	38	32	30	164	299	
Anchoveta (Peruvian anchovy)	Peru, Chile	6959	2251	884	987	4945	2101	3613	5408	3772	F-O
East. Pac. bonito	Peru	51	7	18	10	5	19	35	27	40	
Chub mackerel	Ecuador,Chile,Peru	103	527	412	201	149	174	236	245	402	M
Squids	Chile, Peru	1	1	2	19	6	5	7	11	22	U
Others		362	402	677	713	746	727	765	836	906	
Total area		8038	5731	7780	10743	13002	10991	13776	15338	13945	

a/ Species and area totals have been revised because of boundary changes between areas 77 and 87, the latter now including Ecuador and Colombia, the catches of which were previously included in the former.

Table 20

Southern Oceans (Areas 48, 58 and 88)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t) a/									
Notothenia rossii											
Area 48 b/	USSR	83	7	11	2	0	0	0	0	0	0
Area 58 c/	USSR	47	13	5	2	1	0	0	0	0	0
Notothenia squamifrons											
Area 48 b/	USSR	0	1	0	1	0	0	2	1	0	?
Area 58 c/	USSR	22	11	7	7	2	3	5	5	3	F-O
Patagonotothen brevicauda											
Area 48 b/	USSR	0	3	18	12	16	9	13	13	0	?
Notothenia gibberifrons											
Area 48 b/	USSR	0	8	7	8	2	3	10	2	0	F-O
Champsocephalus gunnari											
Area 48 b/	USSR	3	62	63	16	14	71	36	22	11	F-O
Area 58 c/	France, USSR	24	28	10	8	17	4	2	24	1	F-O
Other fishes											
Area 48 b/	USSR	1	16	17	8	4	5	19	34	32	
Area 58 c/	USSR	3	1	1	8	1	3	1	2	1	
Area 88	Poland, USSR	0	0	1	0	0	0	0	1	0	
Total fishes											
Area 48		87	97	116	47	36	88	80	72	43	
Area 58		96	53	23	25	21	10	8	31	5	
Area 88		0	0	1	0	0	0	0	1	0	

Table 20 (continued)

Stock	Main fishing countries (1990)	1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation
		Catches ('000t) a/									
Krill											
Area 48	USSR,Japan,Chile,Poland	5	93	253	181	426	347	363	395	350	U
Area 58	Japan, USSR	0	27	104	6	16	29	7	0	30	
Area 88	Japan	0	1	5	5	4	0	0	0	1	
Total areas											
Area 48		92	190	369	228	462	435	443	467	393	
Area 58		96	80	127	31	37	39	15	31	35	
Area 88		0	1	6	5	4	0	0	1	1	
Total Southern Oceans		188	271	502	264	503	474	458	499	429	

a/ Split year fishing season: July 1 to June 30;
split-year data shown under the calendar year in which the split-year ends.

b/ Principally around South Georgia.

c/ Principally around Kerguelen.

Table 21

Tuna and other tuna-like species

Ocean	Species	Main fishing countries (1990)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation a/
Atlantic	Albacore	Spain, Taiwan (Prov. of China)	78	72	64	73	75	64	67	64	69	North: M South: M
	Bigeye	Japan, Spain, Portugal,France, Ghana	51	53	66	77	60	49	57	70	65	F
	N. Bluefin	France, Spain, Italy, Japan	16	23	22	26	21	20	25	23	23	West: D East: F
	Skipjack	Spain, Ghana, France, Brasil	75	85	131	114	115	108	142	115	133	M
	Yellowfin	Spain, France, Venezuela,Taiwan (Prov. of China)	86	124	142	148	133	136	130	155	159	East: F West: ?
	Billfishes, swordfish	Spain,Italy,USA, Algeria, Japan	21	21	29	42	41	45	52	54	51	Blue & white marlin: F Sailfish, east: U Swordfish, north: F
Total principal tunas, billfishes and swordfish			327	378	454	480	445	422	473	481	500	
Small tunas and seerfishes		Turkey, Mexico Ghana, Senegal	88	86	121	100	86	106	120	108	112	
Total Atlantic Ocean			415	464	575	580	531	528	593	589	612	

Table 21 (continued)

Ocean	Species	Main fishing countries (1990)	Catches ('000t) 1970-74	1975-79	1980-84	1985	1986	1987	1988	1989	1990	State of exploitation a/
Indian	Albacore	Taiwan (Prov. of China)	11	11	16	9	28	42	41	19	40	F-?
	Bigeye	Korea Rep, Taiwan (P. China), Japan	16	33	37	43	47	49	54	40	43	F
	S. Bluefin b/	Japan, Australia	50	38	43	35	27	26	23	19	16	D
	Skipjack	Maldives, Spain, France, Indonesia	38	34	63	137	149	169	205	238	221	L-M
	Yellowfin	Spain, France, Oman, Taiwan (Prov. of China)	30	38	55	101	118	129	180	154	180	F
	Billfishes, swordfish	Taiwan (Prov. of China), Sri Lanka, Korea Rep., India, Japan	6	7	10	17	18	18	18	16	14	Swordfish: M
Total principal tunas, billfishes and swordfish			151	161	224	342	387	433	521	486	514	
Small tunas and seerfishes		India, Sri Lanka, Pakistan, UAE, Yemen, Iran	56	86	140	214	221	262	278	278	285	
Total Indian Ocean			207	247	364	556	608	695	799	764	799	

Table 21 (continued)

Ocean	Species	Main fishing countries (1990)	Catches ('000t) 1970 -74	1975 -79	1980 -84	1985	1986	1987	1988	1989	1990	State of exploitation a/
Pacific	Albacore	Taiwan (P. China), Japan,USA,Korea R.	121	118	104	105	108	110	116	162	124	North: F South: F
	Bigeye	Japan, Korea Rep.	83	125	111	124	150	150	121	128	150	F
	N. Bluefin	Japan, USA	20	19	19	11	14	12	6	9	6	?
	Skipjack	Japan,USA,Philip., Indonesia, Taiwan (P. of China)	395	506	666	661	815	756	935	868	885	M
	Yellowfin	Mexico,USA,Japan, Philip.,Indonesia	300	390	400	476	542	602	586	627	648	East: M Center & west: U
	Billfishes, swordfish	Japan, Taiwan (Prov. of China)	59	60	62	57	66	73	76	76	81	Swordfish: M
Total principal tunas, billfishes and swordfish			978	1278	1362	1434	1695	1703	1840	1870	1894	
Small tuna and seerfishes		Indonesia, Philip., Japan,Thailand,Korea R.	340	369	532	627	641	695	815	874	918	
Total Pacific Ocean			1318	1647	1894	2061	2336	2398	2655	2744	2812	
Total all oceans principal tunas, billfishes and swordfish			1456	1817	2040	2256	2527	2558	2834	2837	2908	
Total all oceans small tunas and seerfishes			484	541	793	941	948	1063	1213	1260	1315	
Total all tunas and tuna-like fishes			1940	2358	2833	3197	3475	3621	4047	4097	4223	

a/ Refers to no specific FAO statistical area(s), but the entire stock.

b/ Includes S. bluefin caught in the Pacific and Atlantic.

NO : 11105

136 + 12

148