ANNEX IV

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ALTERNATIVE MANAGEMENT STRATEGIES:

POTENTIAL AND LIMITS OF LICENSING SYSTEMS

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1. Introduction

There are a large number of fishery management techniques, which can be classified in terms of three groups of complementary criteria:

(i) control of the composition in size of catches or control of the exploitation rate;

(ii) medium/long-term control of fishing effort or short/medium-term adjustment (essentially annual) of fishing effort on the basis of changes in biological and economic parameters;

(iii) direct control of fishing effort (number and technical features of vessels) or indirect limitation of effort (production quotas, taxation of production facilities or fishing effort).

The fishing regulations for waters under EEC jurisdication concern mainly three management techniques:

- catch limitation by species and by area (TACs);
- the definition of technical features of fishing gear used (mesh sizes, types of trawl, etc.);
- the fixing of a minimum commercial size for each species.

Mesh size regulations and other constraints with regard to the technical features of fishing gear are designed to alter the catch pattern in terms of age class.

The TACs are a control technique directed at the level of exploitation of stocks. The control of fishing effort which the TACs engender is a short/medium-term facility and takes effect indirectly.

For many years, the system of limitation of total catches by species and the concept of maximum production at equilibrium (F_{max} or MSY) often associated with it have been much criticized. Use of a system of direct control of fishing effort by licensing is often urged as an effective alternative to the TAC system:

> " ... the EEC will have to face up to the problem, sooner or later, that fisheries cannot be effectively managed until all the inputs are controlled, the most important of these being the amount of fishing effort. It is in this area that the Commission considers that future developments must inevitably lie." (Holden, 1984).

The purpose of this memorandum is twofold: to summarize the theory behind the TAC and licensing systems, and to outline the necessary elements for the introduction of a licensing system and the nature of related difficulties.

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Another type of criticism relating to the definition of maximum production level concerns technical, biological and ecological interdependence between fish stocks:

- because of by-catches, a given maximum renewal production level for one species (presuming this can be defined) may lead to over-fishing of another species;
- the various species are interdependent because they compete for food or because some species prey on others;
- the role of abiotic factors (density, temperature, salinity, etc.) for fish is not properly understood.

Some biologists therefore think that it is quite wrong to attempt to define a level of fishing mortality and a maximum production corresponding to it stock by stock. Misguided use of the single species approach is questioned. The "multi-species" approach, allowing for the way some species prey on others, is not yet well enough understood to be used. On the other hand, the "pluri-species" approach, allowing for technological interaction, could be followed (J-C. Le Guen, R. Chevalier, 1982). This would involve two changes from the approach used so far in the North Sea: (i) the need for monitoring the fishing effort and (ii) the use of a weighting system like the price of the species, to avoid giving the same importance to a ton of sole, a ton of cod and a ton of horse mackerel.

In practice, the controversy as to the right TAC corresponding to F_{max} or to a level below F_{max} is irrelevant: actual fishing is usually above F_{max} (Table 1).

Table 1: Fishing mortality (F) since 1962

SPECIES	AREA	AVERAGE F					F_{max}
		1962-65	1967-71	1972-76	1977-81	1982-83	
Herring	IV+VIId	0.45	1.07	0.94	0.22	0.23	n.d.
Cod	IV	0.51*	0.61	0.74	0.77	0.92	0.18
Cod	VI		0.54	0.66	0.78	0.76	0.31
Whiting	IV	0.90	0.88	0.99	0.87	0.77	0.41
Whiting	VI	0.64*	0.77	0.99	0.65	0.54	n.d.
Haddock	VI		0.48	0.71	0.59	0.60	0.26
Haddock	IV	0.90	0.82	0.95	0.92	0.82	0.36
Saithe	IV	0.33	0.28	0.50	0.36	0.26	0.27
Saithe	VI	0.23	0.12	0.23	0.25	0.22	n.d.

Source: ICES
* 1963-1966
n.d.: F_{max} is not determined.

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2. Criticism of the TAC system

The criticism of the production restriction system concerns two separate aspects of it: firstly, the criterion taken to fix the level of the limitation of production, and, secondly, the actual principle of production limitation as a single indirect method of controlling fishing effort.

2.1 Establishment of the TACs on a biological basis

Under the present arrangement, scientific advice for TAC recommendations is based, for each species taken separately, on a twofold criterion:

(i) to enable a class of recruits to provide its production maximum (to which corresponds the F_{max} mortality level);

(ii) to ensure the preservation of spawning stock biomass at a level normally ensuring that recruitment will not collapse.

The first criterion was for a long time the basis of biological advice with regard to stock management. The disadvantages of this criterion in strictly biological terms were already realized in the 60's (P.A. Larkin, 1977):

- as the fish approach maturity, their growth in weight terms is rapid and their natural mortality low; accordingly, the spawning stock biomass at F_{max} is often mainly made up of young fish which are reaching the age of breeding for the first time and the quality of whose eggs may be inferior to that of older fish;

- for certain stocks, F_{max} already corresponds to a low number of breeding age class; consequently, poor recruitment leads to high instability of production in the long term.

These dangers of decline in recruitment are aggravated by the technical difficulties hampering the estimate of F_{max}, even when catch statistics are available:

- the growth of individuals, and, particularly, natural mortality are not well described;

- the yield per recruit depends on the catch diagram (eumetric curves);

- the yield curve per recruit may not have a clear maximum (the maximum is reached for a wide band of F values).

To offset some of the shortcomings connected with the F_{max} criterion, the level of the spawning stock biomass is also referred to. Biologists have also been using as reference the level of mortality by fishing operation F, which, on the yield per recruit curve, corresponds to the point at which the marginal gain is one tenth of the theoretic yield obtained from a virgin stock by one unit of fishing effort ($F_{0.1}$): this level of fishing mortality is lower than F_{max}, which makes it possible, for many stocks, to have more age classes and a larger breeding stock (Report of the ad hoc meeting on the provision of advice on the biological basis for fisheries management 5-9 January 1976, C.M. 1976/Gen:3).

2.2 The economic limits of the TAC system

Apart from biological criticism of the way the TACs are defined, the approach adopted and the traditional criticism of biologists have the feature of focusing fishing management on the impact it may have on fish stocks. This is a matter of stock management. On the other hand, the impact of such stock management on the operations and profitability of fleets is widely ignored. The question is not that of the management of the exploitation of stocks (Troadec, Maucorps, 1984).

The main theoretic criticism of the TAC system, at whatever level it may be fixed, is that it cannot prevent "over-investment" in fishing and therefore a dissipation of profit.

The process of dissipation of profit in fishing was shown theoretically in the 1950's for fisheries to which access is unrestricted: high profits draw in new vessels and reduce yields and therefore individual profits; the process continues until total income from the fishery matches total costs (Gordon, 1954; Scott, 1955). At this point the economic "rent" has disappeared altogether.

The fixing of a maximum level of production, without other restriction of fishing effort, does not prevent a similar process. As long as there is a high profit, new vessels will be drawn into the fishery. Total catches and catches per unit of effort remain constant because of the TAC system. However, the number of days of operation, and in particular the catches of each vessel, decline, while certain costs remain unchanged (fixed investment costs). The process continues until profits disappear altogether. The fishing season is shortened and production is carried out with a number of superfluous vessels, entailing ineffective costs in economic terms. A mathematical presentation of this process can be found in Clark (1979). A simplified example is given in Annex 1.

In theoretic terms, the quota system entails, as where there are no regulations, nil economic rent for producers. It does, however, have an advantage for consumers: total production is maintained at high levels and therefore theoretically at relatively moderate prices. The consumer "surplus" is generally higher than when there are no regulations.

The practical criticisms as to the consequences of the TAC system are of different types.

For fishing enterprises, late fixing of the TACs (sometimes after the season has begun) has often hampered fishing plans. This is an operational problem which is not necessarily bound up with the TAC system. On the other hand, uncertainty as to the closing date for a fishery, as soon as the TAC or quota is reached, is inherent in this system. This uncertainty is aggravated by lack of foreknowledge of the actual level of the TAC, which is changed each year. It is hard to see how this can be avoided where recruitment varies widely from year to year. The fixing stock by stock of the TACs makes it impossible to temper uncertainties: if, on a biological basis, the TACs of several stocks must be reduced, in practice the fishing enterprises cannot carry out this reduction simultaneously without suffering operating losses. The absence of short/medium-term adjustment as between the TACs and the production minimum necessary to maintain the profitability of enterprises is the reason why the latter have not always complied with the quotas.

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The internal consistency of the Common Fisheries Policy is based on co-ordination of three of its components: resources - structures - markets. Specifically, the multi-annual investment guidance programmes are normally implemented with a precise objective:

"in respect of the fishing sector, a satisfactory balance between the fishing capacity to be deployed by the production facilities covered by the programmes and the stocks which are expected to be available during the period of validity of the programmes" (Regulation (EEC) No. 2908/83).

With the TAC system as implemented, the follow-up of changes in catch capacities and fishing effort has often been neglected. The result has been that it is not possible to assess adjustment between catch capacities and stocks. Action taken to reorganize and modernize fleets and action relating to stock management are therefore liable to get out of phase.

A perceived incompatibility between the TACs on the one hand and fleet catch capacity and fishing enterprise profitability on the other hand often leads to false catch declarations. This means increased monitoring difficulties, especially as fraud is not necessarily restricted only to the fishing enterprises.

The basic information (landing returns) on which scientific advice is based is the actual object of the limitation and monitoring of fishing. The problem of assessing discards and the danger of working on false data (e.g. when the catch capacities exceed the quotas or TACs fixed) are such that stock assessment is always fraught with serious difficulties. The procedure for issuing scientific advice is already cumbersome (which is one of the reasons for the delays in fixing the TACs). It could probably be simplified (see for example J. G. Shepherd, 1983). However, with the present system of TACs, there is still some uncertainty as to the reliability of the data and therefore of the assessments.

2.3 Explanation of the use of the TAC system

The shortcomings of the TAC system as single mechanism for indirect control of fishing effort have been known for many years. The reason why the system is used is essentially the historical one that the countries have failed to agree on the share of resources.

In 1946, at the London Conference on overfishing, the United Kingdom Government proposed a plan to avoid excess exploitation of resources and a loss of profitability for fishermen. Its analysis was as follows:

"if fishing is uncontrolled, the level of stocks will inevitably fall, the catch per unit of effort will diminish progressively and fishing will become unprofitable" (Conference Paper # O.F.C.1).

The solutions proposed were not based on a limitation of total captures:

"it seems doubtful whether a quota system could be applied successfully to such an area as, for instance, the North Sea. (...) it is highly probable that the permitted quota would be reached well before the end of each year."

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On the other hand, catch capacity limitation was contemplated:

> " ... a simpler plan would be to limit directly the number, size and tonnage and/or fishing capacity (e.g. size and number of trawls) of the vessels permitted to fish in a given area."

The European countries failed to agree on catch capacity limits for each country, and the proposal was turned down.

Competition between the various fleets led to heavy overfishing of certain stocks and led the scientists to concentrate only on the implications of management of the state of the stocks. In the absence of agreement on sharing out the resources, the only common objective that could be envisaged was to prevent the collapse of stocks. Hence the stock conservation policy pursued in Europe. The stock management measures were proposed independently of the economic conditions of their exploitation. This does not mean that economic aspects were ignored by the biologists. Here are three examples:

> "The management of fisheries is intended for the benefit of man, not fish: therefore the effect of management upon fish-stocks cannot be regarded as beneficial per se" (M.D. Burkenroad, 1952)

> "It is necessary to convert the scales of yield and fishing intensity of the eumetric yield curve into the economic equivalents of the total value of the annual yield and the total running costs of generating any fishing intensity (...). On economic grounds alone, and supposing that the fishing industry is to be regarded as a self supporting economic unit, the fishing intensity which enables a good balance to be achieved between the benefits to the industry and to the consumer is perhaps that corresponding to the maximum profit level (...). There will be other factors, however, social or political, which may make it desirable for a somewhat higher fishing intensity to be exerted." (R.J.H. Beverton, 1953)

> "It is very doubtful if the attainment of the maximum sustained yield from any one stock of fish should be the objective of management except in exceptional circumstances." (Gulland, 1969).

The introduction of exclusive economic zones (EEZ) up to 200 miles from the coasts and the establishment of the Common Fisheries Policy changed the institutional context and the context of fisheries policy. In January 1983, the EEC countries agreed on a share of resources in the form of allocation of the TACs in national quotas (Council Regulation No. 172/83). The agreement covers share of resources among countries and thus authorizes the transition from a stock management policy to a management policy including economic and social aspects of stock exploitation. This is the new context within which alternative or supplementary management policies can be examined.

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3. Theoretic potential of fishing licences

Since the end of the 60's, use of a fishing licensing system as a means of adaptation between catch capacities, stock availability and marketing scope has been developing in certain countries (Table 2).

Table 2: Limiting licensing systems for nationals

COUNTRY	FISHERIES	YEAR OF INTRODUCTION
AUSTRALIA	Crawfish (West) Shrimps ...	1963 1974 1974/1975
CANADA	Salmon (British Columbia) Herring Roe (British Columbia) Coast Lobster (Atlantic) Licences + individual quotas ...	1969 1974 1967 1985
UNITED STATES	Salmon (Alaska) Herring (Washington, California) Salmon (Washington, Oregon, California) ...	 1973/1974 1974
FRANCE	Trawling (Mediterranean) Scallops (St. Brieuc Bay) Trawling (Charente narrows)	1970/1972 1973 1983
UNITED KINGDOM	Herring (Isle of Man) Multi-species/EEC (Shetland box)	1977 1983
JAPAN	Trawling (east China Sea) Inshore fishing High sea and distance fishing ...	1917
NEW ZEALAND	Crawfish	1980/1981

The licensing systems vary very widely. A common feature of the systems listed in Table 2 is that they set strict limits on the number of ships licensed to fish certain stocks. Other potential participants are barred. What are the theoretical advantages of such a limitation of fishing effort?

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In biological terms, there is no fundamental difference between indirect control (TACs) and direct control (licences) of fishing effort. The relationship between catches, fishing effort and average exploitable biomass can be set out as follows:

> $C = F*B = q*E*B$
> where C is the catches, F fishing mortality, B average biomass, E fishing effort and q the catchability coefficient (fishing mortality per unit of effort).

If the catchability coefficient is constant, it is equivalent to limit catches C or fishing effort E to the corresponding level.

For certain demersal stocks, the hypothesis of a constant catchability coefficient is a reasonable approximation. A licensing system enables annual TAC reviews to be avoided, since the fleet maximum fishing effort is fixed and since it leads directly to the catch levels which would have been established by the TACs. On the other hand, for pelagic species like herring, the aggregative behaviour of fish is such that the catchability coefficient varies in terms of the level of exploitable biomass. Here, the variation in catchability must be allowed for in determining the fishing effort corresponding to the fishing mortality and to catches.

In economic terms, as indicated above and in Annex 1, having a number x of vessels operating throughout the year is not the same thing as having a higher number of vessels, y, operating only part of the year. In theory, the licences authorize, like the TAC system, the fixing of the exploitation rate at a level at which the abundance of stocks and catches per unit of effort are high. The theoretic advantage of the licences is that they enable the vessels to make the most of the high level of catches per unit of effort, avoiding, through a numerus clausus, overcapacity of the fleet. The profitability of fishing enterprises can thus be appreciably improved over the situation with the TAC system. The economic value arises as soon as the costs of operating and monitoring the licensing system do not exceed the total gains in profitability.

In theory, the licences have a twofold advantage: moderate annual adjustments of the total fishing effort and, above all, an improvement in individual and overall profitability. Normally, these advantages will help to reduce conflicts between fishing methods, facilitate compliance with regulations (meshes, commercial size, quotas if they are applied at the same time) and lessen the danger of false catch reporting. This means an improvement in the reliability of stock assessments. On paper, the picture is ideal. The limits and the practical difficulties of this management system are, however, far from negligible.

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4. Licensing systems: limits and the difficulties

4.1 Technical difficulties of implementation

- Definition of types of fishing effort

The fishing effort is made up of various combinations of production factors (labour, capital, other inputs). Direct and total limitation of fishing effort would presuppose that all the production factors going into the fishing effort were monitored; in practice this is not possible (or, indeed, desirable, unless the aim is to fossilise the industry completely).

For each method, the most relevant features of the fishing effort to be limited - number and size of vessels, features of fishing gear, horsepower of engines, etc. - must be defined. The practical difficulties are important. For example, for trawling, the trawling power of a vessel depends not only on the horsepower of the engine but also on the engine/propellor ratio, variable or fixed pitch propellors, etc. The types of trawling or aids to shoal detection also have an effect on the determination of the fishing effort. There is a balance to be struck between the degree of precision of the restriction of fishing effort and the ease of monitoring and application of the restriction. These practical difficulties are aggravated by technical innovations.

- Definition of management units

With restriction of the fishing effort and the technical interdependence between stocks, the management unit can no longer be only the stock. New management units must be defined according to complementary criteria related to methods of fishing, geographical area, stocks fished, fishing seasons. The wide variety of types of fishing makes this definition no easy task. Here again, a balance has to be struck between a high degree of accuracy and ease of application.

One risk connected with poor definition of management units is that it may prevent the development of fishing of certain under-used stocks.

- Relationship between fishing effort and fishing mortality

The relationships between fishing efforts and fishing mortality are not easy to determine. The wide range of types of vessel and of methods of fishing the same resource necessitates comparison of their fishing power. This comparison is not facilitated by the fact that each method of fishing can exploit different stocks at the same time or, for the same stock, different age classes.

A good deal more research and statistics (on fishing effort and production) are needed to help overcome the technical difficulties associated with the definition of a licensing system. As a recent study has pointed out:

> "The gaps left by the data collection systems on fisheries in certain Member States, in particular with regard to fishing effort, hamper the construction of a specific model on the fishery products production system." (R. G. Houghton, N. A. Nielsen, C. de Verdelhan, 1981).

In so far as a licensing system is intended to improve the economic conditions for fishing enterprises, a system of supplementary information on costs and landing prices is required.

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4.2 Institutional mechanisms and decision criteria

Institutional mechanisms are needed for the decisions that must be taken for the operation of a licensing system. The role allocated respectively to the representatives of fishing enterprises and the authorities can be crucial for the proper working and the effectiveness of the licensing system: several sets of choices have to be made.

- Determination of the number and types of vessels authorized

The resources abundance, the production level, the individual and overall profitability in the fishery, and the level of employment are linked to the forms and total level of fishing effort authorized and to the effective implementation of the measures agreed. Hence the importance of the levels of decision-taking and of the criteria governing choices.

The first set of choices concerns the definition of management units, the number and types of fishing vessels - gear authorized, the object of the licensing (individuals, fishing enterprises or vessels).

- First allocation of licences

Licences may be allocated automatically to fishermen applying or only to those meeting given criteria (seniority in the fishery, features of vessels, etc.). A transitional phase could be contemplated before reaching the level and forms of effort taken as objective.

- Duration and transfer of licences

Licences can be allocated for limited periods or indefinitely. The rules governing transfers may be of a wide range of types: administrative transfer under predetermined criteria, sale by private contract between fishing enterprises, temporary sale by tender procedure, etc.

The rules of allocation and transfer of licences are crucial, since upon them depend access of fishermen or of the most effective fishing enterprises and research into improving the economic efficiency of fishing operations.

- Withdrawal of surplus fishing capacity

Catch capacity may be in surplus in terms of the objectives fixed for several reasons:

- the fleet capacity is already in surplus at the outset. This is generally the case for licensing systems introduced because the fisheries are not profitable;
- technical developments have the effect of increasing catch capacity of the same number of vessels. Efficiency gains of vessels may lead to effective reduction in production costs and an improvement in economic performance provided the supply of stocks is not reduced: a reduction in the number of fishing units is required if the most is to be made of improvements in the effectiveness of catch techniques;

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changes in biological (stock supplies), economic (cost of fishing effort, markets, employment, etc.) or political conditions may entail changes in the objectives set.

There are several possibilities of withdrawal of surplus catch capacity:

- the licences of fishermen retiring are not reallocated, where these licences are not directly transferable by artisanal fishing enterprises;
- buy-back of surplus capacity by the authorities, or even the fishing federations.

- Levy on profits

In so far as the licensing system introduced allows of an improvement in the economic performance of fishing enterprises, part of this improvement may be paid in the form of levies to cover the system's operating and monitoring costs.

A levy on profits may also be charged to curtail investment designed to improve the efficiency of fishing effort components not subject to limitation: as long as additional costs are below the value of additional contributions, fishing enterprises can seek to increase their share in the catches by expanding uncontrolled production factors. This was the case for the licensing systems introduced in North America (G.A. Fraser, 1977; R. B. Rettig, 1984).

Licensing is a management technique the effectiveness of which, in terms of achieving the objectives set by the central authorities or fishing associations, depends on its method of operation: i.e. institutional mechanisms introduced, choices with regard to allocation, transfer and withdrawal of licences, quality of scientific and technical information available, and the way this information is used. Differences in method of operation and scope for adaptation to the difficulties encountered account for the varying degrees of success of existing licensing systems.

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5. Conclusion

The licences and the TACs both restrict exploitation of stocks. The two systems are not necessarily mutually exclusive. Indeed, they can be complementary: control of fishing effort is medium to long term for licences, indirect and short to medium term for the TACs. Under a licensing system, the TACs may constitute a means of short-term adjustment necessitated because of the exploitation of multi-species stocks and changes in catchability. Compliance with the TACs is here favoured by the fact that catch capacities are not excessively in surplus and the fishing enterprises remain prosperous.

Three additional criteria may be useful to assess the case for and against each:

- the system's ease of application and flexibility;
- its economic efficiency, i.e. wealth creation;
- wealth distribution.

These three criteria correspond respectively to operational (practical aspects of implementation), analytical and political aspects.

Considering only the first two aspects, licences appear to be of mixed value: valuable in theory, in practice difficult to apply. The practical difficulties could well be such as to discourage the authorities, perhaps wrongly, from using the licensing system.

Experiments already carried out in certain countries are also inconclusive. In the United States, Canada and Australia, efficiency gains have not always been substantial, for two reasons:

(i) insufficient withdrawal of surplus catch capacity, and

(ii) increased investment in the fishing effort components not subject to limitation (R. Bain, 1983; R. B. Rettig, 1984).

Foreign experience is not susceptible of generalization: the implications of a licensing system depend essentially on the method of operation of this system; here, it could be argued that there are only special cases.

For the EEC, only the introduction of a licensing system for a pilot fishery would make it possible to assess a posteriori the advantages, limits and scope for improvement of such a system. It might be part of the STCF's rôle to consider in detail scientific and technical aspects arising in connection with the introduction of licences as an adjunct to the TAC system. The enlargement already planned of the disciplines of the experts who may be convened to the STCF makes this development possible. On the other hand, the definitions of the institutional mechanisms and of the decision criteria are either political or administrative; they come directly under the responsibility of the relevant professionals and authorities.

ANNEX 1 ECONOMIC DIFFERENCE BETWEEN THE TACS AND THE LICENCES:

A simplified example (1 type of ship, 1 stock)

A. Free access vs. limitation of fishing effort

Figure 1 shows total revenue and total costs of a fleet exploiting a stock. The hypotheses corresponding to this simplified example are the following:

- costs
  - . variable cost FF 35 000/day = FF 9 million for 260 days
  - . fixed cost (operation) FF 4.5 million/year
  - . fixed cost (replacement) FF 2.5 million/year

  Total fixed cost = FF 7 million/year

  Total cost = FF 16 million/year for 260 days
- price of kg landed: FF 5.70/kg for a quantity landed of 180 000 tonnes (total revenue = FF 1 120 million)
- stock in equilibrium situation (i.e. ponderal recruiting and gains offset losses by natural mortality M and fishing mortality F)
- unchanging and single technology.

Free access will be reflected by the operation of 70 vessels, each fishing for 260 days (18 200 days) and producing 9.9 tonnes per day. With a smaller number of ships, productivity and profits would be higher. The expectation of positive profits leads to an increase in the number of vessels; the process continues until the profit from each vessel is nil (70 vessels). Exploitation of the fishery then produces no profit:

overall revenue = FF 1 120 million

cost	= FF 1 120 million	variable cost	FF 630 million
		fixed cost	FF 490 million

Attempts to achieve maximum overall profit would involve the operation of only 50 vessels, each fishing for 260 days (a total of 13 000 days) and producing 13.8 tonnes per day:

overall revenue = FF 1 120 million

costs	= FF 800 million	variable cost	FF 455 million
		fixed cost	FF 345 million

profit of FF 320 million (FF 6.4 million per vessel).

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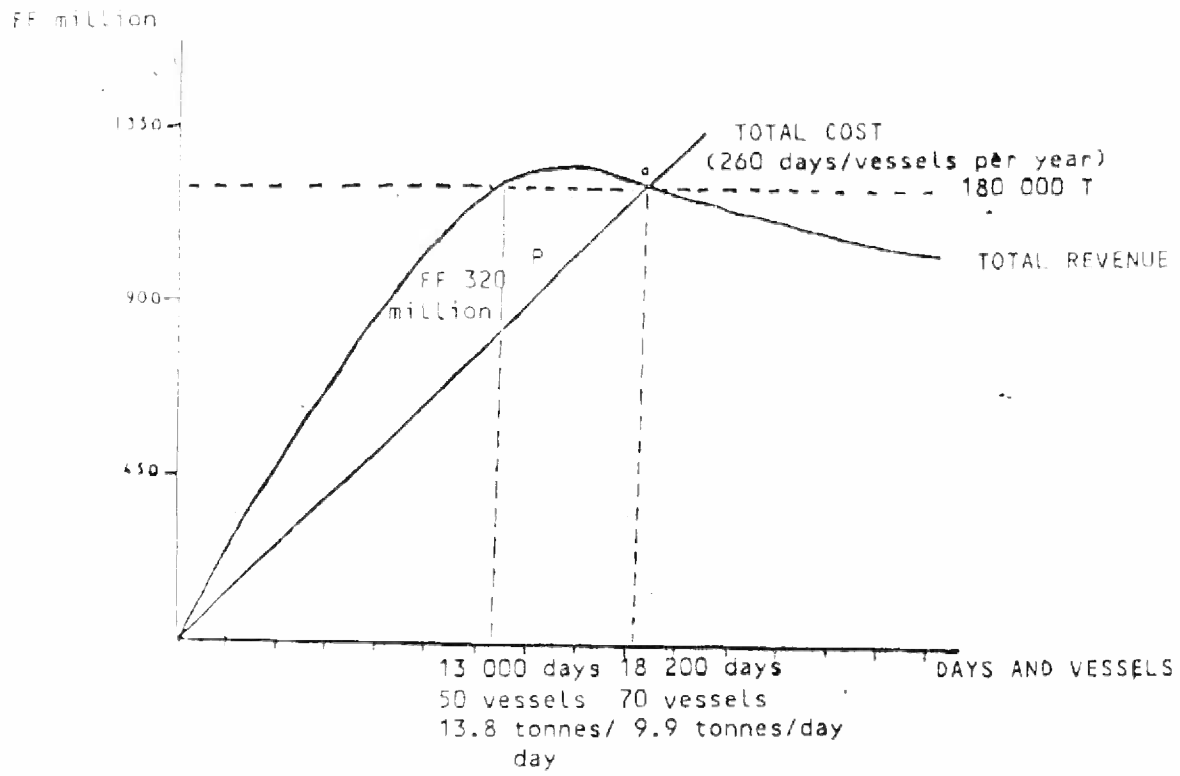
FIGURE 1



B. Licences vs. TACs

Figure 2, similar to Figure 1, illustrates the possible implications of a decision to curb total catch in two different ways:

- fishing licences which may enable maximum profit to be achieved if the number of vessels is limited to 50; the adoption of more effective fishing techniques supposes a reduction in the number of vessels (as long as maximum profit is the objective sought);

- quotas: the original existence of a profit may entail the operation, even within capacity, of a higher number of vessels than 50 (until nil profit is reached):
  with 95 vessels fishing for 137 days (i.e. 13 000 days and 13.8 tonnes/day), profit is nil:
  (revenue FF 1 120 million)
  (cost FF 1 120 million (variable cost FF 455 million
  fixed cost FF 670 million))

The quota technique may make it possible to achieve biological objectives (high level of biomass, of CPUE and total catches), but at a high economic cost in terms of profits.

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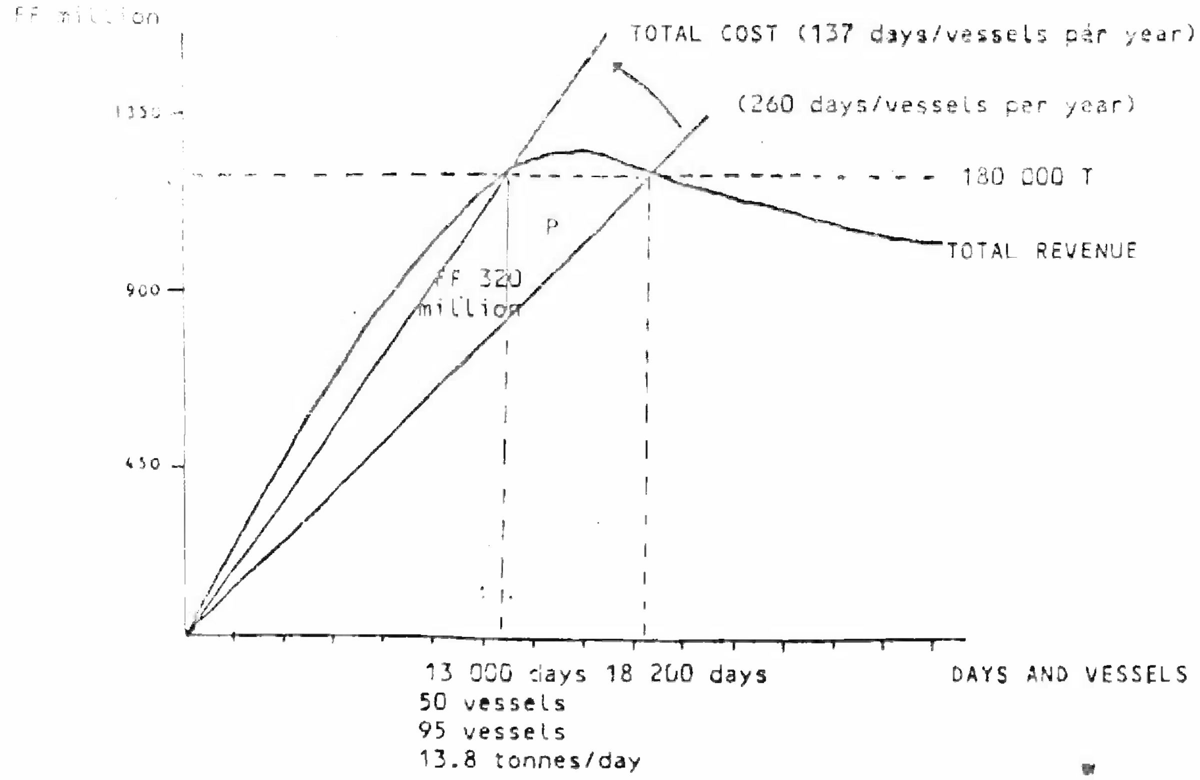
FIGURE 2


FF million
1350
900
450
TOTAL COST (137 days/vessels per year)
(260 days/vessels per year)
180 000 T
P
FF 320
million
TOTAL REVENUE
13 000 days 18 200 days
DAYS AND VESSELS
50 vessels
95 vessels
13.8 tonnes/day

BIBLIOGRAPHY

ACMRR , 1980
Working Party on the Scientific Basis of Determining Management Measures, Hong Kong, 10-15 December, 1979, FAO Fisheries Report (236): 149 p.

ANNALA (J. H.), 1983
"The introduction of limited entry: the New Zealand rock lobster fishery", Marine Policy, April pp. 101-108

ASADA (Y.), **HIRASAWA** (Y.), **NAGASAKI** (F.), 1983
"Management of fisheries in Japan", FAO Technical Document, Fisheries (238): 28 p.

BAIN (R.), 1983
"Vessel licences, gear control and fishermen licensing in Australia; Australian experience of these and related management measures", a paper presented to the FAO Consultation on the Limitation of Fishing Effort, Rome, 17-26 January, 19 p.

BEVERTON (R. J. H.), 1953
"Some observations on the principles of fishery regulation", J. Conseil (ICES), Vol. 19, pp. 56-68

BURKENROAD (M. D.), 1952
"Theory and practice of marine fishery policy", J. Conseil (ICES), Vol. 18, pp. 300-310

CHRISTY (F. T. Jr.), 1983
"Rights of territorial use in sea fisheries: definitions and conditions", FAO Technical Document, Fisheries (227): 11 p.

CLARK (C. W.), 1979
"Towards a predictive model for the economic regulation of commercial fisheries", University of British Columbia, Resource Paper N° 40, 65 p.

CRUTCHFIELD (J.A.), 1979
"Economic and social implications of the main policy alternatives for controlling fishing effort", J. Fish. Res. Board Can., 36, pp. 742-752

FAO , 1983
"Report from the Technical Consultation on the regulation of fishing effort (mortality by fishery)", Rome, 17-26 January 1983 - Preparatory Meeting for the FAO World Conference on fishery management and development - FAO Fisheries Report (289): 36 p.

FRASER (G. S.), 1977
"License limitation in the British Columbia Salmon Fishery", Economics and Special Industry Services Directorate, Pacific Region, Environmental Canada, Technical Report Series N° PAC/T-77-13, 74 p.

GORDON (H. S.), 1954
"The economic theory of a common property resource", Journal of Political Economy, Vol. 62, pp. 124-142

GULLAND (J. A.), 1969
Manual of methods for fish stock assessment: Fish population analysis, FAO manuals in fisheries science, N° 4, 154 p.

HOLDEN (M.), 1984
"Management of fisheries resources: the experience of the European Economic Community", in Experience of the Management of National Fishery Zones, enlarged meeting on problems of management of national fishery zones, OECD, 30 May-1 June 1983, pp. 126-135.

./.

HOUGHTON (R.G.), **NIELSEN** (N.A.), **de VERDELHAN** (C.), 1981
"Analysis of methods used to determine fishing capacity and establishment of a method suitable for Community needs", CEC, Internal Information on Fisheries, N° 12, 104 p.

ISTPM, 1983
"Initiatives relating to the improvement of current practices in the management of Community fisheries", internal document, December, 5 p., mimeo

KARPOFF (J. M.), 1984
"Insights from the markets of limited entry permits in Alaska", Can. J. Fish. Aquat. Sci., Vol. 41, pp. 1160-1166

LARKIN (P. A.), 1977
"An epitaph for the concept of Maximum Sustainable Yield", Transactions of the American Fisheries Society, Jan., Vol. 106, N° 1, pp. 1-11

LE GUEN (J.-C.), **CHEVALIER** (R.), 1983
"Studies of fisheries: considerations on the environment and multispecies management", Rev. Trav. Inst. Pêches Marit., Vol. 46(1), 1982, pp. 9-70

Mc KELLAR (N. B.), 1977
"Restrictive licensing as a fisheries management tool", Fishery Economics Research Unit Occasional Paper Series, Whitefish Authority, Edinburgh, October, 55 p.

Mc KELLAR (N.), **SCOTT** (I.), **CORMACK** (K.), 1983
"An update of the "case for aid" with a critique of alternative measures for fisheries management in the U.K.", See Fish Industry Authority, Fishery Economics Research Unit Occasional Paper Series, N° 4, 34 p.

PEARSE (P.), 1980
"Regulation of fishing effort: general considerations and application to trawling in the Mediterranean", FAO Technical Document, Fisheries (197): 80 p.

RETTIG (R.B.), 1984
"Licence limitation in the United States and Canada: an assessment", North American Journal of Fisheries Management, Vol. 4, N° 3, pp. 231-248

RETTIG (R. B.), **GINGER** (J. J. C.), 1980 (eds)
"Limited entry as a fishery management tool", University of Washington Press, Seatle, 463 p.

SCOTT (A.), 1955
"The fishery: the objective of sole ownership", Journal of Political Economy, Vol. 63, pp. 116-124

SCOTT (A.), 1979
"Development of economic theory on fisheries regulation", J. Fish. Res. Board Can., 36, pp. 725-741

SHEPHERD (J. G.), 1983
"Status quo catch estimation and its use in fishery management", STCF Discussion Paper, 261/XIV/83.E, 14 p.

TROADEC (J. P.), 1982
"Introduction to management of fisheries: value, difficulties and main methods", FAO Technical Document, Fisheries, (224): 64 p.

TROADEC (J. P.), **MAUCORPS** (A.), 1984
"Development of methods of managing fisheries with the new Law of the Sea", in Experience of Management of National Fisheries Zones, enlarged meeting on problems of management of National Fisheries Zones, OECD, 30 May-1 June 1983, pp. 148-160