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Distant Water Fleets: An Ecological, Economic and Social Assessment

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Distant Water Fleets: An Ecological, Economic and Social Assessment

Fisheries Centre, University of British Columbia, Canada

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Directors Foreword

The first distant water fleet was a secret. In 1497, Giovanni Caboto (aka John Cabot), a Venetian adventurer financed by Bristol merchants and the English King Henry 7th, found seasonal villages already thriving on the shores of 'New Founde Lande'. His voyage, usually represented as an attempt to procure oriental spices, may actually have been prompted by reports of Portuguese sailors who, for some years, had been returning with a stunning abundance of cod, and who had, understandably, kept the location of their prolific and profitable fishing grounds concealed. Britain was having problems with Icelanders over cod at the time. Almost 500 years later in the 1970s, British distant water trawlers, greatly expanded after WW2, sparked off a 'cod war' with Iceland, an echo of the earlier conflict. Iceland was ahead of the pack in extending its jurisdiction beyond 12 nautical miles, but, soon, under the law of the Sea, everyone did this, and there was hope that 200-mile Exclusive Economic Zones would solve the problem. They didn't.

At home, the establishment of EEZs sparked off government subsidies to catch 'what are now our own fish'. Such actions, in false expectation of catches matching those of the former DWFs, invariably overcapitalized domestic fleets and in Canada, analysis now shows, ultimately doomed those Newfoundland cod, already reduced to a shadow of their former abundance by DWFs. Indeed, the legacy of DWFs effects around the world is only just beginning to be comprehended. For example, packs of eastern block large trawlers, supported by factory vessels and commanded to catch tonnes per ship each day, scoured what were then international waters. They destroyed long-lived sponge forests that harboured juvenile snapper and groupers off northern Australia and shifted the ecological balance towards more volatile pelagic fish in marine ecosystems off the west coasts of North America and Latin America. Moreover, displaced DWFs have shaped world fisheries over the past two decades. For example, cleverly-worded and politically-levered joint venture or licence agreements have disadvantaged developing nations, who, hoping to earn benefits from their fisheries, have typically received less than 5% of the catch value.

These issues are analysed in *Distant Water Fleets: an ecological, economic and social assessment* which publishes the Fisheries Centre teams' contribution to a larger project sponsored by WWF's Endangered Seas Campaign and published in 1998 as *Footprints of Distant Water Fleets on World Fisheries.* The Fisheries Centre's work reviews DWFs for selected case studies, especially from developing nations, in whose waters 85% of fish products now originate. We use ecosystem simulations (ECOSIM) to make a detailed economic evaluation for Namibian fisheries, and employ the Centre's recently developed rapid appraisal technique, RAPFISH, to examine the impact of DWFs on West African fisheries. The work is reprinted as papers under individual authorship here with the permission of WWF.

Fisheries Centre Research Reports publishes results of research work carried out, or workshops held, at the UBC Fisheries Centre. The series focusses on multidisciplinary problems in fisheries management, and aims to provide a synoptic overview of the foundations, themes and prospects of current research. *Fisheries Centre Research Reports* are distributed to appropriate workshop participants or project partners, and are recorded in *Aquatic Sciences and Fisheries Abstracts.* A full list appears on the Fisheries Centre's Web site, htpp://fisheries.com. Copies are available on request for a modest cost-recovery charge.

Tony J. Pitcher
Professor of Fisheries
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Abstract

This report reviews the balance of costs and benefits of distant water fleets (DWFs) for coastal nations. It is based on selected case studies representative of a wide range of conditions: off Mauritania and Senegal, Northwestern Africa; off Namibia; off Iceland; in the North Atlantic waters between Iceland and Norway; around the Galapagos Islands and in the North Pacific 'Donut Hole' between Russia and Alaska. The analyses are based on catch and landings data of the Food and Agriculture Organization of the United Nations (FAO), complemented with national and other data where available.

Two detailed evaluations were made. First, for Namibian fisheries, mass-balance simulations (ECOPATH and ECOSIM) of the upwelling ecosystem from which the catches originate, serve as the basis for comparing economic scenarios with and without DWFs. The results show that activities of DWFs can halve the potential earnings of home fisheries. Secondly, a rapid appraisal technique (RAPFISH) provides an ordination of relative status of West African DWFs and home fleets in ecological, economic, social and technological areas. In relation to similar fisheries that focus on small pelagics, the DWFs can reduce sustainability by 20%.

The overall conclusion of these analyses is that extended fisheries jurisdiction, which has radically altered the relationship between coastal states and DWFs, provides a framework within which both coastal nations and DWFs can work jointly to define the nature of their relationships. This can avoid the negative impacts of unregulated DWFs on coastal resources, documented in this report. For fishing grounds outside of EEZs, formal agreements, involving all potential players, are required to prevent the resources from being rapidly depleted.

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Acronyms and Abbreviations

APEC	Asia-Pacific Economic Cooperation
CECAF	Commission for Eastern Central Atlantic Fisheries
cm	centimetre(s)
CSD	United Nations Commission on Sustainable Development
CSRP	West African Sub-Regional Commission on Fisheries
d	day(s)
DWF	distant water fleet
DWFN	distant water fishing nation
EEZ	exclusive economic zone
EFJ	extended fisheries jurisdiction
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
g	gram(s)
GATT	General Agreement on Tariffs and Trades
GDP	gross domestic product
GRT	gross registered tonnes
ICNAF	International Commission for Northwest Atlantic Fisheries
INPFC	International North Pacific Fisheries Commission
ITQ	individual transferable quota
kg	kilogram(s)
km	kilometre(s)
m	metre(s)
MDS	multidimensional scaling
mm	millimetre(s)
NAFO	Northwest Atlantic Fisheries Organization
NAFTA	North American Free Trade Agreement
OECD	Organisation for Economic Cooperation and Development
OY	Optimum yield
RFMO	regional fisheries management organization
t	tonne(s)
TAC	total allowable catch
UN	United Nations
UNCED	United Nations Conference on Environment and Development
WTO	World Trade Organization
y	year(s)

Note: miles quoted are nautical miles, 1 nautical mile is equivalent to approximately 1.852 kilometres.

Introduction

Distant water fleets (DWFs), loosely defined in the past as collectives of fishing vessels operating outside the waters surrounding their own territories, and presently best defined as those fishing outside their own exclusive economic zones (EEZs), have been roaming the global oceans since ancient times (the best modern example being perhaps the whaling fleets of the last two centuries). As time passed and technological advances permitted more remote voyages and longer times at sea, DWFs extended their range of action to faraway places. The growth of these operations in modern times was led initially by a few nations after the end of World War II but others joined later. By the 1970s, DWFs were diverse in nationality and covered practically every ocean basin and sea around the world while fishing for a great variety of species. Around the same time, fisheries expansion in the developing world started to take place. These two events brought fleets from coastal and distant nations in contact with one another, and often led to conflicts over ownership of fishery resources and most frequently caused the overexploitation of marine populations. Where fishing occurred on the high seas, the typical situation of open-access common-property resources prevailed, also leading often to overexploitation. The establishment of EEZs by most countries around 1977 and the ensuing agreement for extended fisheries jurisdiction of the United Nations (UN) in 1982 dramatically changed the rules of the fishing game between countries. In recent years, the activities of distant water fishing nations (DWFNs) have been circumscribed by the need to obtain legal access to the EEZs where they want to fish, or otherwise having to remain restricted to fishing in the high seas, or as shown below, to engage in illegal activities such as poaching.

Although DWFs have been at times thought of as a negative element of the global fishing industry, our research shows that this is not always necessarily the case. The ecological impacts of DWF fisheries have often been negative in the past, but the same overfishing effects have happened and still occur inside many EEZs without any DWF activity: the real problem in both cases is overcapacity and excessive effort. From the economic and social point of view, each situation of DWF-coastal nation interaction offers possibilities for failure or success. The final outcome depends on the decisions made by each party and varies from case to case. While some coastal nations are better prepared for dealing with the challenge posed by granting access to DWFs others are less prepared. Choosing between licensing, chartering, or setting up joint-venture schemes can determine the success or failure of the whole enterprise. The capacity to administer the fishery and monitor and enforce compliance with regulations plays another important role in the success of the interaction. Usually, these capabilities are intrinsically linked with the level of economic and social development of the coastal nation. On the other hand, the attitude of the DWFNs performs perhaps an even more important role: whether seeking their own benefit or an equitable deal, DWFNs have in their hands most of the power in situations where the coastal nation is not fully prepared for the challenge. The possible combinations of these and other factors are complex and difficult to determine. Nevertheless, it is clear that the possibilities for successful and efficient DWFN-coastal nation relations exist, and these interactions are not negative per se. The last few years of DWF activities offer a great variety of situations that range from failed attempts for cooperation or unfair business between DWFs and coastal nations, to exemplary cases of sensible and successful cooperation, with equitability in the share of benefits among all parties.

The present report provides a broad-brush picture of the current state and the effects of DWF operations around the world. The work, as agreed with WWF at the beginning of the project, addresses the ecological, economic, and social effects of DWF fisheries. The final deliverables are:

1. a map showing the most important cases including stocks and players
2. an overview of the recent and current state of DWFs based on seven case studies around the world
3. an ECOPATH/ECOSIM model of the ecological and economic effects of DWFs in Namibia
4. an overview of the economics of distant water fisheries
5. an overview of social impacts of distant water fisheries
6. a multivariate analysis of a distant water fishery.

Project Direction and Management

The project was directed by the principal investigator Dr Daniel Pauly. Dr Ramón Bonfil was in charge of overall research, coordination and report production, and editing. Management of the project was done by Mr Nigel Haggan. All the work was discussed and planned by a team composed of the above-mentioned researchers plus Drs Gordon Munro and Ussif Rashid Sumaila. Additional collaborators who provided specific parts of the case studies and who were added halfway through the project were Mr Hreidar Valtysson and Dr Miriam Wright.

Methodology

Overall Strategy

The initial planning of the work, designation of responsibilities, and strategies for achieving the aims of the project were discussed in a couple of meetings with full participation of the research team. Weekly meetings were held to discuss progress and "brainstorm" on approaches. This was important in developing a common mind in an interdisciplinary team such as this. More importantly, from a WWF perspective, it served to identify several key sources of biological and economic information as well as sources on international conventions, legal agreements, etc.

As a result of the planning phase, a decision was taken to address specific fisheries that can be defined in terms of geography, and focus on species rather than fleets which can and do target more than one resource and/or move from one resource to another. This makes it possible to perform ecological, economic, and rapid appraisal assessments. Nevertheless, a global overview of DWFs was also performed and is presented as a preamble to the case studies.

Although we originally planned for a total of nine case studies to be included in the study, the constraints of availability of information, timeliness in accessibility of information, and overall amount of work prevented the preparation of some cases. Most of the case studies were to be addressed in as much detail as the overall size of the report and the availability of information allowed. A few more cases were to be briefly presented as shorter "boxed" cases. The selected case studies reflected the range of situations currently found in DWF fisheries around the world, including examples from the north and the south, interactions between developed and developing countries, situations of DWFs in the high seas, and from all geographical regions of the world. According to correspondence exchanged between Tony Pitcher and Michael Sutton on 29 October 1997, the project deliberately did not consider tuna fisheries. This decision was reached as tuna fisheries are quite complex, are considered a whole league of their own, and are known for being very difficult to document in enough detail. Given the scope of this project and the resources available for it, it was not possible to consider them here.

In the present report, we allude to industrial fisheries in the sense of those carried out with technologically advanced systems (i.e. large size of vessels, mechanized deployment/recovery of gear, electronic instrumentation for fish detection and navigation) as opposed to the alternative use of the term which refers to fisheries whose catch is destined for industrial production of fishmeal. Alternatively and for readability, we sometimes also use the term large-scale fisheries. In a similar fashion, we apply the terms artisanal fisheries or small-scale fisheries to those carried out from small-sized vessels that typically lack modern electronic instrumentation for positioning or fish detection and might even lack powered retrieval of gear.

Of those case studies included in this final report, the case study of Namibia suffers from a lack of historical information on catches by DWFs. The Namibian case study was originally singled out as the case chosen for the ECOPATH and economic analysis because it is a current and important example of DWF-coastal state interactions, and because of the global significance of the fisheries off Namibia. In addition, the research team decided that this case offered the best possibilities in terms of the availability of information (expected good contacts in the Namibian Fisheries Department and the coincidental participation of one of the project's collaborators on a separate project in Namibia, that would allow him to obtain first-hand information during his visit to Namibia). As it happened, all the contacts we explored for obtaining the valuable pre-independence information for Namibia proved to be of no use for data acquisition. Although this has not affected the modelling exercise, it prevented the proper documentation of the case study under the global overview. In a similar fashion, the lack of good contacts to gather the information required for our study made it impossible to address the Chilean horse mackerel case. Nevertheless, a new case study – from Iceland – was incorporated. Iceland presents an interesting case of a country formerly host of many DWFs and now in complete control of its own resources and a DWFN in its own right.

The following is the final list of the case studies that are presented below and that constitute the core of the report:

1. Mauritania and Senegal
2. Illegal fishing in the Galapagos Islands*
3. Pollock in the Bering Sea "donut hole"
4. Iceland
5. Norwegian spring-spawning herring*
6. Northern cod in eastern Canada
7. Namibia.

An asterisk (*) denotes case studies that are presented in brief format only as boxed cases.

The case studies are presented in a standardized format agreed by the research team to facilitate comparison among cases.

The major part of our strategy rested on finding reliable data collaborators. This took longer than anticipated and for some cases was not as fruitful as originally expected. A second-level strategy was to research several sources of economic and fisheries information, such as scientific literature databases, Internet resources, and review of newspaper archives for relevant articles. A specialist in library studies was sub-contracted for the latter task.

■ Ecological and Economic Modelling

The ecological and economic impact analyses were done for the Namibia fishery for hake, horse mackerel, and pilchards. For details of the ECOPATH and ECOSIM modelling frameworks and software see Christensen and Pauly, 1992 and Walters et al., 1997. Core papers on the specific ECOPATH models used to capture the essence of the Namibian ecosystem are Jarre-Teichmann and Christensen, 1998a and b.

To permit economic analysis, a framework based on valuation techniques developed by environmental economists was used (see Angelsen et al., 1994 and the references therein). Essentially, what we did was to take the catches and fishing efforts generated by ECOPATH/ECOSIM under the "with" and the "without" DWF scenarios, and apply appropriately determined unit prices for the fish landed, the cost of exploiting the fish, and the discount rate. In this way we were able to compute the net discounted economic rent that is achievable under the different scenarios, which in turn allowed us to determine the economic impacts of DWFs under these scenarios.

Rapid Appraisal of Fisheries Sustainability

The technique employed for evaluating the sustainability or "health" of fisheries uses multidimensional scaling (MDS) to achieve ordinations of fisheries in four different fisheries science disciplines: biology, economics, sociology, and technology. An overall combined ordination is produced using the results of the four disciplinary ordinations to generate an unweighted interdisciplinary assessment of fisheries sustainability. Full details of the method are provided in Pitcher and Preikshot, 1998.

Disciplinary ordinations are produced first in the four disciplines. Each discipline has a checklist of nine attributes that are scored on a ranked scale from 0 to 4 according to information available in published literature, "grey literature", and from personal contacts. Scoring is generally carried out as a team exercise. The attributes for the biological, economic, sociological, and technological ordinations were selected to meet the following criteria: utility in representing long-term sustainability of fisheries, ease of assigning extreme scores to "good" or "bad", discrimination of changes in time series information, addition of independent information to the overall assessment, agreement in scoring, and wide availability for all fisheries.

MDS is then used to reduce each multidimensional data matrix to a two dimensional output. The first two axes of the MDS ordination represent different contributions from the associated attributes in order to explain as much total variation in the original data as possible. Goodness-of-fit is provided by "stress" scores, and ordinations with stress above 0.27 are rejected.

Two simulated fisheries are included to supply fixed reference points and a gradient of sustainability. The "good" fishery was given the highest possible scores on all attributes contributing to long-term sustainability in the ecological, economic, sociological, and technological spheres. The "bad" fishery was scored in the opposite fashion. In addition, 20 random sets of attribute scores are included, and expressed as 95 per cent confidence intervals along the x and y axes after ordination. The original data is then re-centred to the zero of these "random fisheries", and the 95 per cent confidence interval plotted.

Simulations have been carried out to validate the monotonicity of the sustainability axis from “good” to “bad”, the central tendency of the random fisheries, and the lateral displacement normal to the sustainability axis of changes unrelated to sustainability (see Pitcher and Preikshot, 1998).

After the data have been ordinated within each discipline, they are subjected to the following conventions to make their appearance more suitable for interpretation. The axes are rotated so that the “good” fishery is plotted in the upper left corner of the graph and the “bad” fishery opposite to it at lower right. The interdisciplinary ordination is the result of performing MDS on the first two axes of the fisheries in the four disciplinary ordinations.

A Global Overview

■ Fishing Patterns of DWFs 1950-1994

Although our research focuses on the activities of DWFNs in specific regions and fisheries around the world, we first provide a brief analysis of global trends in distant water fisheries. This study is based on catches reported to the Food and Agriculture Organization of the United Nations (FAO) and includes historical data from 1950 to 1994. The present analysis is approximate as it is impossible to obtain exact figures of the catches made by any one nation outside of its own EEZ from the FAO fishery statistics. The approach used here is to group the catches of each country by FAO Statistical Area, and then exclude the catches reported in the FAO area(s) pertaining to the EEZ of each country. Thus we work only with catches made outside each nation's own FAO areas. This method might produce somewhat underestimated catches for the DWFs, but it is hoped this bias will be similar for all nations and that these data will still reflect the relative importance of each fleet and preserve the most relevant trends. Catches from 1950 to 1994 were summed over species or species groups to arrive at cumulative totals by species. These numbers are the ones used to infer the most important patterns and trends in distant water fisheries.

Two countries stand out as the all-time most dominant DWFNs: the USSR (until its disappearance) and Japan. Together, they account for over half of the total catches by DWFs, the USSR with 32 per cent, and Japan with 21 per cent of the total. Spain follows in third place with about 10 per cent of the catches. Other important DWFNs are, in order of importance: the Republic of Korea (5 per cent), the Russian Federation and Poland (4 per cent each), Taiwan, Portugal, Germany, and France (3 per cent each), Ukraine (2 per cent), Norway, Romania, Cuba, Bulgaria, and the United States (1 per cent each), and then 53 other nations with smaller catches. Table A1 in the appendix is a complete list of all the DWFNs identified through this analysis.

Throughout its existence, the Soviet block and in particular the USSR, dominated the catches made by DWFs, together accounting for nearly 50 per cent of the total. Even today, the ex-Soviet block nations keep a very high profile in distant water fisheries. Asian countries, led by Japan, are the second most important group of DWFNs. Some other important DWFs are of western European origin: Spain, Portugal, France, and Norway are notable.

The main fishery resources pursued by each of the top 21 DWFNs and the FAO areas where they have centred their activities are shown in Table 1. For each DWFN, the list of species and areas follows a hierarchical order. Most fleets from eastern Europe and Asia have very long ranges of activity, whilst nations from western Europe tend to concentrate their fishing in more discrete parts of the world. Interestingly, there seems to be a very strong correlation in fishing practices among eastern European DWFNs, as well as between Japan and the Republic of Korea. In both cases the species and areas fished are strikingly similar among nations.

Table 1. **Main DWFNs and the resources and FAO areas they fish, arranged by total cumulative catches in distant waters 1950-1994**

Country	Catch ($t \times 10^3$)	Main fishery resources caught	Main oceans and FAO areas fished
USSR	74,370	Diverse resources, horse mackerels, Chilean horse mackerel, Cape hake and horse mackerel, European pilchard	Worldwide, CE Atlantic Ocean, NW Atlantic Ocean, SE Atlantic Ocean, NE Pacific Ocean, SE Pacific Ocean
Japan	49,570	Diverse resources, Alaska pollock, skipjack and bigeye tunas, squids, yellowfin tuna	Worldwide, large catches in NE Pacific Ocean, then CW Pacific Ocean
Spain	22,860	Diverse resources, Atlantic cod, Cape hakes, European pilchard, yellowfin and skipjack tunas, octopi	Atlantic and Indian Oceans, CE Atlantic Ocean, NW Atlantic Ocean, SE Atlantic Ocean
Korea Rep.	11,090	Diverse resources, Alaska pollock, squids, yellowfin and skipjack tunas	Worldwide, NE Pacific Ocean, CW Pacific Ocean, CE Atlantic Ocean, SW Atlantic Ocean, W Indian Ocean
Russian Fed.	10,450	Diverse resources, Chilean horse mackerel, European pilchard	Worldwide, CE Atlantic Ocean, SE Pacific Ocean, SE Atlantic Ocean, Atlantic-Antarctic Oceans
Poland	8,200	Diverse resources, southern blue whiting, Cape horse mackerel, Atlantic mackerel, Pacific cod	Worldwide, NW Atlantic Ocean, SW Atlantic Ocean, SE Atlantic Ocean, CE Atlantic Ocean, NE Pacific Ocean
Taiwan	7,370	Diverse resources, albacore, Argentine squid, yellowfin and skipjack tunas	Worldwide, CE Pacific Ocean, SW Atlantic Ocean, CW Pacific Ocean, W Indian Ocean
Portugal	7,090	Diverse resources, Atlantic cod, Cape hakes	Atlantic Ocean, NW Atlantic Ocean, CE Atlantic Ocean, SE Atlantic Ocean
Germany	6,850	Diverse resources. Atlantic cod, Atlantic herring, Atlantic redfishes, horse mackerels	Worldwide, large catches in NW Atlantic Ocean, then CE Atlantic Ocean
France	6,040	Diverse resources, Atlantic cod, yellowfin and skipjack tunas	Atlantic and Indian Oceans, NW Atlantic Ocean, CE Atlantic Ocean, W Indian Ocean
Ukraine	4,210	Diverse resources, European pilchard, Cape horse mackerel, Chilean horse mackerel	Worldwide, CE Atlantic Ocean, SE Atlantic Ocean, Atlantic-Antarctic Oceans, SE Pacific Ocean
Norway	2,820	Atlantic cod, harp seals, sardines, horse mackerels	Atlantic and South Pacific Oceans, NW Atlantic Ocean, CE Atlantic Ocean
Romania	2,530	Diverse resources, Cape horse mackerel, horse mackerels	Atlantic and Indian Oceans, CE Atlantic Ocean, SE Atlantic Ocean
Cuba	2,320	Diverse resources, Chilean and Cape horse mackerels, Cape hake, silver hake, other hakes	Atlantic and South Pacific Oceans, SE Pacific Ocean, SE Atlantic Ocean
United States	2,250	Skipjack and yellowfin tunas	Pacific and Atlantic Oceans, CW Pacific Ocean
Bulgaria	2,140	Diverse resources, Cape horse mackerel, Atlantic mackerel	Worldwide, SE Atlantic Ocean, CE Atlantic Ocean, NW Atlantic Ocean, NE Atlantic, SW Atlantic Ocean
Latvia	,890	Diverse resources, Chilean horse mackerel, horse mackerels, European pilchard	Atlantic and Pacific Oceans, SE Pacific Ocean, SE Atlantic Ocean, SW Atlantic Ocean
Italy	,810	Marine fishes, marine molluscs	Atlantic and Indian Oceans, CE Atlantic Ocean, some NW Atlantic Ocean, W Indian Ocean
Lithuania	,790	Diverse resources, Chilean horse mackerel, sardines, horse mackerels	Atlantic, Indian, and South Pacific Oceans, CE Atlantic Ocean, SE Pacific Ocean, SE Atlantic Ocean
Estonia	1,460	Diverse resources, Chilean horse mackerel, horse mackerels, European pilchard	Atlantic and South Pacific Oceans, CE Atlantic Ocean, SE Pacific Ocean, SE Atlantic Ocean
Faeroe Is.	1,440	Atlantic cod	NW Atlantic Ocean

Data from FAO Fishery Statistics

Although most DWFNs catch a large variety of fishery resources there are clear patterns showing that eastern European nations specialize in fishing for high-volume, low-value small and middle pelagic fishes such as horse and true mackerels, and sardines. In contrast, Asian nations, while also fishing for a wide range of species, tend to diversify into both low-price high-volume species such as pollock, and high-price species such as tunas and squid. Other nations, such as the Faeroe Islands, concentrate on only one area and species.

Overall, tunas are the fishery resources most intensively fished by DWFNs, amounting to just over 32 million tonnes (t) during 1950-1994 (Table 2). These are followed closely by horse mackerels – and in particular the Chilean horse mackerel – of which over 31 million t have been fished. However, throughout modern fishing history, two species stand out as the most heavily fished by DWFNs: Atlantic cod (*Gadus morhua*) and walleye pollock (*Theragra chalcogramma*), each accounting for more than 20 million t of accumulated catch. Other important stocks are sardines and hakes. Cephalopods, true mackerels, flatfishes, grenadiers, billfishes, and crabs also rank prominently among the fishery resources sought by DWFs.

Table 2. **Main fishery resources pursued by DWFNs (cumulative catch 1950-1994)**

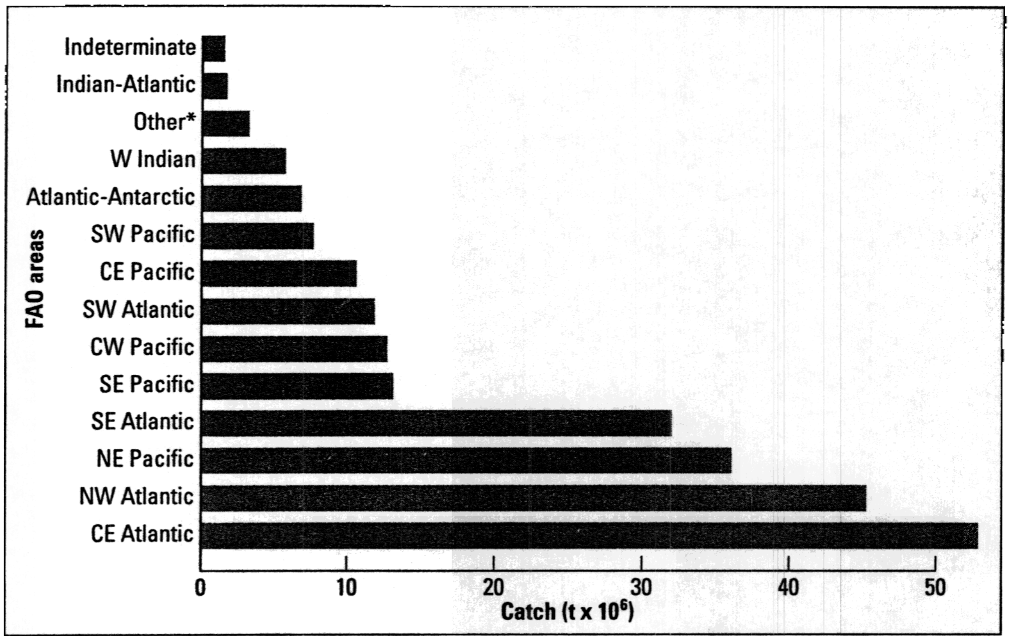
Species	Catch 1950-94 (t x10^3)	Notes
Tunas	32,096	38% Skipjack, 29% yellowfin
Horse mackerels	31,779	65% Chilean and Cape horse mackerels
Sardines etc.	23,502	77% Sardines (59% European pilchard), 18% herrings (74% Atlantic herring)
Cods	23,152	91% Atlantic cod
Hakes	21,290	53% Cape hakes, 19% silver hake, 13% North Pacific hake
Walleye pollock	20,620	
Cephalopods	14,997	77% Squids (22% Argentine shortfin squid), 14% octopi
True mackerels	7,962	92% Atlantic and chub mackerels
Flatfishes	3,825	26% Yellowfin sole, 19% Greenland halibut
Grenadiers	2,777	59% Blue grenadier
Billfishes	2,187	34% Indo-Pacific blue marlin, 23% swordfish
Crabs	443	95% Snow and king crabs

Source: FAO fishery statistics

Geographically, the activities of DWFNs cover the entire globe, from the Antarctic Ocean to the Arctic. However, the catch data of DWFNs show that most of the fishing activity has historically been centred on four main FAO areas: the Central Eastern Atlantic (FAO Area 34), the Northwest Atlantic (FAO Area 21), the Northeast Pacific (FAO Area 67), and the Southeast Atlantic (FAO Area 47) (Figure 1). Fishing in these four areas represents about 75 per cent of the total historical catches by DWFs as defined here. Fishing in Area 34 was dominated by the USSR and Spain. Fishing by DWFs in Area 21 (mainly for Atlantic cod) was dominated by the USSR which took by far the largest catches, although other countries such as Spain, Portugal, Germany, France, Poland, Norway, and the Faeroe Islands also had important catches. For Area 67, most of the catches were walleye pollock and were made mainly by Japan and to a lesser

Figure 1. **Cumulative catches (1950-94) of DWFNs by FAO Statistical Area**

The Central Eastern Atlantic, the Northwest Atlantic, the Northeast Pacific, and the Southeast Atlantic have been the hardest hit.



Other (*) includes Mediterranean-Black Seas, Pacific-Antarctic, Antarctic intermediate, E Indian, and NE Atlantic areas.

Based on FAO Fishery Statistics

extent by the USSR and the Republic of Korea. In Area 47, the main DWFN was the USSR, with Spain, Japan, and Poland having also very important catches.

■ Selected Case Studies of DWFs

Map 1 identifies the seven case studies selected for analysis within the global overview. There are two categories within these case studies: five are reviewed in detail and two are presented briefly as boxed cases. This division reflects both the relevance of each case and the availability of information.

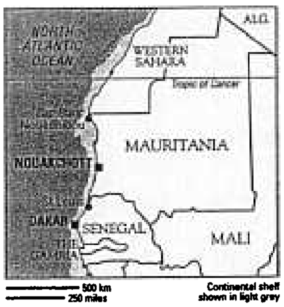
■ Case Study: DWFs off Mauritania and Senegal

ECOSYSTEM

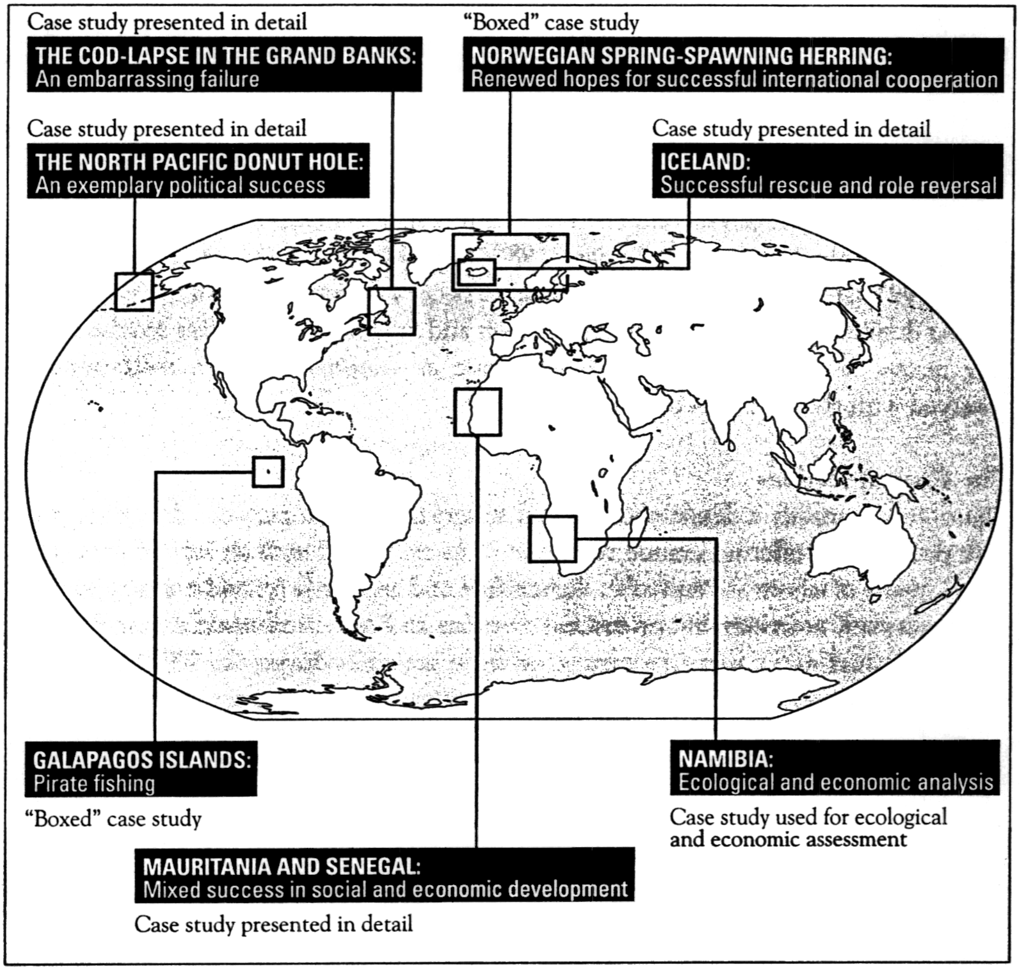
Environmental Conditions

The coasts of Mauritania and Senegal are situated in the eastern central Atlantic between 15° and 25° N in a very productive area of major upwellings, the Canary Current System. The coastlines of these two countries extend for more than 1,200 kilometres (km) (754 and 531 km respectively; Map 2). The continental shelf in this region is on average 50 km in width. According to Minas et al. (1982; cited by Mann and Lazier, 1991), this region is divided into two major zones by a front that separates North Atlantic central water from South Atlantic central water at around Cap Blanc.

Map 2. **Mauritania and Senegal lie along one of the richest coastal upwelling systems in the world**



Map 1. The seven case studies of distant water fleets analysed provide a diverse mixture of situations



The nutrient-rich water to the south of Cap Blanc is carried northwards well into the Cap Blanc area by the poleward subsurface counter-current of the upwelling region. The region around Cap Blanc and northwards enjoys year-round upwellings, whilst the southern region has upwellings mainly in winter and spring. The result of this combination of oceanographic features gives the area around Cap Blanc the highest primary productivity in western Africa (about 730 grams per square centimetre per year (g cm^{-2} y^{-1}) or 2 grams per square centimetre per day (g cm^{-2} d^{-1}) on average) because upwelling is from nutrient-rich South Atlantic central water and occurs year-round. The northern region's primary production is lower as North Atlantic central water is poorer in nutrients and to the south, upwelling is seasonal.

Food Chain

In general, phytoplankton blooms occur in upwelling systems during the slack between upwelling events, when stratification occurs allowing phytoplankton to remain and thrive in the shallow nutrient-rich layers of water (Mann and Lazier, 1991). Strong upwelling in the Mauritania-Senegal area generally tends to carry offshore the abundant zooplankton production that follows phytoplankton blooms (Trumble et al., 1981; cited by Mann and Lazier, 1991). As upwelling intensity weakens towards the autumn, zooplankton remains in the continental shelf and populations attain their peak of abundance (annual mean estimated at 60 g cm^{-2} y^{-1} wet weight; low and high of 40 and 120 g cm^{-2} y^{-1}). This outstanding biological production means that the coast off sub-Saharan Africa is one of the world's most productive regions (during 1986, 2 per cent of the world's marine catch was taken in this area representing about 0.0002 per cent of the world ocean; Goffinet, 1992). Fish production in this system is dominated by pelagic species, mainly sardines (*Sardina pilchardus* and *Sardinella aurita*), followed by horse mackerels (*Trachurus trachurus* and *T. trecae*) and jacks (*Decapterus ronchus*); some redfish (Sparidae) are also abundant. The four first species mentioned constituted about 75 per cent of the fish catch in the early 1980s (Trumble et al., 1981; cited by Mann and Lazier, 1991). The two sardine species seem to occupy different parts of the system with *Sardina* dominating the cooler northern region and *Sardinella* the warmer southern part. The ranges of these two species are dynamic as seasonal northern migrations are observed with the approach of summer.

The Coastal Nations

Mauritania is mostly a desert country that suffers from harsh periodic droughts. It is a very poor nation offering limited resources to its nearly 2.3 million inhabitants (CIA, 1997), many of whom are nomadic. Agriculture and mining (iron and copper) were the main economic activities, but protracted droughts and decreased world demand for iron and copper had strong negative impacts on these activities during the 1970s and 1980s. The government thus turned to the rich marine stocks as the main source of foreign currency and income. The declaration of the EEZ regime in 1979 was the first step of a new fisheries policy that set the stage for a more successful control over fishery resources. This policy required all foreign companies to establish joint ventures (with 51 per cent Mauritanian ownership), to land their catches in the port of Nouadhibou or have them inspected at sea, to construct fish processing facilities at Nouadhibou, and to employ at least five Mauritanians per vessel. This focus on fisheries provided clear initial benefits, but declines in the fishery sector were evident by the early 1990s (Maus, 1997). This decline was mainly caused by the deterioration of the industrial national fleet in the late 1980s. New policies adopted during this period encouraged expansion of the artisanal fisheries aimed at trying to solve pressing problems of unemployment and increased urban immigration, and the slowdown in fishing activity. The growth of the artisanal fisheries sector has been outstanding in the last few years. An estimated 93 per cent of the entire fleet was motorized by 1993 and the share of the valuable octopus production of this sector increased to about 20 per cent in 1992. However, a large part of this growth is at least partially due to the influx of Senegalese artisanal fishermen using pirogues (Maus, 1997). Thus, the aims of solving unemployment and developing a truly Mauritanian fishing capacity probably have not been fully met.

Nouadhibou, the oldest deep water port in Mauritania, has been in operation since 1919. A new deep water port off Nouakchott opened in 1986. Although these two ports concentrate all of the industrial fleet and about 56 per cent and 26 per cent of the artisanal fleet respectively, there are approximately 23 different landing sites for artisanal vessels along the Mauritanian coast (Maus, 1997).

In comparison with Mauritania, Senegal is a more densely populated country (9 million in 1996) and has more abundant water resources. Agriculture (peanuts and grains) and phosphate mining were the main economic activities until the 1980s. With the downturn in world markets for peanuts and phosphates, fish became Senegal's main source of foreign exchange with seafood exports accounting for nearly 25 per cent (US$15 million) of this country's total export earnings (Goffinet, 1992). Senegal has a very long tradition of skilful artisanal fishermen unparalleled in western Africa. This capacity to take advantage of their rich natural marine fauna has meant that Senegalese artisanal fisheries account for most of the total catch in their EEZ, limiting the activity of DWFs to a minor role (Goffinet, 1992). Most of the total annual fishery catches of Senegal (about 350,000 t) are caught by artisanal vessels. Dakar is the only industrial port, but there are approximately 200 landing sites for small-scale vessels along the Senegalese coast (Samba, 1994a). After centuries of using sail-powered pirogues, Senegalese fishermen started motorizing their fleet in the early 1970s: in 1971 49 per cent was motorized and by 1976 this reached 73 per cent. Presently almost 100 per cent of the pirogues are motorized (Gerlotto et al., 1979; Kebe, 1994). This development, together with the successful introduction of purse seines for these pirogues initiated a steep expansion of the pelagic artisanal fishing sector and concurrent increases in the overall catches. The industrial fishing sector of Senegal relied mostly on shrimp and flatfish stocks in the late 1960s, but declines in shrimp stocks in the late 1970s and most of the 1980s inspired the diversification of demersal catches. A suite of favourable conditions is responsible for the successful growth of Senegalese artisanal fisheries in the last 30 years. Among these, Kebe (1994) mentions: improvements in the pirogue (motorization and cold storage capacity); introduction of purse seines, introduction and improvement of cuttlefish traps, improvements in bottom longlines, etc.; adaptability to changes and dynamism of the fishermen; favourable conditions with strong local and external demand for fishery products; and adequate incentive and aid policies from the government.

THE DWF NATIONS

The poor monitoring and enforcement capabilities of these two west African countries allowed several DWFs to fish unchecked for many years in this area, especially before 1977. The USSR, Spain, the Republic of Korea, Japan, Norway, Greece, Poland, Romania, Portugal, and Bulgaria were among the main fishing nations catching fish during the pre-EEZ period in the region. In fact, the USSR, Spain, and Japan were known to fish off Mauritania since the early 1960s (Maus, 1997). At least a dozen nations are suspected to have exploited fish stocks in the region, but since the establishment of the EEZ regime, many nations have signed fishing agreements or pursued joint ventures with Mauritania and Senegal. Still, monitoring and compliance remains an important problem. Table 3 lists the countries reporting catches off Mauritania and Senegal to the Commission for Eastern Central Atlantic Fisheries (CECAF) since 1972, together with the importance of their fishing operations. A total of 32 countries is included, however, it is worth noting that many countries seemed to have stopped fishing in the region more than 10 years ago (Norway, Poland, Egypt, Iceland, Libya, and France). Other nations have started fishing operations only in the last decade (Belize, China, Estonia, Georgia, Latvia, Lithuania, Russian Federation, Ukraine, Vanuatu). Several of the small nations included in the list are well known flag-of-convenience countries.

Nations and groups of nations fishing under agreements in this region presently or in the recent past are: Nigeria, the European Union (EU), Japan, and Ukraine. The joint-

Table 3. **The DWFNs known to have fished off Mauritania and Senegal**
Data include Mauritania and Senegal for comparison. Countries with mean landings less than 1,000 t have been combined.

DWFN	Period fishing	Catch (t x 10^3) Total	Mean
USSR	1972-1991	17,856	893
Senegal	**1972-1995**	**5,731**	**239**
Russian Fed.	1992-1995	703	176
Ukraine	1992-1995	656	164
Spain	1972-1995	3,232	141
Norway	1972-1975	467	117
Poland	1972-1981	692	69
Latvia	1992-1995	273	68
Romania	1972-1993	1,470	67
Lithuania	1992-1994	180	60
Estonia	1992-1993	96	48
Germany	1972-1990	532	30
Italy	1972-1995	687	29
Japan	1972-1991	513	26
Korea Rep.	1977-1995	274	25
Bulgaria	1972-1992	314	22
Georgia	1992-1995	88	22
Greece	1972-1995	396	16
Mauritania	**1972-1995**	**327**	**14**
Egypt	1972-1977	69	12
Iceland	1975	11	11
China	1990-1995	48	8
Portugal	1972-1974/1986-1995	101	8
Honduras	1986-1995	47	5
Côte d'Ivoire	1972-1995	97	4
Libya	1980-1988	28	3
Cuba	1972-1995	58	2
Panama	1984-1995	21	2
St Vincent	1988-1993	5	1
Others	1973-1995	17,548	2,078

Source: CECAF Fishery Statistics

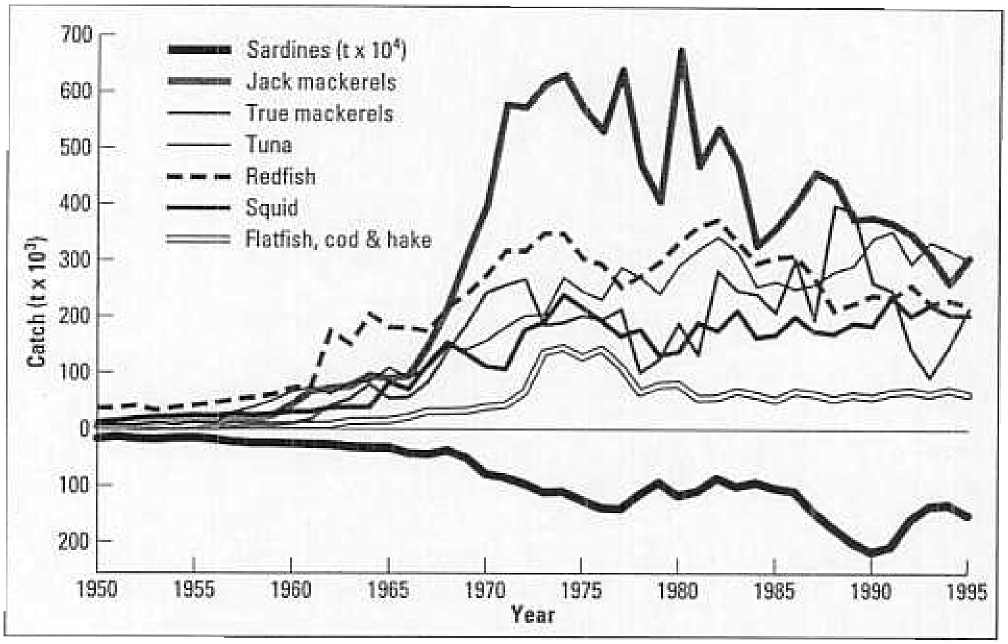
venture fishing scheme promoted by Mauritania since 1979 has resulted in partnerships with the following countries: Algeria, China, France, Libya, Romania (ceased early 1993), Russia, the Republic of Korea, and Tunisia. The main DWFs fishing off Senegal are the eastern European pelagic fish fleets and the demersal fish fleets of the EU (Samba, 1994a).

THE FISHERY RESOURCES AND FISHING SECTORS

The waters off sub-Saharan Africa are favoured with diverse and very abundant fishery stocks, being one of the most productive marine ecosystems in the world. The total reported catch of all species for the northwest Africa upwelling system in 1974 was 2.68 million t (Ansa-Emmin, 1982; cited by Mann and Lazier, 1991). One million t were clupeids, with 0.67 million t of these being sardines. Half a million t were horse mackerel and 0.2 million t were squid. A dozen industrialized countries led by the USSR took most of the catches. The USSR caught 287,000 t of sardines, 55,000 t of sardinellas, 360,000 t of horse mackerel, and almost 200,000 t of true mackerel (*Scomber* spp.). Fisheries production in the region has not grown since then, indicating perhaps that the sustainability of the fisheries has already been achieved or surpassed.

In general terms, fisheries production in Area 34 (from Morocco to Congo), has averaged about 2.8 million t for the last 20 years (Figure 2). However, there have been substantial fluctuations over this period principally attributable to variations in the catch of sardines and jack mackerels. Sardine production attained an all time peak of 2.2 million t in 1990 then dropped to 1.5 million t by 1995. Meanwhile, jack mackerel catches have shown an overall decrease from the circa 0.5 million t/y level of the 1970s to about 300,000 t in 1995. These reductions in catch might be more linked to decreases in effort in the early 1990s after the collapse of the Soviet bloc and the ensuing disarray of its former fishing fleet, rather than to decreases in fish abundance.

Figure 2. **Sardines account for the majority of the catches in the Western Central Atlantic – FAO Area 34** (All catches are in t x 10^3, except sardines (t x 10^4))



According to Resources Development Associates (1985; cited in Goffinet, 1992), cephalopod and sardine stocks in the western African area had been overexploited since the early 1980s, while sardinellas, mackerels, and sea breams were classified as "possibly fully exploited". Russian research suggests that the size and structure of the spawning populations of horse mackerels have remained unchanged over the last 10 years (Sedletskaya, 1995). Sutinen et al. (1980; cited in Goffinet, 1992) give tentative estimates obtained in the late 1970s of sustainable yields for the fisheries off northwest Africa. Reportedly, the potentials were of about 1 million t of sardine, 0.5 million t of sardinella, 0.2 million t of mackerel, and 0.4 million t of demersal fishes (sea breams, hake, croakers). The abundance of very valuable stocks of octopus off the coasts of Mauritania and Senegal has been linked, to a certain extent, to changes in the community structure as a result of fishing activity (Pereiro and Bravo de Laguna, 1980 and Gulland and Garcia, 1984; cited in Caveriviere, 1994). This seems to be particularly true for the surprising increase in the abundance of octopus off the southern coast of Senegal starting in 1986, which prompted the development of a new fishery with artisanal as well as industrial vessels. The decrease in abundance of sparids and serranids in these areas has been proposed as one of the mechanisms to explain the increased recruitment in octopus populations (Caveriviere, 1994).

Most of the DWFs fishing in sub-Saharan Africa can be classified in three groups. Those fishing mainly for small and medium pelagic fish (sardines, sardinellas, jack mackerels, etc.) were mainly the Soviet-bloc DWFs and their descendants. Those fishing for demersal fish and shellfish were mainly European nations, while cephalopods were pursued chiefly by Asian nations such as the Republic of Korea, China, and Japan, along with some European countries. DWF trawlers fishing in the south of Senegal catch mainly cuttlefish, octopus, and Sparidae (Thiam and Gascuel, 1994). The DWFs of the EU (mostly Spanish) fish mainly hake and shrimp, although some vessels fish for lobster and tuna (Maus, 1997).

According to Maus (1997) the main species in Mauritania are: (1) demersal species: cephalopods such as octopus (*Octopus vulgaris*), squid (*Loligo* spp.), and cuttlefish (*Sepia officinalis hierredda*), hakes (*Merluccius merluccius*, *M. senegalensis,* and *M. polli*), prawns (*Parapenaeus longirostris*), rubber-lip grunt (*Plectorhynchus mediterraneus*), canary dentex (*Dentex canariensis*), burro (*Pamadasys incisus*), smooth hound (*Mustelus mustelus*), barbelled houndshark (*Leptocharias smithii*), and spiny lobster (*Panulirus regius*); (2) small pelagics: European sardine (*Sardina pilchardus*), Spanish sardine (*Sardinella aurita*), Madeiran sardinella (*S. maderensis*), Atlantic horse mackerel (*Trachurus trachurus*), Cunene horse mackerel (*Trachurus trecae*), bluefish (*Pomatomus saltator*), mullet (*Mugil* spp.), and false scad (*Decapterus ronchus*); (3) tunids: yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), skipjack (*Euthynnus pelamis*), West African Spanish mackerel (*Scomberomorus tritor*), Atlantic bonito (*Sarda sarda*), and Atlantic little tuna (*Euthynnus quadripunctatus*).

There are three distinctive fishing sectors in Mauritania (Maus, 1997): the artisanal fishermen, the industrialized "local" fishermen (which can be further split into national and joint-venture components), and the DWFs. The artisanal fisheries target mainly octopus, burro, grunt, dentex, smooth hound and hound shark, spiny lobster, bluefish, mullet, Spanish mackerel, bonito, and little tuna. The industrialized local fleets target mainly cephalopods, but also some demersal fishes, lobsters, and some pelagic fishes.

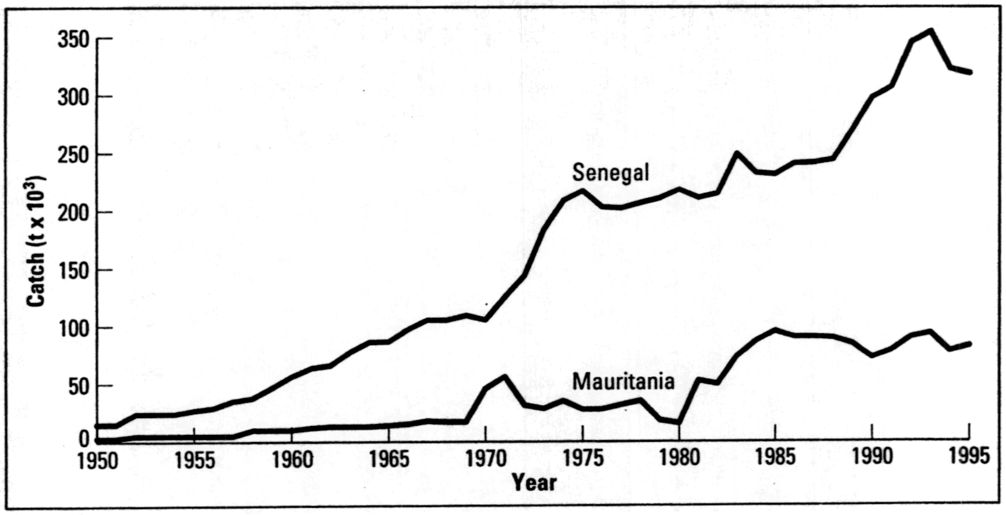
In Senegal, artisanal fishermen are by large the most important sector accounting for more than two-thirds of the total catches of the country (Samba, 1994a). Pelagic pirogues comprise the largest part of the Senegalese fisheries production, landing more than 50 per cent of the total catches in 1991. Pelagic fishes (mostly clupeids, with some carangids and scombrids) account for about 80 per cent of the total artisanal catch. Demersal fisheries in Senegal used to concentrate on high-value species such as shrimps and soles, but reductions in shrimp stocks induced a diversification of this sector. More recently, fish such as *Pagellus*, *Arius*, and *Pseudolithus* account for most of the demersal catches (Samba, 1994a). The artisanal pirogues of Senegal catch a wide range of species depending on the type of gear they use. Samba (1994a) lists about 25 major species for the pelagic pirogues and 22 for the demersal pirogues. Among the most important species reported in artisanal fisheries by Gerlotto et al. (1979) are: *Sardinella* spp., *Cybium tritor*, *Caranx ronchus*, *Pomadasys* spp., *Sphyraena* spp., *Euthynnus alleteratus*, *Ethmalosa fimbriata*, *Arius* spp., *Brachydeuterus auritus*, sharks and rays, soles, and others. More recently, *Octopus vulgaris* has become a very important species for the Senegalese artisanal sector (Caveriviere, 1994). According to Thiam and Gascuel (1994), the trawl fleet catches and lands at least 70 different species. The most important in weight for the Dakar-based trawlers are: *Pseudolithus*, *Arius*, *Galeoides decadactylus*, Sparidae, cuttlefish, and octopus.

HISTORICAL CATCHES

Catches of the Coastal Nations

The fisheries of Mauritania were minor before 1970 (10,000-20,000 t/y) when increasing but unstable landings were recorded. However, the real growth of Mauritanian fisheries took place between 1980 and 1985. Statistics from FAO indicate a peak of landings in 1985 with 95,000 t, and relatively stable landings fluctuating around 85,000 t/y since then (Figure 3). In contrast, the evolution of fisheries in Senegal shows a better performance. With the exception of the years 1994 and 1995, Senegalese catches have generally maintained a trend of growth since very early in the statistical record, with maximum growth during the early 1970s. Landings of Senegal currently attain some 320,000 t/y.

Figure 3. **Senegalese fishermen have capitalized more successfully on their rich fishery resources than their Mauritanian counterpart**



The bulk of Mauritanian landings is composed primarily of squids, redfishes, and sardines; unfortunately a large proportion of the landings of this country are masked under the term "various fishes" (Table 4). It is evident that despite the relatively large coast of the country, Mauritania does not utilize much of the very abundant pelagic stocks found in and just outside its EEZ, such as sardines and horse mackerels. In general, the participation of Mauritania in the exploitation of its fishery stocks continues to be very limited. While some reports quote the potential of Mauritania's

Table 4. **Marine Catches of Mauritania for the years 1950-1995**

Species	Mean catch (t)	Maximum catch (t)	Year of maximum
		55,344	1993
		21,840	1989
		33,859	1984
		17,400	1971
		2,020	1989
		4,030	1979
		2,718	1982
		564	1981
		686	1981
		921	1987

Table 5. **Marine Catches of Senegal for the years 1950-1995**

Species	Mean catch (t)	Maximum catch (t)	Year of maximum
Sardines	72,204	228,508	1993
Redfishes	26,248	60,730	1985
Horse mackerels	16,777	38,183	1978
Various fishes	16,091	42,050	1975
Octopus and squid	3,074	20,217	1991
Flatfishes	2,825	11,857	1994
Conchs etc.	2,645	10,000	1980
Sharks	2,126	7,477	1995
Shrimps	3,231	12,703	1989
Tunas	2,707	12,402	1985
Tilapias	7,483	19,215	1975
Mackerels	1,262	8,000	1987
Clams and Cockles	20	926	1995
Molluscs	6	267	1995
Oysters	115	600	1963
Crabs	99	520	1994
Lobsters	116	787	1994
Aquatic plants	33	360	1975
Cods and Hakes	3	33	1993
Crustaceans	5	108	1974

fishery resources to be around 930,000 t per annum, only about 90,000 t or slightly less than 10 per cent is caught by the national fleet (Anon., 1996a).

Senegal capitalizes to a greater extent on its availability of large fishery resources. The fisheries of Senegal are driven by sardine catches, which account for almost two-thirds of the total (Table 5) and peaked in 1993 at almost 230,000 t. Other significant stocks in order of importance include redfishes, horse mackerels, squids, shrimps, tunas, and flatfishes.

CATCHES OF THE DWFs

It is very difficult to provide reliable historical catch statistics for DWFNs fishing off the coasts of Mauritania and Senegal. The most detailed geographical references used by FAO for purposes of reporting fishery catches (FAO Statistical Areas) do not provide enough geographical detail to pinpoint catches off Mauritania and Senegal since 1950. CECAF reports data starting only in 1972. The best we can do to provide figures for the 1950-1971 period is to speculate around the figures reported for the Central Eastern Atlantic (FAO Area 34) using available knowledge of the distribution of fishery resources within this area and ancillary information from the fishing operations of the DWF. A first approximation of the total catches of DWFNs off the coasts of Mauritania and Senegal can be made by subtracting the catches of all west African coastal states. After this, the catches of tunas and tuna-like fishes are estimated from the totals of Area 34 by pro-rating the catches of each species each year, according to the approximate proportion of each species that has been traditionally fished in Mauritanian or Senegalese waters. The maps of catches of tuna and related species by geographical grid reported by the International Commission for the Conservation of Atlantic Tuna (ICCAT, 1997) were used for this task. The results (Figure 4) show that high exploitation in the region started in1967 and reached a first peak of just over 2 million t in 1971. Catches decreased sharply in 1978 with the establishment of the EEZ regime, and bounced back in 1980. The period 1988-1991 again saw catches around 2 million t but fisheries production declined greatly after 1991 mainly due to political change in the ex-Soviet world, which before its collapse took the lion's share of the catches and accounted for over 50 per cent of all DWF catches over the same period.

Figures 4 and 5 illustrate the extremely disproportionate share of the total catches between coastal and DWF nations. Although there is a very slight trend of increased share of the fishery resources by the coastal nations, for over 45 years about 80 per cent of the total catch has been taken by the DWFs leaving only about 20 per cent to the coastal nations.

Figure 4. **DWFNs took peak catches of almost 2 million tonnes off the coasts of Mauritania and Senegal (FAO Area 34)**