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An investigation into effective management structure for tuna resources in the West Indian Ocean

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ABSTRACT

Tuna fisheries in the coastal states of the West Indian Ocean (WIO) have been at the centre of the social, economic and political development of the region. Their significance in creating employment, providing food, and generating revenue for the people in the region cannot be overemphasized. To be able to derive full benefits from the tuna resources in the WIO, the coastal states will have to devise an efficient management strategy, not individually, but collectively. Currently, there is no such management structure in the region to accomplish this goal.

This study is, therefore, an attempt to find some solution to this important issue, and to propose a suitable management framework that would guarantee an efficient and profitable tuna resource management mechanism in the region. To tackle this task, data were collected through documentary statistical sources as well as by the use of questionnaires. Information was received from many fisheries organisations, as well as from other international fishing institutions.

The results show that there is an urgent need for a regional organisation to manage tuna resources in the WIO, in order to avoid overfishing and stock depletion which will have adverse consequences on the economic and development prospects of both the coastal states and distant water fishing nations (DWFNs) operating in the region.

This study recommended the establishment of a "Regional Organisation for the Management of Tuna in the West Indian Ocean" (ROMTWIO) using a contingency-political model in recognition of the need for a systems organisational structure that reflects the political elements in the region. The organisation should address the issues of joint co-operation in self-determination and self-management of tuna resources in the region within the remit of existing international laws, and in recognition of the significant role other international bodies can play in the realisation of the benefits of a common tuna resources for all.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Fisheries have substantial social and economic importance to the coastal states of the West Indian Ocean (WIO). To the people of Madagascar, they are one of the main providers of food, employment and foreign exchange. One vital aspect of fisheries on which the lives of the citizens of Madagascar depends is tuna purse seine fisheries. A drastic reduction in tuna fish stock to biologically and ecologically harmful levels will result in a loss of potential benefits (food, income, and employment) both immediately and in the long-term. There is therefore the need to ensure prudent management of WIO coastal states' fish stock, especially the tuna species.

Fisheries management entails a complex and wide ranging sets of goals and tasks, aimed at securing maximum benefits for local users, state or region. This is very significant in the case of WIO coastal states. There are even greater management problems associated with such migratory fish species as tuna, not only in Madagascar, but also around the coastal states of the WIO. This is the focus of this study: to examine how best the management of tuna can be most effectively approached.

In this introductory chapter, an attempt has been made to highlight the important legal issues in world fisheries, and also provide an insight into the global trends in the management of fisheries, leading to the identification of the research problems, and then a statement of the research questions. The tuna and tuna fisheries in the Indian Ocean are described. The purpose and scope of this study are also discussed.

According to FAO (1996), world fish production reached a record of 109 million tonnes in 1994. The increase compared to the 1993 production figures was surprisingly high in view of global fish stock decline (Eurofish Report, 1995). The five per cent growth in world fish catches in 1994 was exclusively due to production increases in China, Peru and Chile, making the three countries the main fish production countries (FAO, 1996). There is no doubt that reaching this record level of production has

considerably increased the pressure on fish stocks to the point that the majority of the world's capture fisheries are regarded as over-exploited. FAO (1993) stress that the depletion of various stocks of fish has occurred in virtually all coastal states throughout the world, and whilst the declining stock base can be attributed to various factors, the most important of this is overfishing.

Generally, overfishing occurs when fishing operations are continued beyond the natural replenishment limit of a stock. A broad indication of overfishing includes a reduction or disappearance of the main commercial species, a diminution of size of the fish caught and an increase in the proportion of less valuable species landings (Gulland, 1974). This pattern has occurred in different fisheries in the world. Typical examples of overfishing are documented by FAO (1993) where *inter alia* significant drop in catches of Atlantic redfish, herring, mackerel and Pacific Ocean perch is noted. In the absence of regulation, natural economic forces often cause fishing effort to expand beyond the level needed to take the Maximum Sustainable Yield (MSY), consequently, the fish stock is reduced and further increases of fishing effort may possibly lead to the collapse of the stock. Thus, to avoid this problem, controls on exploitation are necessary. Therefore, the need to manage fisheries resources becomes critical.

The United Nations Convention on the Law of the Sea (UNCLOS, 1982), after long period of discussions, was opened for signature at the end of 1982. On the 16th November 1994, twelve months after the deposit of the sixtieth instrument of ratification, the Convention was established. Thus, the coastal states, as a result of UNCLOS became bound by the system for the compulsory settlement of Law of the Sea disputes laid down in the Convention (Brown, 1997). As noted by Slatyer (1987), the Law of the Sea is the "international law" that governs the behaviour of nations in the oceans. Freestone (1994) states that the Convention seeks to provide a comprehensive framework for the orderly exploitation and conservation of the world's oceans. Part 5 of UNCLOS is one of the most important outcomes of the Convention for the coastal states as far as the fishery resources and their conservation are concerned. It allows the creation of a 200-nautical miles Exclusive Economic Zone (EEZ) and recognises the sovereignty of coastal states over the living and non-living resources within this zone. In fact, it places under the jurisdiction of coastal states about 35 per cent of the world's oceans which account for about 95 per cent of the world's marine biological resources.

The conservation and management of the living resources of the high seas are dealt with mainly in Part 7, Section 2 of UNCLOS. The extension of jurisdiction has had several effects, the most important being the delegation of authority to coastal states which could potentially result in effective management of their fisheries resources.

Different provisions of UNCLOS, particularly Articles 61 to 68, define the conservation and management regimes applicable to different types of fish stocks. Tuna and tuna-like species are highly dispersed, i.e. the same species may be found across a wide area of the ocean (Slatyer, 1987). Owing to the migratory nature of tunas, their management comes under a number of different components of the Law of the Sea. Broadly, the disposition of the five types of stock identified below, and following the classification given by Caddy (1982), may apply to tuna and tuna-like species during their migration:

a) Category I: stocks within the EEZ

This category applies mainly to stocks that lie entirely within the EEZ of a single country. Article 56 gives coastal states sovereign rights for the purpose of exploring, exploiting, conserving and managing all the natural resources of the EEZ including fisheries. There are different opinions with respect to the term "sovereign rights" (Lowe, 1986; Burke, 1984), the general idea of which can be found in Articles 61 and 62 which encourages the coastal states to determine the allowable catch of the living resources in its EEZ and thereafter to determine the state's capacity to harvest these resources. Assuming the coastal state does not have the capacity to harvest the entire allowable catch, that coastal state has the duty to allow other states to have access to the surplus. The management of the fisheries resources occurring wholly within the EEZ of a single country can be carried out on an exclusively national basis. This has some implications for the management of fisheries in the WIO.

b) Category II: shared stocks

UNCLOS identifies shared stocks as the same stock or stocks of associated species occurring within the EEZs of two or more coastal states. The interdependency of the resources available to each zone would result in a consultative approach between the concerned coastal states. Article 63 (1) provides for such states to "seek and agree", either directly or through appropriate subregional or regional organisations, upon the

measures to co-ordinate and ensure the conservation and development of stocks occurring in their EEZs. This situation is applicable to the states engaged in management of their tuna resources around the West Indian Ocean.

c) Category III: straddling stocks

Transboundary or straddling stocks are defined as the same stock or stocks of associated species occurring both within the EEZ and in an area beyond and adjacent to the zone. As stated by McRae and Munro (1989), there is no recognition that ownership of a straddling resource is vested in the coastal state. Nevertheless, the coastal state has full authority over the straddling resource for the time when it comes into its EEZ. Problem arise when the straddling stock occurs outside the EEZ of the coastal state. In this case, UNCLOS (1982) simply provides for an element of co-operation. To this end, Article 63 (2) provides for the coastal state and the states fishing for such stocks in the adjacent area to "seek and agree", either directly or through appropriate subregional or regional organisations, upon the measures necessary for the conservation of these stocks in the adjacent area.

d) Category IV: highly migratory stocks

No operational definition of "highly migratory species" is given in UNCLOS. However, it provides in Annex I a list of 17 fish species that are included and qualified as highly migratory species as listed in Appendix A. The list includes nine species of tuna, 12 species of billfish, two tuna-like species, four species of sauries, pomfrets, dolphin fish, oceanic sharks and cetaceans. The problem here is similar to that of straddling stocks occurring outside the EEZ of a coastal state. Article 64 specifically deals with highly migratory species: it sets out a provision for coastal states and other states fishing in the region to co-operate, with a view to ensuring conservation and promoting the objective of optimum utilisation of such species throughout the region, both within and beyond the EEZs. The joint management of such highly migratory species as tuna falls under this category.

e) Category V: high seas stocks

High seas stocks are those stocks that exist beyond national jurisdiction. These stocks include species distributed essentially beyond 200-mile limits, though they may spend periods of their life cycles in areas under national jurisdiction (FAO, 1994). Article 87 states that the high seas stocks are subject to open access. Although Article 116 sets out the condition of freedom of fishing on the high seas, Article 118 requires that states exploiting such stocks or different ones in the same area "shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned". Several conflicts among European nations over fishing rights demonstrate the difficulties relating to the proper interpretations of this provision.

All the above five dispositions apply to tuna species during their biological cycle. This implies that their management should be co-ordinated through national, regional and international levels. However, Hilborn and Sibert (1988) conclude that many countries of the world are capable of managing skipjack and yellowfin tuna stocks without recourse to international catch regulations. Experience has shown that accomplishing international co-ordination is very difficult. Furthermore, UNCLOS prescribes only in general terms the co-operation and co-ordination needed to manage high seas resources. This ambiguous situation has resulted in coastal states and distant water fishing nations (DWFNs) taking various measures according to their interpretation of the Convention.

In response to UNCLOS, new international arrangements have been created in different parts of the oceans to deal with the management of fisheries resources. Prior to this event, many international fishery bodies were created for the acquisition of data, sharing of information and the implementation of conservation and management measures (FAO, 1993). Although these fishery bodies were successful to some extent some were abolished, or their role was considerably reduced, during the 1970s as national jurisdiction of coastal states was extended to 200 nautical miles from their shore. Concurrent with the creation of international fisheries bodies, there has been a resurgence of organisations dedicated to regional fisheries management. The South Pacific Forum Fisheries Agency (FFA) is a typical example. This body, in which membership is restricted to coastal states of the region, has operated relatively effectively in co-ordinating the negotiations of its member states with the foreign countries whose

vessels wish to gain access to the region and also in establishing minimum terms and conditions.

The trend over the past two decades has been to increase the strength of coastal states within regional arrangements and to decrease the role of the non-regional states, although attempts to resist this trend are still being made by DWFNs (FAO, 1993). Furthermore, the role of the regional fisheries organisations is expected to be further strengthened with the adoption of the "Agreement for the implementation of the provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks" (United Nations, 1995). The Agreement provides a comprehensive framework setting out the principles that should guide the management of transboundary marine resources and the means by which co-operation for the definition of management measures, and compliance to these measures should be achieved (Thébaud, 1996). Therefore, it is of considerable importance for the coastal states to adopt the Agreement and bring it into force as soon as possible.

Straddling and highly migratory stocks occur generally within the EEZs of coastal states and the high seas, and this particular feature creates considerable difficulty with respect to management of these resources. When a fishery is under the control of a single state, the conservation and management of the fishery falls under the responsibility of that state. Conversely, when a fishery is under the control of different states, the need for co-operation to manage that fishery is crucial. As noted above, experience shows that a co-operative management regime is very difficult to achieve. Usually, the DWFNs and the coastal states are on opposite sides of the issue (King, 1979). Furthermore, Windsor and Hutchinson (1996) opine that the difficulties in the negotiation of international fisheries treaty can be exacerbated by the wide national, cultural, sociological and economic differences that exist between those exploiting the resource. In this respect, UNCLOS (Part 7) is rather vague and prescribes only in general terms the rights and obligations of states relating to the exploitation of high seas stocks.

At the United Nations Conference on Environment and Development (UNCED, 1992), it was recognised that the regime for the high seas fisheries was in urgent need of further elaboration and development (Freestone, 1994). As a result, concerted efforts

were made to convene a "United Nations Conference on Straddling and Highly Migratory Fish Stocks", which eventually held its first organisational session in April 1993. The Conference had a total of six sessions, one of which was organisational and the remaining five were substantive (Doulman, 1995). The author, as Director of Fisheries of his country at that time was present at the second session, which was held in July 1993 in New York (USA). During the Conference, the author was in a position to observe the different views between participating states on the same subject. Broadly, a clear dichotomy emerged from the meetings. There is a big gap between the stand point of the DWFNs and the position of the other coastal states. The two groups of states have quite different interests with respect to the fisheries resources occurring in the high seas. As stated by Joseph (1991), in many respects, different interest groups such as coastal states and DWFNs will have different objectives. On the one hand, the DWFNs sought to keep their privileged position of freedom of fishing in the high seas as stated in Article 87 of UNCLOS. The coastal states, on the other hand, aware of the interdependency of the high seas resources and the resources occurring in their EEZs, voted in favour of restricting the high seas fishing within the same regime of management as their national waters. This conflict is nowhere more apparent and pressingly in need of resolution than in the tuna fisheries of the WIO, and this problem has served as the focus for the development of this study.

At the end of its sixth session in August 1995, the outcome of the Conference was the adoption of the "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks". The Agreement was opened for signature on 4 December 1995, and comes into force 30 days after the receipt of the thirtieth instrument of ratification or accession. The Agreement consists of a Preamble and 8 Parts divided into 50 Articles. It also has two annexes dealing with the standard requirements for the collection and sharing of data and guidelines for the application of precautionary reference points in the conservation and management of straddling and highly migratory fish stocks.

The main objective of the Agreement is to ensure the long-term conservation and sustainable use of straddling and highly migratory fish stocks through effective implementation of the relevant provisions of the Convention. Part II of the Agreement deals with conservation and management of high seas stocks. It puts emphasis particularly on the need to apply the "precautionary principles" widely to conservation, management and exploitation of straddling and highly migratory fish stocks. The concept of precaution requires management authorities to take pre-exemptive action where there is a risk of severe and irreversible damage to human beings and, by extension to the resources and the environment, even in the absence of certainty about the impact or the causal relationships (FAO, 1995). This precautionary approach is dealt with in Article 6 of the Agreement. Furthermore, FAO (1995) believe that the absence of adequate scientific information to establish precautionary limits should not be used as a reason for postponing or failing to take conservation and management measures. In essence, this disposition forms the basis of this study which argues that management measures for the tuna resources of the WIO should be taken although the available data and information are limited.

1.2 Issues in the management of fisheries

Panayotou (1982) defines fishery management as the "pursuit of certain objectives through the direct or indirect control of effective fishing effort or some of its components". This means that fisheries management is essentially "management by objectives". Alexander (1993) accepts this definition by stating that the term "management" refers to the regulation of activities and resources in fisheries in order to achieve certain objectives. Arnason (1993) broadly classifies fisheries management into two classes, i.e. biological and economic fisheries management. In most cases the most widely used objectives of fisheries management are the biological objectives of resource conservation and physical yield maximisation, whilst the economic objective of profit maximisation, and other political and social objectives, are concerned with employment and equity.

Traditionally, resource management systems have tended to accentuate the importance of the conservation of fish stocks, however, more recently there has been a trend to stress the economic, social, political and legal aspects (King, 1995). The long-

term goal of sustainability of fish resources appears to be the focus of modern fisheries management, particularly in the case of the coastal states that depend heavily on revenues derivable from the exploitation of fish resources. King (1979) observes that the majority of the coastal nations have recognised the need to protect their national fisheries, consequently, conservation has been the fundamental goal of their national fisheries management plans.

In reality, fisheries management means different things to different people (Schoning, 1984), but there are some basic features shared by the different definitions. These are: optimum utilisation of resources; realistic but simplified management and associated regulations; and appropriate allocation of resources among users (Carlander, 1969; Lackey, 1978). In all these definitions, the accomplishment of goals and objectives (Barber and Taylor, 1990) and taking decisions relating to what should be done with fishery resources regarding its perpetuation and profitability (Schoning, 1984), have dominated discussions. In the end, a more generally acceptable working definition has been provided by the FAO (1997) as:

> "the integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives".

This definition has been adopted as the most comprehensive and satisfactory definition for the purpose of this study.

Garrod (1987) opines that the aim of fisheries management globally is to maintain the overall stability of the industry with agreed shares for each of the participating countries, and to manage the stocks at a level which maintains both the catches and a profitable catch rate, based on the biological potential of the resources available. Similarly, Pope (1982) states that the essence of managing fisheries is to prevent too many fish being removed in any one year and to prevent fish being caught at too young an age, in order to guarantee a sustainable yield.

Wilson *et al.* (1994) have identified the central tenet of acceptable fisheries management as the long-term abundance of a single exploited species linked directly to the amount of fishing effort directed at that species. In essence, the main thrust of fisheries management practice is to exercise control over fish stocks by enforcing landing quotas and checking limits of effort. There are several arguments in favour of having in place a fishery policy to give focus to fisheries management. Gwiada (1993) thinks it would lead to more rational exploitation of fish stocks within the established EEZ; increase the efficiency of the fishing industry; stabilise incomes of fishermen and the fish market; and lead to better management of fishing effort. In the final analysis, the objectives of fisheries management can be identified as: maintaining stability; maximising the profitability of fishing; ensuring a steady supply of fish to the market; and guaranteeing sustainable yield.

Alexander (1993) outlines the different stages in fisheries management process as:

(i) data acquisition, assessment and monitoring phase which involves selected observation of key processes within the ecosystem, followed by an assessment of the ecosystem, and monitoring to determine the nature of the variations in the ecosystem;

(ii) planning involving the establishment of management objectives and the development of a strategy for action in order to achieve the objectives. It is at this phase that objectives are prioritised, and decisions on commitment to invest are made;

(iii) implementation of the management plan, and translating decisions into actions, policies into practice. Here, cost-effectiveness analysis is carried out to determine relative efficiency;

(iv) feedback system involving the analysis of the events of the previous stages of planning and implementation. Errors are rectified, success elements identified; and the fisheries management plan and policies are reviewed and updated.

FAO (1997) have outlined useful guidelines on fisheries management process. These include:

(i) setting policies and objectives for each fishery or stock to be managed in consideration with the biological characteristics of the stock, and the potential social and economic benefits to the people;

(ii) determining and implementing the actions necessary for all concerned to work towards identified objectives. This would mean that management plan will have to be

developed and implemented; fishery data will be collected, analysed and the information generated could be used for assessment, monitoring, control, and in achieving the objectives;

(iii) consulting and negotiating with groups engaged in activities in the coastal zones which have impacts on fisheries. Here, the management must ensure that the interests of fisheries are catered for adequately;

(iv) reviewing regularly the management objectives and evaluating them to ensure they are appropriate and effective, as well as acceptable to users;

(v) reporting to appropriate authorities, users and the public on the state of resources and management performance.

From these outlines on the fisheries management process, it becomes obvious that the essential components are: stating the objectives, assessment, planning, implementation, monitoring, evaluation, and the feedback mechanism.

In conclusion, fisheries management is important but global fisheries are common property resources, and there is need to control and maintain stability. Since it is not possible to rely on simple market forces to bring fisheries into a satisfactory equilibrium state, management is therefore vital. This should lead to co-operative action from all concerned, and may call for government intervention. The survival of many fisheries must depend on effective management.

1.3 Definition of concepts

Some common fisheries concepts used in this study are defined below:

(a) Maximum Sustainable Yield (MSY)

Broadly, maximum sustainable yield can be defined as the greatest physical yield that the stock can produce year after year (Gulland, 1974). Barber and Taylor (1990) explain that MSY was the fisheries management goal from the early 1900s to the late 1960s. The concept of MSY is relatively simple and straightforward and can be easily explained to the political and industrial sectors (Patterson, 1991). It can be calculated using either surplus-production or age-structured models. However, several authors (Larkin, 1977; Gulland, 1977b; 1984) have discussed the limitations of the MSY as a

fisheries management objective. The main criticism of MSY lies in the fact that it does not take into account the social and economic aspects of fishery. Nevertheless, as stated by Pope (1982), the long-term objectives of fisheries management are usually expressed as the attainment of MSY but the short-term objectives are expressed as some percentage change from the current level of fishing activity. Moreover, Kesteven (1997) opines that the starting point of a rational approach of a quota system is the definition of MSY. The approach taken in this study is that, despite the fact that there are wide varieties of management objectives, MSY should be the prime fisheries management objective of a coastal state owning valuable fish resources such as tuna. Besides, the concept of management based on MSY has been highlighted in UNCLOS (1982).

(b) Overfishing

Overfishing can be defined as fishing beyond the natural replenishment limit of a stock. Joseph (1991) identifies two different forms of overfishing:

i) Growth overfishing which occurs when the fish are exploited at relatively small sizes and are not allowed to grow to their full size before being caught. In other words, the effort applied to the fishery is too high and exceeds the effort needed to catch the MSY. Joseph (1991) argues that growth overfishing can lead to recruitment overfishing, although recruitment overfishing does not always follow from growth overfishing. Various measures can be used to avoid growth overfishing, but the essential one is to regulate effort applied to the fishery in relation to the effort at which it is expected that MSY will be landed.

Recruitment overfishing occurs when the abundance of mature fish is so reduced by fishing that the abundance of their progeny decreases, resulting in reduced catch of that species in subsequent years. Sparre *et al.* (1989) opine that a stock is recruitment overfished when the parent stock biomass is reduced to a level where there is a relationship between its biomass and the recruitment it can produce. To avoid recruitment overfishing, it is crucial to adopt certain measures in order to prevent the spawning stock size from falling to low levels. Experience has shown that it is more difficult to detect recruitment overfishing (as compared to growth overfishing) in tuna fisheries.

(c) Fishing effort

Rothschild (1977) points out that an understanding of fishing effort is fundamental to understanding the assessment and management of fish stocks. Indeed, fishing effort is the controllable variable that can be manipulated to optimise catch. Several authors (Clark, 1985; Cunningham *et al.*, 1985) have defined fishing effort as the number of standardised vessel-gear units actively fishing at a given time. Broadly, there are two kinds of fishing effort, i.e. "nominal fishing effort" and "effective or real fishing effort". The relationship between these two efforts can be expressed as follows:

$$F = q*f$$

where: "F" is the effective fishing effort and "f" the nominal fishing effort;

"q" is the catchability coefficient, which indicates the amount of fishing mortality induced upon the population by a unit of nominal fishing effort.

This research is concerned with purse seine fishing and thus it is necessary to analyse purse seine fishing effort. Defining the fishing effort in purse seine fisheries is particularly difficult due to the fact that searching for fish is a major element of the total time at sea (Williams, 1977). However, according to Hallier (1993), in purse seine fisheries, units of effort generally used are "fishing day" or "searching day". The indices of abundance derived from these efforts are therefore "catch per fishing day" or "catch per searching day". For the purposes of this research, the effort expressed in "fishing day" is used. Mathematically, the effort in "fishing day" can be represented as below:

Days fished = days spent at sea - days adrift due to mechanical breakdown or other work stoppage.

For a standardised set of fishing power and purse net characteristics vessel-gear units, the fishing effort depends mainly on the number of the units and on the fishing time, i.e. days fished. This is important for the regulation of the fishery by either restricting the number of units or the fishing time.

(d) Open access and common property

The understanding of these two concepts is important as they individually, or combined, form one of the main causes of resource depletion. Although the terms are often used to mean the same thing, Ciriacy-Wantrup and Bishop (1975) have pointed out that common property is not the same as open access.

i) Open access

Basically, open access means a situation of no rules. At the present time, the exploitation of the high sea fisheries is a typical example. Explaining when a given resource is open access, Baland and Platteau (1996) comment that the agents (fishermen) have to decide whether or not they should enter and exploit the resource. Their choice is based on the comparison between the price of entry which they have to bear and the expected income they will get. As long as the net expected benefit is positive, they decide to enter and exploit the resource. Because there are no restrictions, the exploitation will expand and continue until the net benefit is dissipated. This situation is more devastating for a highly valued resource where the fishery is still viable for a relatively low catch.

(ii) Common property

McCay (1996) relates common property to specific kinds of property institutions, whereby a certain group of people hold specific rights to use and enjoy certain resources in common. The main difference with the open access is that it supposes the existence of a well-defined group and the access to the resource is not open. Despite this difference, open access and common property can both generate resource abuse and economic losses. Concluding their analyses of open access and common property, Baland and Platteau (1996) stress that under open access, a "right of inclusion" is granted to anyone who wants to use the resource, whilst under common property, the "right of exclusion" is assigned to a well-defined group.

1.4 Fisheries management systems

All over the world, different systems and techniques have been used in the management of fisheries. The system adopted for any particular fishery, very often, is directed at the possible achievement of the goals stated, and to minimise problems in the

management of specific fish species. For instance, the system adopted in the management of the highly migratory tuna is bound to be different from the techniques used in managing the less migratory fish species.

Crean (1993) has outlined the main fisheries management mechanisms as:

(i) those measures directed at limiting inputs to fisheries resulting in a system of licences allocation to specific vessels or fishermen thereby controlling access to the resource;

(ii) checking outputs from the fisheries through the mechanism of total allowable catch (TAC), giving rise to quota systems;

(iii) other series of measures such as mesh regulations, closed seasons, taxes and subsidies aimed at reducing the overall level of exploitation through the indirect regulation of fishing effort.

Warren *et al.* (1982) in advancing the bio-economic model of fisheries management have outlined two systems, namely: reducing the size of the fleet while holding the days fished per vessel constant; and seasonal regulation. They are quick to add that both measures involve a reduction in fishing effort. Fleet regulation usually involves the limited licensing of fishermen or of boats as a means of unity catches by directly specifying the level of exploitation allowable. Limited entry schemes have been adopted in some fisheries. Sometimes, a transferable licence would tend to move fisheries towards profitable extremes, while a non-transferable licence could result in stagnation in fisheries (Pope, 1984).

Garrod (1987) explains that TACs are being applied to a large number of stocks as a basis for negotiating shares of fisheries resources between countries in order to achieve a given percentage stock harvest annually. Understandably, fishermen, fish processors and the market tend to prefer a constant TAC. In years of a high stock, the fishery would have to be closed early, and conversely, in years of a low stock, the need for a rapid and expensive injection of extra fishing effort to maintain TAC balance, becomes imperative. However, Crean (1993) points out that there are problems with the allocation of TACs as quota, and very often, fish businesses show some tendency to overcapitalise in order to increase their share of the TAC, with a possible result in the disruption in the pattern of fishing.

The Individual Transferable Quota (ITQ) system has become a widely used mechanism in fisheries management. There are currently at least forty individual quota management systems operating in the world's fisheries (Muse, 1991). Christy (1973) states that the ITQ system originated as a reaction to the failure of licence limitation programs to curb the impetus to increase gross fishing power despite the fact that the number of participants was held in check. Under the ITQ system, fixed quantities or shares of the TAC are allocated to individual operating units of vessels or companies licensed to fish the quota species. The principal objective of the ITQ system is to maintain tighter control over fishing effort thus reducing levels of overcapitalisation and leading to fishing fleet efficiency (Crean, 1993).

Mesh regulation is another system of fisheries management. It is based on the assumption that the optimal management of each species may require a different mesh size. For instance, a small-meshed purse seine can catch virtually everything that it encloses, whereas a large-meshed gear will catch only a determined size of fish. The regulation of mesh size is intended to protect particular species of specific sizes and ages, and bring about a check in overfishing and guarantee a stable stock.

Seasonal regulation is an important aspect of fisheries management. The usefulness of closed areas and seasons depends on the control strategies and the particular age or size of fish which needs to be protected. In the case of migratory species such as tuna, their value in terms of targeting specific fishing groups, and managing certain fisheries becomes difficult, expensive and almost hard to enforce (Warren *et al.* 1982; Garrod, 1987).

Caddy and Mahon (1995) opine that modern fisheries management is largely based on biometric or econometric models focusing on mathematical conceptualisation of fish populations. A number of theoretical issues raised by fishery models are discussed in Chapter 3. There has been some debate suggesting that the relationship between fishing mortality, stock biomass, and yield can provide the basis for "reference points". As Caddy and Mahon (1995) argue, if fishing mortality is applied over a number of years, it would produce an average yield equivalent to MSY; and the fishing mortality which maximises the average yield per recruit would result in the stock biomass that produces a

desired level of recruitment. In practice, most modern fishery management strategies are geared towards controlling fishing mortality or to sustain stock biomass at levels corresponding to target values using different approaches.

Analytical models incorporating growth and mortality rates and age at first catch, are frequently used in fisheries management especially in developed economies. In the final analysis, the value of reference points in fisheries management cannot be over-emphasised, and its utility and link to the logical framework analysis is valuable. It is in recognition of this fact that a logical framework analysis is provided at the end of this chapter.

1.5 Tuna and tuna fisheries in the Indian Ocean

More than twenty tuna and tuna like-species are known to occur in the Indian Ocean. Five of these species are at the present time exploited commercially, namely: skipjack (*Katsuwonus pelamis*, Linnaeus, 1758); yellowfin (*Thunnus albacares*, Bonnaterre, 1788); bigeye (*Thunnus obesus*, Lowe, 1839); albacore (*Thunnus alalunga*, Bonnaterre, 1758) and southern bluefin tuna (*Thunnus maccoyii*, Castelnau, 1872). There are other species of relative commercial importance commonly known as little tunas, like kawakawa (*Euthynnus affinis*, Cantor, 1849), frigate tuna (*Auxis thazard*, Lacepède, 1800), bullet tuna (*Auxis rochei*, Risso, 1810) and longtail tuna (*Thunnus tonggol*, Bleeker, 1851), which are essentially exploited by artisanal fisheries. The tunas are the target of a number of different fishing fleets. They may be broadly divided into artisanal and commercial fishing operations. The latter are characterised by the use of longline and purse seine fishing methods. Of the 758,405 tonnes of tuna caught in the WIO in 1994, purse seiners accounted for about 40 per cent, followed by gillnetters (20 per cent), longliners (9 per cent) and other fishing gears (31 per cent).

Fishing operations in the Indian Ocean yielded a total of 968,419 tonnes of oceanic tuna in 1994 (FAO, 1996). This shows a decline compared to a catch of over one million tonnes in 1993. However, the 1994 figure represents about 21 per cent of the total world landings of tuna and classifies the region in second place after the Pacific Ocean. FAO, for statistical purposes, divides the Indian Ocean into three main fishing areas: FAO Statistical Area 51 which includes the western part of the Indian Ocean,

FAO Statistical Area 57 for the eastern Indian Ocean and FAO Statistical Area 58 for the Antarctic Indian Ocean. Fishing activities in the western part of the Indian Ocean account for about 78 per cent of the total tuna catch from the Indian Ocean.

1.5.1 *Artisanal tuna exploitation*

Tuna and tuna-like species have been caught in the artisanal fisheries of the Indian Ocean coastal states for centuries; for example, yellowfin tuna has been exploited for more than 200 years (Anderson and Hafiz, 1985). The artisanal fisheries in the WIO employ various types of fishing gears such as gill nets, trawls, hand lines, troll lines, seine nets and so on. The catches consist mainly of skipjack, juvenile yellowfin and little tunas. Although the degree of development of the artisanal fisheries varies greatly between the island and coastal states of the region, it is important not to underestimate the social and economic contributions artisanal fisheries make. Whilst artisanal fisheries development is minimal in Madagascar, the sub-sector is important in the Comoros and Maldives as identified in Chapter 5. The evaluation of the total catch from these fisheries is hindered by the lack of reliable statistics. Moreover, the standardisation of the fishing effort poses a serious problem due to the many varieties of fishing gears used.

1.5.2 *Commercial tuna exploitation*

The commercial fishery for tuna and tuna-like species started in the Indian Ocean at the beginning of the 1950s and at first developed gradually from a few vessels to more than 400 longliners and 50 purse seiners active in the region in 1995. In the early years of the fishery, longlining was the most commonly used fishing technique and was employed by fleets from Japan, Korea and Taiwan. Purse seining was not introduced to the region until the early 1980s, as a result of successful experimental commercial trials by fishing fleets from France.

a) The tuna longline fishery

The tuna longline fishery was initiated in 1952 by Japan and at first confined to the eastern equatorial Indian Ocean. By the early 1960s, the areas fished covered almost the whole Indian Ocean. In 1971, Japanese longliners started fishing operations in the waters of Madagascar, but despite their good catches, they ceased activities in 1975,

apparently for economic reasons (Info-pêche, 1994). Initially, Japanese longliners targeted mainly albacore and yellowfin tuna. After 1975, the fishing pattern of Japanese longliners shifted from the regular to the deep type, and the target species changed from the albacore and yellowfin to southern bluefin and bigeye tunas (Suzuki, 1991). The change in fishing pattern and consequently the target species was probably driven by the changing world market. Moreover, targeting the two most highly valued tuna for the Japanese *sashimi* market, i.e. southern bluefin and bigeye tunas, was relatively more profitable than targeting other species.

Currently, the Japanese longline fishery operates about 180 vessels in the Indian Ocean. Generally, the fishing effort in the longline fishery is expressed in numbers of hooks. Thus, the total Japanese tuna longline fishing effort applied to the Indian Ocean fishery in 1994 was 76 million hooks. This was about 60 per cent of the peak effort which occurred in 1985 (Anon, 1995). The fishing activities on the grounds were relocated in some cases moving southward of 40° S for southern bluefin tuna or northwards of 15° S for bigeye tuna.

The Korean longline fishery began in 1957, and became commercial in 1965 (Park, 1991). The main targets were bigeye and yellowfin tuna and the fishing activity was concentrated north of 10° S in the Indian Ocean. About 50 Korean tuna longliners are active in the region at the present time (Anon, 1995).

The Taiwanese longline fishery started in the eastern Indian Ocean in 1956 and expanded to the entire Indian Ocean in 1963. Similar to those of the Japanese, two kinds of fishing patterns are involved in Taiwanese longline fishery, i.e. regular longline and deep longline, which have quite different target species (Hsu and Liu, 1991). Regular longliners operate at or near to the surface water layer and thus target mainly albacore, bigeye and yellowfin. Deep longliners operate in waters close to the thermocline and target bigeye, yellowfin and sometimes southern bluefin tuna. A total of 250 Taiwanese deep longliners and 58 regular longliners fished in the Indian Ocean in 1994 (Anon, 1995).

b) The tuna purse seine fishery

Commercial trials of purse seining started in the Indian Ocean in 1979 and full scale commercial activities started in 1982 (Lablache and Lestang, 1988). Presently the purse seine fishery contributes the largest catch in the western part of the Indian Ocean with landings of 305,000 tonnes in 1995 whilst that of the longliners is estimated to be around 70,000 tonnes. The purse seine fishery is dominated by foreign fleets mainly from France, Spain, Panama and Liberia (see Table 1.1). The Panama registered vessels are managed by Spanish interests whilst Liberian registered vessels are those previously belonging to the former USSR. Amongst the coastal states of the region, Mauritius has established three purse seiners since 1987 and Seychelles two purse seiners. However, the total catch from these purse seiners are far less than the catch from countries outside the region.

Table 1.1 Tuna purse seiners fishing in the WIO by country, 1990-1995

Country	1990	1991	1992	1993	1994	1995
France	21	18	17	17	17	17
Spain	25	20	19	22	18	16
Japan	5	11	12	11	1	0
Panama	1	1	3	3	3	2
Russia	9	5	5	4	0	0
Liberia	0	0	0	0	7	9
Mauritius	2	3	3	3	3	2
Seychelles	0	2	1	0	0	0
Others	0	1	0	0	4	3
Total	63	61	60	60	53	49

Source: Seychelles Fishing Authority (SFA, 1995).

The Japanese tuna purse seine fishing vessels began to withdraw from the WIO in 1994 and were absent in 1995. This withdrawal was due probably to the eroding profitability of the Japanese operations, in the face of competition from fleets from China and Taiwan. Taya (1995) believes that the profitability of the Japanese tuna fishing declined each year and thus the fishing enterprises took various streamlining measures to

survive. For example, they were withdrawing from the Pacific West longitude fishing ground and reforming the fishing fleet to focus on bluefin tuna. The number of the European Union (EU) vessels has decreased steadily from 46 in 1990 to 33 in 1995. This can be attributed to the return of part of the EU fishing fleet to their previous fishing area, the Atlantic Ocean. Presumably, the decrease share of yellowfin in the total catch composition in the Indian Ocean is the main cause of the return to the Atlantic Ocean.

1.6 Research questions

Fisheries exploitation is one of the major economic activities of the majority of the coastal states of the WIO. It is one of the main sources of revenue to the governments, on which the implementation of the various development programmes is dependent. The fishing industries provide employment to the people and therefore, in addition to serving as a major source of food and jobs, the quality of life of the people is tied to the prosperity of the fishery industry. Tuna species constitute the bulk of foreign fisheries activities not only in the Malagasy oceanic environment, but in many other coastal states and international waters of the WIO. Because of the highly migratory nature of tuna species, management problems exist. If the economic development and the well-being of the country and people of Madagascar and the other regional states is to be maintained, effective fisheries management strategies for the future will have to be devised, and this calls for a proper understanding of the best ways to manage tuna purse seiners throughout the WIO.

This research, therefore, originated from the concern about how to manage tuna resources in Malagasy waters effectively, and to generate optimum benefits for the people and the country. The focus is on tuna fisheries management in the waters of Madagascar and bordering coastal states of the WIO.

This study will seek to answer the following questions:

(i) What is the status of the main tuna species available to the purse seine fishery?

(ii) What are the organisational patterns for the exploitation of tuna purse seiners in the region?

(iii) What are the capabilities of the existing fisheries organisations in Indian Ocean?

(iv) Are there good reasons for the creation of a new fisheries organisation for the management of tuna resources in the region?

(v) Which coastal states would participate in a new fisheries organisation?

(vi) What would be the most suitable organisational structure for tuna fisheries management in the WIO?

1.7 Purpose of the study

The main purpose of this study is to examine ways in which a permanent organisational structure can be established for the effective management of the tuna resources in the region of the West Indian Ocean. At present, there is no such structure in the fisheries management arrangement in Madagascar and possibly in the other regional states. In order to be able to achieve this goal, this study will address the following issues:

(i) review the literature on the management procedures for tuna fisheries in different parts of the world so as to obtain some ideas on how to tackle the issue in the study region;

(ii) examine available information on the Malagasy tuna fishery with the aim to highlighting the objectives, institutions, profiles, and industrial issues;

(iii) identify the tuna management boundaries in the region;

(iv) highlight the fisheries organisations of the study region;

(v) discuss the different aspects of the population dynamics of the tuna species targeted by the purse seiners in the region;

(vi) discuss the different issues related to regional management of tuna species; and,

(vii) suggest an alternative management organisation for the West Indian Ocean tuna fisheries.

1.8 Structure of the thesis

In Chapter One, background information on the legal elements of world fisheries is provided together with the examination of the issues involved in fisheries management. Concepts are explained and the research questions and purpose of the study spelt out.

The chapter also outlines the structure of the thesis. Finally, a logical framework analysis is provided to give focus to the study.

Chapter Two reviews the world tuna fisheries literature and presents the main characteristics of the major species of tuna, their exploitation and the regional and international regimes applied to their management, and the future prospects.

In Chapter Three, the research methods are explained. This includes the models, identification of the study area, data collection procedure, analysis of data, and the logical framework approach.

Chapter Four describes the Malagasy tuna fishery, highlighting the fishery sector and the international fisheries agreements and their impact on the national economy.

Chapter Five traces the regional management boundaries and identifies the member states who would be represented in any new fisheries organisation.

Chapter Six highlights issues in organisational theories, systems and analyses the performance of the existing organisations using contingency approach.

Chapter Seven deals with data analysis and discussion of the results.

Finally, chapter Eight summarises the different conclusions reached and made recommendations. It proposes a regional organisation for the management of tuna in the WIO based on contingency-political model.

1.9 Scope of the study

The research has focused only on one aspect of the tuna fishery in the WIO, i.e. the tuna purse seine fishery. The result is therefore valid for this particular fishery and could not be generalised to the other fisheries. The implementation of a management plan is vital in order to regulate the tuna fishery in the WIO. Although the interaction between the three fisheries, i.e. purse seine, longline and artisanal fisheries is thought to be marginal, the fusion of the three management plans into one overall management plan for the purpose of effective management of the tuna resources in the WIO would be valuable.

Differences in the fisheries policies of the various coastal states mean that generalisations must be made with some caution. For example, the Maldives exploit fully their tuna resources from catching to marketing whilst Kenya and Somalia do not have the same policy (see Chapter 5)

The review and analysis of the coastal states that would constitute the new management organisation were limited by several factors such as time, money and up-to-date information. In fact, further and detailed analyses could be performed if these three resources were available.

Although every care has been taken to cross-check the tuna fisheries data used in the analysis, they do show some slight inaccuracies and in due course it will be necessary to improve the accuracy of these data by updating and improving the data collection systems within the appropriate framework.

The late submission of data from the DWFNs, with delays of sometimes up to two years, impinges on effectiveness of the task of stock assessment. For example, the data currently available cover the fishing period of 1995, and accordingly, the present stock assessment works are based on these data.

The confidentiality of some specific data such as those related to financial exploitation of tuna purse seiners or those describing exactly the locations of the best fishing grounds has limited the scope of the analysis.

The analysis of the questionnaire survey was relatively limited by the fact that certain fisheries organisations felt that they could not express their opinions without the consent of the member states.

Finally, the models used for data analysis have some limitations as explained in Chapter 3.

1.10 Logical Framework Approach (LFA)

The Logical Framework Approach provides a starting point for more detailed planning of the implementation of projects. Although the LFA was developed mostly to cope with the requirements of donor organisations, it is nevertheless a useful tool for initial project planning, co-ordinating all the major issues affecting all participants and beneficiaries of a project, and also assisting the subsequent evaluation of projects in the

fisheries sector (Haywood and Palfreman, 1994). The LFA is used in the thesis mainly to identify the major issues in improving the management of the WIO tuna purse seine fishery. As a system of analysis, the LFA has its advantages and limitations. NORAD (1996) summarises some of the limitations and those related to this project can be abstracted as follows:

Information can only be provided at a general level and is complementary to, rather than a substitute for the detailed planning that is also necessary for efficient project management.

In wide-ranging projects it will be difficult to converge on a few identifiable objectives.

Sometimes, the means of checking on changes in objectives can also be tenuous, e.g. it is easy to verify that 20 fishermen have attended a training course but more difficult to ascertain if their performance has improved and can contribute to the real progress of the project.

In order to give this study the focus it deserves, a project framework on how to improve the management of the WIO tuna purse seine fishery has been provided as shown in Table 1.2. It highlights the sectoral regional objectives, and outlines measures for achieving these objectives and provides corresponding means for verification. In addition, issues have been speculated on possible risks and other conditions that could impact on the project.

Table 1.2 Logical Framework Analysis

PROJECT TITLE: To improve the management of the West Indian Ocean tuna purse seine fishery.

PROJECT FRAMEWORK

PROJECT STRUCTURE	INDICATORS	VERIFICATION	ASSUMPTIONS, RISKS AND CONDITIONS
Sectoral regional objectives	Measure of achievement:		On which wider objectives are based:
1. Improved relationship between coastal states of the region	-Exchange of information	-National reports	-Political support at national and regional levels essential to engender co-operative behaviour is available
	-Regional workshops and meetings	-National reports	
	-Diplomatic contacts	-National reports (internal and published)	-Language and cultural barriers can be overcome

Sectoral regional objectives	Measure of achievement		On which wider objectives are based
2. Improved economic performance through tuna industry development:			
	-Fishery trade balance	-Ministry of trade	-Assumes existence of an efficient and effective monitoring control and surveillance
	-Contribution of fishery to national income	-Balance of payments -National reports	-DWFNs willingness to co-operate is imperative
	-Number of fisheries agreements	-National reports	-Assumes that coastal states have the bargaining power in negotiations with DWFNs
	-Quality of fisheries agreements	-Financial compensation	-Third party fisheries agreements
	-Per capita income	-Annual revenue -National income	-Assumes that it is possible to generate a fair distribution of benefits derived from the fishery

Sectoral regional objectives	Measure of achievement		On which wider objectives are based
* Employment	-New jobs created	-Employment statistics	-Sufficient motivation for people to enter tuna fisheries employment -Appropriate incentives are available -Availability of training programme
* Regional development	-Number and location of new infrastructure	-National reports	-Assumes the existence of an effective policy for development
3. Manage the tuna resource of the region at MSY level	-Biomass estimates -Total allowable catch	-Sampling programmes -Tuna production surveys -Logbooks	-Assumes that the coastal States are aware of their common tuna resources -Assumes the compliance of DWFNs in relation to the management regimes in place

Specific objective of the project:	Conditions at end of project		On which specific objectives are based:
1. To create a "Regional Organisation for the Management of Tuna in the West Indian Ocean (ROMTWIO)	-New fisheries organisation operates more efficiently	-Co-ordination of regional data collection -Publication of regional fisheries statistics	-Assumes participation of the coastal states of the region -Assumes financial support needed to create the organisation is available
	-Sustainable tuna resources	-Harmonisation of regional fisheries policy	-Assumes that appropriate national fisheries laws and regulations exist
	-Indicators to show improved utilisation of the resource especially in relation to economies of coastal states	-State budget	-Assumes existence of an efficient and effective monitoring control and surveillance -Assumes existence of national economic policy
	-Less conflict between resources users	-Management plan for tuna resources	-Assumes adhesion of coastal states
	-Less unauthorised fishing activities	-Regional fisheries vessel registration	-Assumes efficient and effective monitoring control and surveillance
	-Benefits accruing to the development of tuna fisheries	-Creation and implementation of regional tuna industries	-Harmonisation of national fisheries policy

Project outputs:	Magnitude of outputs:		On which outputs are based:
1. New fisheries organisation	-Headquarters based in one country of the region	-Implementation of the new organisation	-Ability to win the support of the different national political systems
2. Improved relations between coastal states	-Diplomatic relations -Development of trade agreements in fisheries and other sectors	-Import/Export trade	-Awareness and willingness to co-operate
3. Improved relations between coastal states and DWFNs	-Embassies/Consulates	-Aid and subvention programmes	-Awareness of mutual benefits gained from co-operation
4. Improved benefits to coastal states	-Recovery of stock: * CPUE * Size distribution	-Stock assessment -Commercial survey reports	-Efficient management regime applied to the fishery
5. Change in distribution of benefits amongst coastal states	-Change in earnings with respect to tuna	-National reports -GDP and GNP	-National economy policy

Project outputs:	Magnitude of outputs:		On which outputs are based:
6. Development of vertical integration in tuna fisheries	-Tuna catching, processing and marketing by a national/regional industries	-Creation, implementation and exploitation of tuna regional industries	-Sufficient support to private sector
	-Secondary activities related to tuna fisheries	-Emergence of new enterprises	-Sufficient support to private sector

Project inputs:	Implementation targets:		On which inputs are based:
1. Political impetus (support from coastal states)	-National Government of each coastal State of the region	-Membership of the new tuna organisation	-Political regime in place
2. Input of technical regional expertise	-National fisheries experts -Regional fisheries experts	-Number of national/regional experts	-Existence of efficient national/regional experts
3. Training at high level	-Fisheries directors and managers	-National/regional personnel register	-Availability of training programmes -Availability of personnel -Motivation for training

Projects inputs:	Implementation targets:		On which inputs are based:
4. Financial input	-Bank transfers from member states	-New organisation account	-Effective payment by the member states
5. Monitoring, control and surveillance (MCS)	-Tuna management boundaries of the WIO	-MCS plan	-Funds allocated for MCS

CHAPTER TWO

REVIEW OF THE LITERATURE ON WORLD TUNA FISHERIES

2.1 An overview

Over the last two decades, tuna has become the second most important fishery in the world market. The world production of tuna and tuna-like species has increased steadily from an average catch of about 1.9 million tonnes in the early 1970s to a peak of 4.577 million tonnes in 1993 (see Table 2.2), declining slightly to 4.575 million tonnes in 1994 (FAO, 1996). This decline was partly due to a reduction catch of yellowfin tuna falling to 1.074 million tonnes in 1994, compared to a catch of 1.161 million tonnes in 1993. Tuna is one of the most valuable commercial fisheries resources and therefore constitutes an asset for the coastal states in whose waters they inhabitat. Indeed, many coastal states, particularly the small island nations in the Pacific and Indian oceans, rely on tuna as their prime source of foreign exchange earnings; for the states, proper management of tuna resources is therefore crucial to maintain the benefits derived from the exploitation of the resources.

As indicated in ADB/Infofish (1991), the tuna stocks in the Pacific, Atlantic and Indian Oceans have never really been subject to effective conservation and, as fishing effort continues to increase, the application of effective conservation measures will be needed to prevent the tuna stocks from seriously declining. FAO (1993) is concerned that many of the stocks of the principal market species of tuna appear to be fully exploited and some stocks are overfished.

It is necessary to understand the prevailing situation of the world tuna resources, their exploitation, utilisation and marketing in view of the management requirements. This will not be possible without an extensive knowledge of the biological aspects of the tuna resources. Thus, the aims of this chapter are:

i) to review the main characteristics of major tuna species and their biology;

ii) to review world production of the main commercial tuna species, fishing techniques and main fishing areas;

iii) to review the prevalent management regimes in operation;

iv) to present the prospects of the world tuna fisheries and the factors that may impact on the fisheries; and,

v) to present recommendations and conclusions for the management of tuna fisheries which are relevant to the WIO situation.

2.2 Classification of commercial tuna species

The expression "tuna" and "tuna-like" species applies to all genera of the family Scombridae, except *Rastrelliger* and *Scomber*, and to all genera of the families Istiophoridae and Xiphiidae (Klawe, 1980). The Scombridae is a family of 15 genera and 49 species of mostly epipelagic marine fishes, the mackerels, Spanish mackerels, bonitos, and tunas (Collette and Nauen, 1983). The family Scombridae is essentially confined to marine waters and is divisible into two subfamilies: the Gasterochismatinae and the Scombrinae. On the basis of internal osteological characters the Scombrinae can be divided into two groups of tribes, and the tunas and tuna-like species are of the tribe Thunnini as shown in Figure 2.1. The Thunnini are unique among bony fishes in having counter-current heat exchanger systems that allow them to retain metabolic heat so that the fish is warmer than the surrounding water (Collette and Nauen, 1983). Generally, tunas are fast swimming and known to migrate extensively and have a world-wide distribution. Although tunas generally prefer more oceanic habitats, they are mostly found in the tropical and subtropical areas. The migration of tuna and tuna-like species is known to be related to their constant search of food. In fact, they can consume daily up to 15 per cent of their weight. Mainly, tunas feed on small fishes, crustaceans, and squids. Table 2.1 shows their characteristics.

Figure 2.1 Classification of commercial tuna species

Phylum Chordata

↓

Subphylum Vertebrata

↓

Superclass Gnathostomata

↓

Class Osteichthyes

↓

Order Perciformes

↓

Suborder Scombroidei

↓

Family Scombridae

↓

Sup-family Scombrinae

↓

Tribe Thunnini

↓

Genus *Katsuwonus*	Species *pelamis*
Genus *Thunnus*	Species *albacares* Species *alalunga* Species *maccoyii* Species *obesus* Species *thynnus*

This classification of commercial tuna species shown in Figure 2.1 has been taken extensively from Collette and Nauen (1983) and Wild and Hampton (1993) following Lindberg's (1971) scheme. It identifies the position of each commercial tuna species within the family Scombridae.

Table 2.1 Characteristics of the major commercial species of tuna

Species	Typical size range	Typical weight range	Geographical distribution	Fishing techniques used in its capture	Fishing areas
Yellowfin tuna *Thunnus albacares*	70-150 cm	3-50 kg	Tropical and subtropical seas, absent from the Mediterranean	Purse seine Pole and line Longline	Western Central Pacific Eastern Central Pacific Eastern Central Atlantic Western Indian Ocean
Skipjack *Katsuwonus pelamis*	45-80 cm	2-6 kg	Tropical and warm-temperate waters Absent from the Black Sea	Purse seine Pole and line	Western Central Pacific Eastern Central Pacific Eastern Central Atlantic Northwest Pacific Western Indian Ocean
Albacore *Thunnus alalunga*	40-90 cm	4-15 kg	Tropical and temperate waters	Longline Live-bait and line fishing Trolling	Northwest Pacific Northeast Atlantic Eastern Central Pacific
Bigeye *Thunnus obesus*	90-180 cm	20-80 kg	Tropical and subtropical seas, absent from the Mediterranean	Longline Pole and line	Eastern Central Pacific Western Central Pacific Western Indian Ocean
Northern bluefin *Thunnus thynnus*	160-200 cm	40-200 kg	Tropical and subtropical seas	Longline Pole and line	Atlantic Ocean Pacific Ocean Mediterranean Sea
Southern bluefin *Thunnus maccoyii*	160-200 cm	40-130 kg	Southern oceans between 30° and 50° S	Longline Live bait and line fishing	Eastern Indian Ocean Tasman Sea

Sources: Collette B. B. and Nauen C. E., 1983; ADB/INFOFISH, 1991.

2.2.1 Skipjack tuna, *Katsuwonus pelamis* (Linnaeus, 1758)

Skipjack tuna is an ubiquitous species, being distributed throughout most of the tropical and subtropical regions of the world (see Table 2.1), and occurring occasionally in commercial quantities as far north as 45° N and as far south as 40° S (Joseph, 1995).

Skipjack tuna exhibits a strong tendency to school in surface waters and therefore is most frequently caught by surface gear, such as purse seine and pole and line. This species is found in most parts of the Indian Ocean. Although skipjack tuna is believed to

have a continuous spawning season throughout the year in the Indian Ocean. Conand and Richards (1982) have observed large juveniles concentrations in the south of Somalia and northwest off Madagascar particularly between November and April. This may have a great implication in applying conservation measures based on closure of the fishery on spawning grounds during the spawning season.

Skipjack tuna landings have increased over the years and have become the most important component of the total world tuna catch (see Table 2.2). Despite the fact that many tuna stocks appear to be heavily or fully exploited, skipjack is rather an exception in all oceans (FAO, 1993). Although the peak year for catches of skipjack was 1991 when it was close to 1.6 million tonnes, it has shown a steady increase over the years and in 1994 levelled off around 1.5 million tonnes, or 47 per cent of the total catch. In his forecasts, Joseph (1995) noted that annual catches of skipjack could theoretically reach 1.9 million tonnes (see Table 2.6) by the turn of the century.

2.2.2 Yellowfin tuna, *Thunnus albacares* (Bonnaterre, 1788)

Yellowfin tuna ranks second in terms of world catches, and in 1994 accounted for just under 1.1 million tonnes (see Table 2.2), or 35 per cent of the total catch. Bartoo (1987) states that yellowfin is widely distributed throughout the Atlantic, Indian and Pacific Oceans between 40-45° N and 40-45° S.

Yellowfin tuna is one of the prime targets of longliners as well as the artisanal fisheries and surface purse seiners. Yellowfin is widely distributed throughout the Indian Ocean. Juveniles concentrations have also been reported from November to April in the Seychelles, off Madagascar and in the Mozambique Channel.

Despite some minor fluctuations, yellowfin tuna landings have been fairly stable. The peak year for yellowfin landings was 1993 when catches reached just over 1.16 million tonnes, then decreased to 1.07 million tonnes in 1994. Joseph (1995) states that most assessments of yellowfin stocks indicate that in areas where the species is fished it was fully exploited. It is therefore less certain for yellowfin than for skipjack to expect that increased fishing effort can lead to increased catches. As a consequence, the exploitation of yellowfin tuna has been regulated through international agreements in the

Atlantic and Pacific Oceans. Various measures have been taken such as minimum size regulation of 3.2 kg in the Atlantic Ocean and annual catch quota in the eastern Pacific Ocean. Nevertheless, these different regulations have not had a significant effect on the conduct of the yellowfin fishery (Sakagawa, 1991).

2.2.3 Bigeye tuna, *Thunnus obesus* (Lowe, 1839)

Bigeye is the third most important tuna species by volume. In 1994, bigeye tuna accounted for about 290,000 tonnes (see Table 2.2), or 9.5 per cent of the total catch. Bartoo (1987) states that bigeye tuna is widely distributed throughout the Atlantic, Indian and Pacific oceans.

Bigeye are the prime target of Asian longliners which catch the large deep-swimming individuals. The small ones are caught by pole-and-line and to a lesser extent by purse seining. Stéquert and Marsac (1989) found that bigeye spawn from January to March over a wide area extending to the eastern and western Indian Ocean. Particularly, great concentrations of juveniles have been observed in the northeast off the Maldives from May to October.

The FAO (1990) and ICCAT (1993) state that bigeye tuna were being fished at a level close to maximum sustainable yield in both the Indian Ocean and Atlantic Ocean. Furthermore, Joseph (1995) notes that bigeye stocks in both the Atlantic and Pacific oceans are almost certainly fully exploited, and probably overexploited, and evidently cannot sustain any increases in catch. Therefore, no increase in bigeye catches, and probably even a decrease, is expected by the end of the century.

2.2.4 Albacore, *Thunnus alalunga* (Bonnaterre, 1788)

Albacore is the fourth most important tuna species by volume. In 1994, albacore accounted for about 190,000 tonnes (see Table 2.2), or 6.3 per cent, of the total catch. Bartoo (1987) opines that albacore tuna is widely distributed throughout the Atlantic, Indian and Pacific oceans.

In the Indian Ocean, as stated by Stéquert and Marsac (1989), the main longline fisheries for albacore are situated between the east and northeast of Madagascar as well as along the east coast of Africa. The juveniles distribution is mainly found in two separate and distinct zones, one in the eastern and the other in the western Indian Ocean from November to April.

The landings of albacore have fluctuated over the past few years. Since the ban of the driftnet which is one of the most widely used fishing techniques to catch albacore in 1992, its overall production has declined (see Table 2.2). Anon (1992) states that the driftnet fisheries exploited mainly the young albacore stock. Therefore, after the ban of the driftnet fisheries, it is expected that the reduction in catches of the young albacore will lead to increased recruitment and consequently improvements in the albacore stocks. However, any effective increase will be seen only after several years following the total ban of the driftnet fisheries. Different analyses (FAO, 1990; ICCAT, 1993) show that albacore in the three main oceans are either heavily exploited or the stock position is uncertain. Joseph (1995) advocates that albacore catches from the north Atlantic Ocean can probably increase somewhat. For the Indian Ocean, the information on the albacore stocks is limited and consequently any increase in landings is unlikely to occur.

2.2.5 Northern bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758)

There are two species of bluefin tuna, northern and southern bluefin tuna, both are temperate water species. The two species are the most sought after (in value terms) and overexploited amongst the tunas. Their stocks are very vulnerable to overexploitation (FAO, 1995). Northern bluefin is the fifth most important tuna species by volume. In 1994, northern bluefin accounted for about 46,000 tonnes (see Table 2.2), or 1.5 per cent, of the total catch. The northern bluefin tuna occurs in commercial quantities in the Atlantic and Pacific oceans, from 70° N to 25° N, and to a smaller extent, south of the equator in the Pacific (Bartoo, 1987).

The landings of the northern bluefin have declined and remained fairly stable during the past few years. Despite the relatively high catch of 1994, the northern bluefin tuna is thought to be overexploited. For this reason, although the proposal was withdrawn thereafter, Sweden has nominated Atlantic northern bluefin tuna to be included in the

lists of species considered to be endangered under the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES).

2.2.6 Southern bluefin tuna, *Thunnus maccoyii* (Castelnau, 1872)

Southern bluefin tuna is the sixth most important commercial tuna species by volume. In 1994, southern bluefin tuna accounted for about 13,000 tonnes (see Table 2.2), or 0.4 per cent, of the total catch. Over the last decade, southern bluefin catches have declined from nearly 50,000 tonnes to the present low level. Joseph (1995) argues that this decline is primarily as a result of overexploitation of the younger fish, although some scientists fear that recruitment to the population is weak and is in danger of failing. Over the last few years, an annual limit of about 12,000 tonnes has been set. Thus, southern bluefin catches are not expected to increase in the near future.

Several comments relating to the situation of the world tuna species in general are worthy of mention; they are as follows:

i) the majority of the stocks, with the possible exception of skipjack, appear to be heavily exploited and to some extent even overexploited;

ii) further increases in total landings may be possible only for skipjack and other less valuable tuna-like species;

iii) the present status of the main commercial tuna species suggests that the current management practices have to be improved;

iv) the status of the tuna stocks differ from one region to another. This situation may imply that management regimes should be applied at a regional level and be based on the distribution area of the stock; and,

v) particularly concerning the West Indian Ocean, it has been shown that the spawning season of the majority of the commercial tuna species in the region is between November and April. This feature has to be taken into account in instituting any conservation measures to the tuna fisheries in the region.

2.3 Description of the tuna industry

In this section, issues relating to the tuna industry are examined beginning from catching, through processing to marketing. The section presents a review of the most

important commercial fishing techniques in use. The general trends in world tuna catch, the main utilisation of the species, and markets are analysed.

2.3.1 *Tuna fishing methods*

Tuna fishing methods are broadly divided into two groups, i.e. the artisanal and commercial fishing methods. The use of numerous fishing gears, also the variety in fishing methods, makes it very difficult to review and analyse the artisanal fisheries activities.

Joseph *et al.*(1988) state that most tuna and tuna-like species are commercially caught with purse seine, longline and pole and line methods. However, since the 1970s a significant change in tuna fishing methods has taken place as there has been a shift from pole and line and longline fishing methods to purse seining. As a consequence, purse seining has become the dominant fishing method in the world tuna fisheries.

a) Purse seining

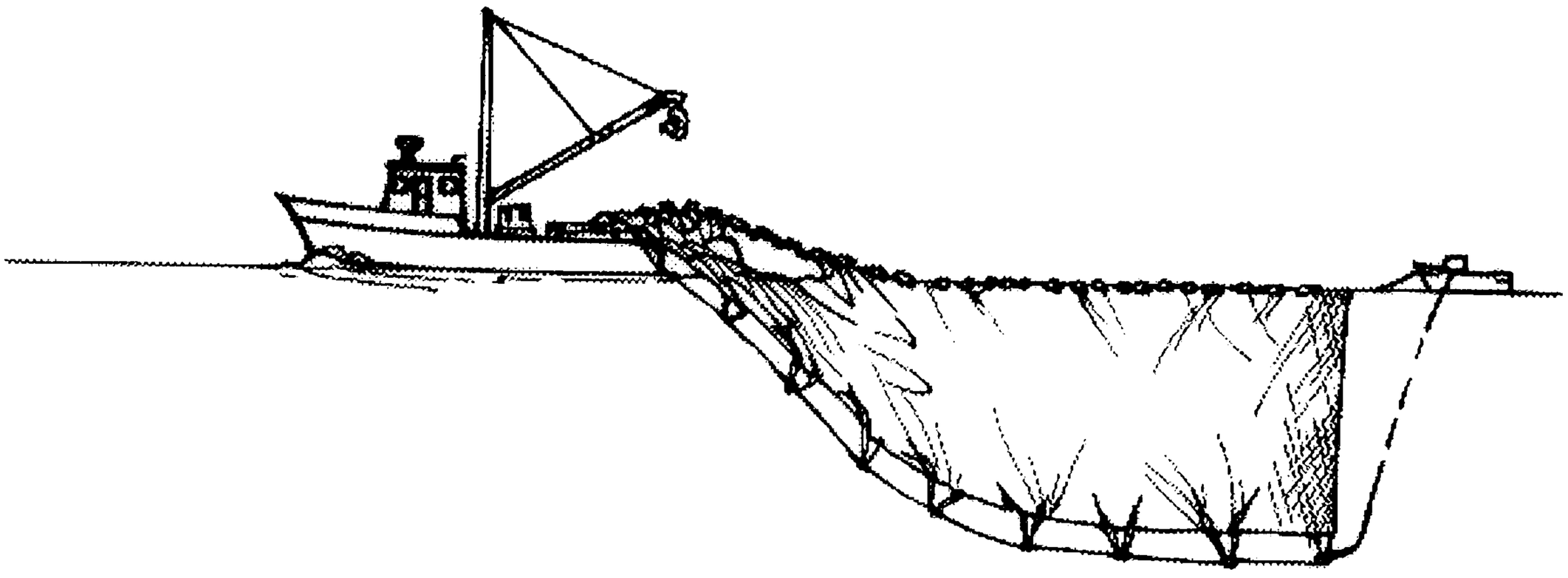
Purse seining is a surface fishing technique used mainly to catch tuna or other pelagic fish. Several authors (Sainsbury, 1986; Ben-Yami, 1995) have described the basic technique of purse seining which mainly involves the setting out of a long net to form a wall of webbing around the school of fish being taken, the top of the net usually being on the surface. When the net has encircled the fish, its bottom is pulled together so that an artificial pond of webbing holds the catch. This pond is then gradually made smaller until the fish are gathered alongside or at the rear of the vessel and may be taken aboard.

Purse seining may be undertaken by either a single vessel, by a pair of vessels or by a combination of large and auxiliary boats. However, the single vessel operation is the most commonly used method especially by the vessels from countries of the European Union. The method of working is illustrated in Figure 2.1 (a-d) which is composed of four different phases: (1) setting out the net; (2) pursing; (3) hauling the web; and (4) removing the fish (Sainsbury, 1986).

Figure 2.1 (a-d) Purse seine fishing operations

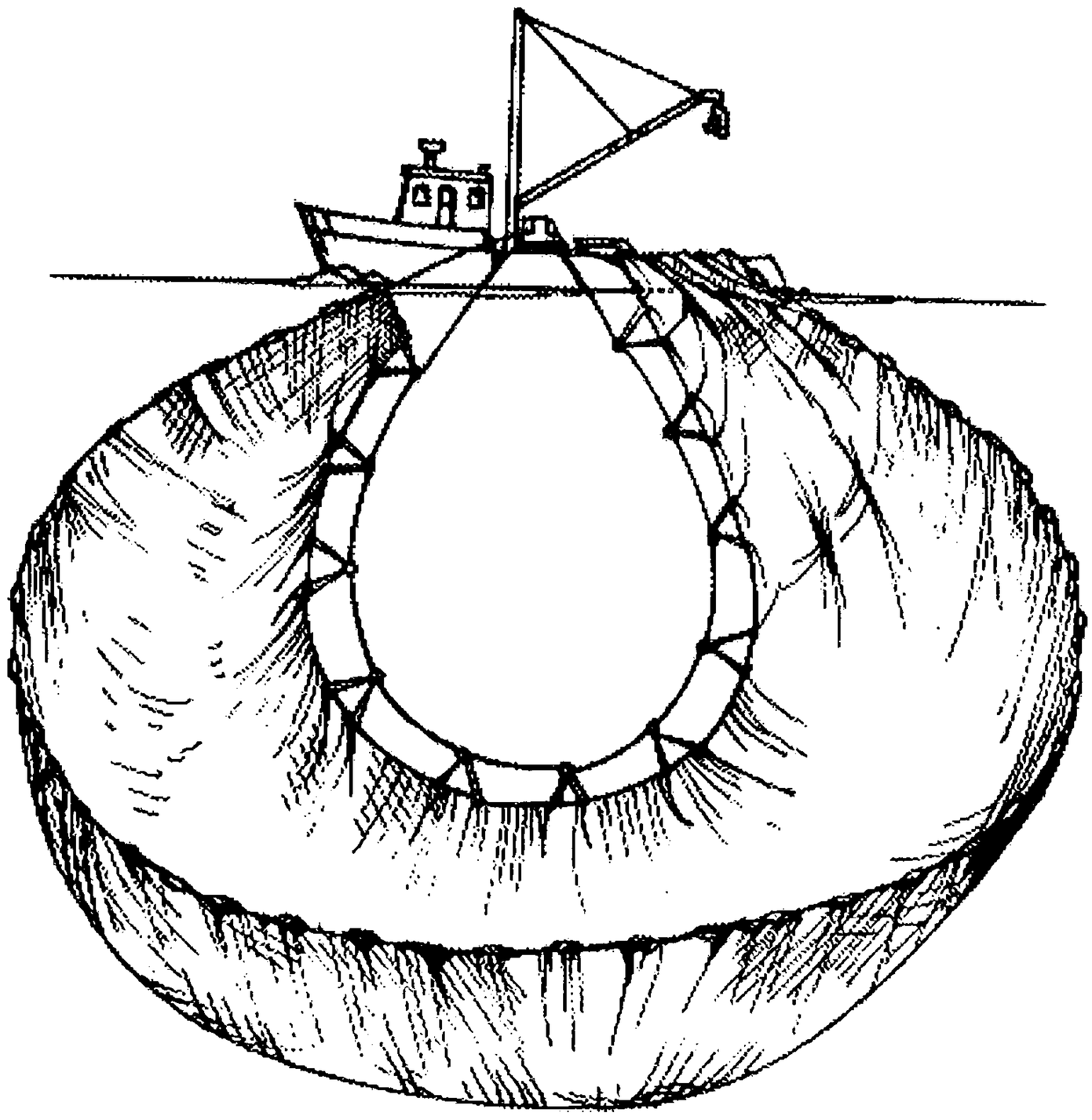
(1) Setting the net: when a school of fish is located, the vessel moves ahead and drops a skiff or buoy with the bunt of the net attached to it. The vessel then steams in a complete circle around the school, paying out the net.

2.1 (a)



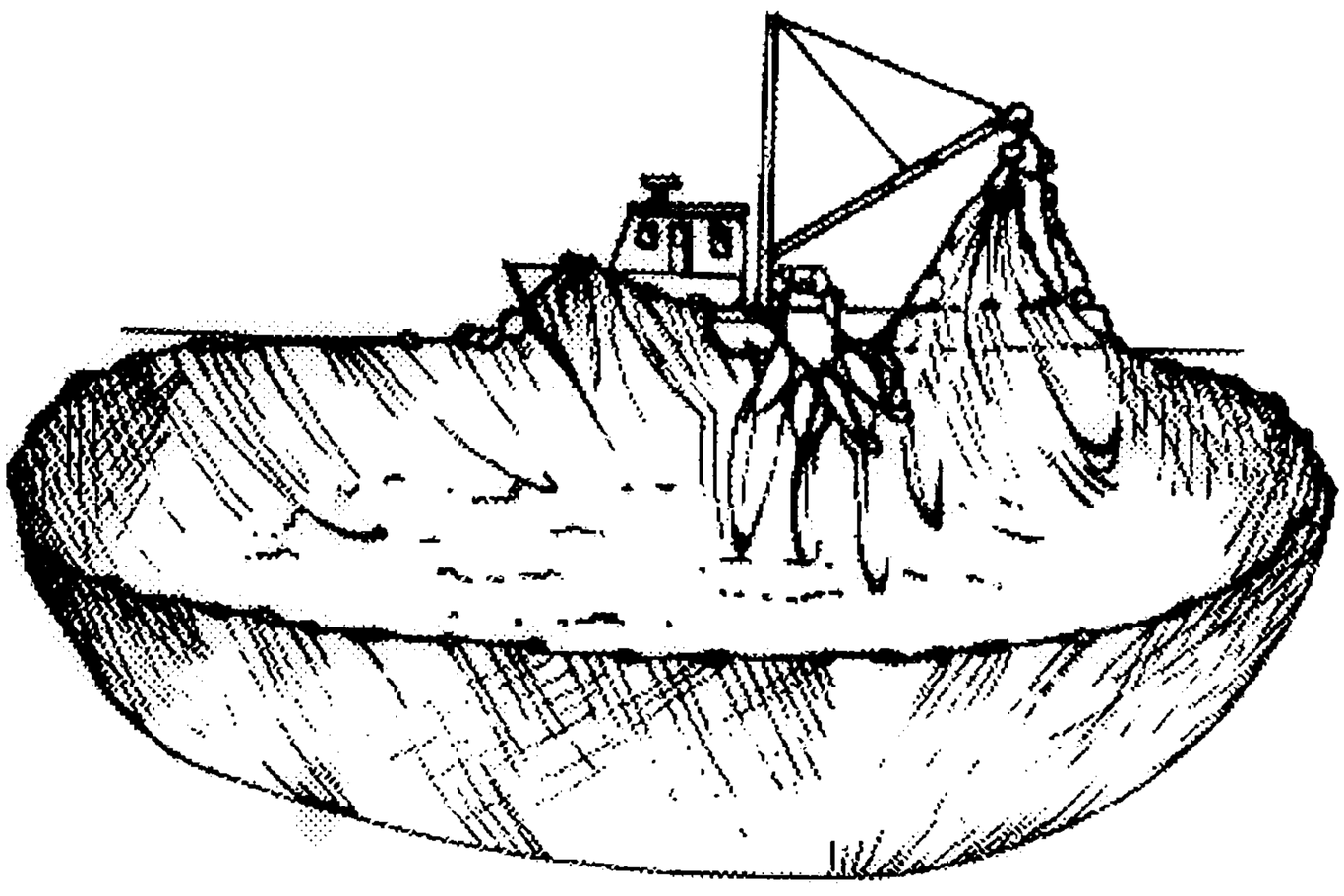
(2) Pursing: the floatlines and purse lines have been brought aboard; each end of the purse line is taken to the purse winch and both ends pulled in together drawing the bottom of the net together.

2.1 (b)



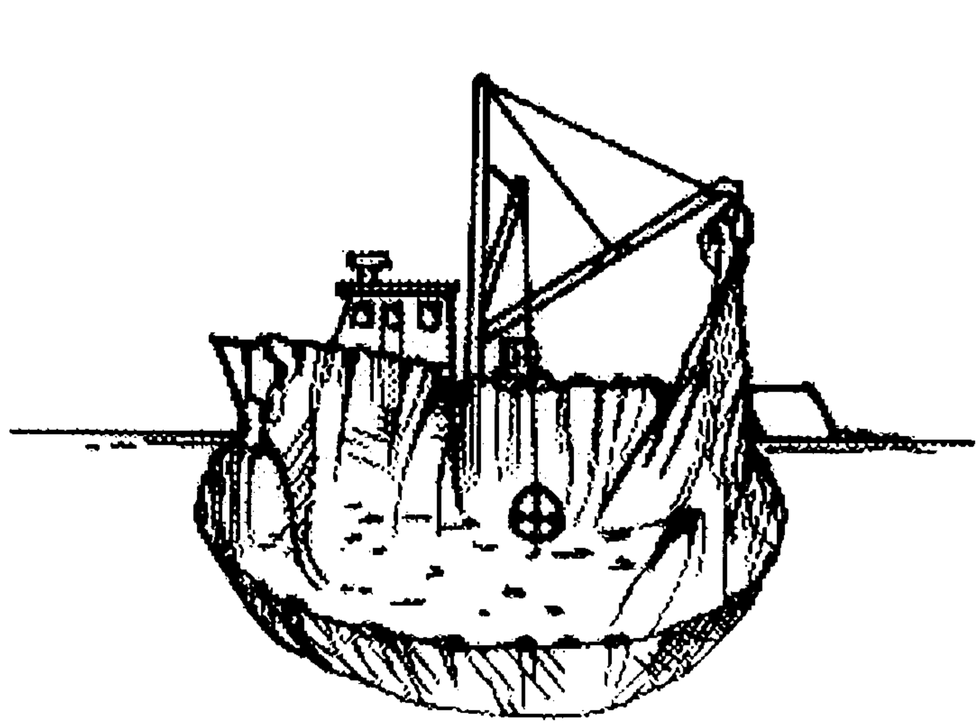
(3) Pursing completed: web being hauled, the purse rings have been pulled up and are hanging over the side. The bunt is secured forward so that the fish cannot leave the net.

2.1 (c)



(4) Ready to remove the fish: the net has been hauled until the fish are gathered close to the ship's side or rear; brailing the catch can begin.

2.1 (d)



The catch of tuna purse seining depends on whether it is made on "log" or "free" schools. Each type of school has a specific characteristic species composition. Usually, the catch made on "log" schools is composed of skipjack and yellowfin juveniles. This feature may have an impact on the management of tuna resources. In addition, as tuna purse seining is a non selective fishing technique, the problem of bycatch and discards is acute and has to be mitigated. Thus, certain practices or technical adjustments should be made to the present tuna purse seining technique.

b) Longlining

Longlining has been practised first and foremost by fishermen from Japan where it originated, and later used by Chinese and Korean fishermen (Ben-Yami, 1995). Generally, there are two kinds of patterns in longline fishing technique, i.e. the regular longlining and deep longlining. This division is mainly based on the depth at which the fishing is conducted. Hsu and Liu (1991) have remarked that the two kinds of fishing patterns have quite different target species. The technique consists mainly in setting out a length of line, usually several miles long, to which short lengths of line carrying baited hooks up to 2,000 and more are attached (Sainsbury, 1986). Usually, buoys are attached intermittently to each end of the line to facilitate retrieval and to warn other vessels. The number of hooks depends mainly on the target species, whether it is a demersal or pelagic species.

The switch from the regular to the deep longlining technique has been mainly dictated by the development of the Japanese *sashimi* market. The deep longline which targeted large species such as northern and southern bluefin tuna was more profitable than the regular longline. This facility in switching the targeted species in longlining may have a significant bearing on stock assessment and consequently on fisheries management. Although longlining is considered to be a selective fishing technique, it produces some undesirable by-catch such as seabirds or sharks.

c) Pole and line fishing

Pole and line fishing has traditionally been used on a small scale in many areas of the Indian Ocean and of the western and central Pacific (Ben-Yami, 1980). The technique consists of locating a school of tuna, approaching it, then attracting it by chumming with live bait and water spraying, and finally, catching the fish using poles and hooked lines. The main feature of this technique is the need for live bait. In fact, during the fishing operation, the bait is scattered overboard to cause feeding excitement amongst the tuna which will bring them to bite at anything in the water, including the hooked lines. Therefore, the availability of live bait is crucial for successful tuna fishing with pole and line. Ben-Yami (1996) asserts that the lack of supply of baitfish was one of the main factors that caused the decline of the tuna pole and line fishery in many areas. In fact, the decline has involved mainly the larger scale pole and line operations, it has

remained popular at the artisanal and small scale levels. The catch of pole and line fishing consists mainly of skipjack and small species such as little tuna. For management purposes, the development of artisanal and small scale pole and line fishing has to be monitored closely as they operate in the vicinity of coastal waters.

2.4 World tuna production

The total world production of the principal species of tuna has shown a steady increase over the past 50 years. Most of the growth came from the increased catches of skipjack (see Table 2.2), and partly from bigeye tuna. Yellowfin catches have improved overall, apart from a slight decrease in 1994. Northern bluefin and albacore catches have both remained fairly stable. On the other hand, southern bluefin tuna catches have levelled off at about 12,000 tonnes *per annum*.

Table 2.2 World tuna catches (tonnes) by species (1990-1994)

Species	1990	1991	1992	1993	1994
Skipjack	1 305 708	1 566 410	1 427 734	1 461 178	1 462 637
Yellowfin	1 065 192	1 015 357	1 123 548	1 161 702	1 074 891
Bigeye	273 569	261 563	271 074	281 492	293 398
Albacore	231 471	169 065	216 122	190 639	193 966
Northern Bluefin	30 766	31 262	34 871	39 051	46 376
Southern Bluefin	16 412	12 312	12 519	14 397	12 738
Total	2 923 118	3 055 969	3 085 868	3 148 459	3 084 006
World total tuna and tuna-like species	4 412 132	4 512 670	4 506 286	4 577 243	4 575 616

Source: FAO Yearbook, 1996.

Table 2.2 shows the fluctuation of the world tuna catches for the years 1990-1994. The general trends of the catches remained rather stable or slightly increased since 1991. At first sight, it seems that the tuna and tuna-like species stocks are still stable and therefore the catch should increase proportionally with the effort applied. However, the analysis of the status of each species shows that some species are already overexploited and necessitate further restrictive regulation to build up the stock.

2.5 Utilisation

Tuna is mainly consumed fresh or processed. ADB/Infofish (1991) indicates that in addition to conventional processed products such as smoked, canned or frozen products, there is an increasing demand for prime quality fresh tuna meat for *sashimi* and *sushi* production. *Sashimi* is a Japanese term for prime quality tuna flesh used in a variety of Japanese fish dishes such as *sushi*. Actually, the main utilisation of tuna is still in canned form and this account for about 70 per cent of the total world catch. About 15 per cent is consumed fresh as *sashimi* while the remainder as smoked or dried. The utilisation of tuna has not changed much over the years apart from the increasing proportion of fresh fish, especially in the Japanese market. ADB/Infofish (1991) summarised the main international traded tuna product forms:

- chilled, deheaded and gutted or gilled and gutted;
- frozen, deheaded and gutted or gilled and gutted;
- canned, "solid packs" (a mixture of pieces of tuna);
- canned, "chunks" (a mixture of pieces of tuna);
- canned, "flakes" (smaller pieces of tuna);
- canned, "grated" (packed pieces of tuna flesh);
- oil and meals;
- pet food and animal feed.

In addition to these main forms, there are specific tuna products destined for the Japanese market such as *sashimi*, *fushi*, *arabushi*, *tsukudani*. It is expected that the demand for canned tuna can only increase due to the potentially emerging new markets in eastern European countries.

2.6 Principal tuna markets

Tuna is an internationally traded commodity which has a relatively free access into the major markets of the world (Peckham, 1995). However, there are three principal markets for tuna products, i. e. Japan, western Europe and the United States. These three markets absorb about 90 per cent of the total world annual tuna production. Japan continues to be the world's major market for tuna products, followed by western Europe and the United States. France and Spain are the top in canned tuna consumption amongst the European countries. In the UK, the consumption of canned tuna has been expanding also. New markets are now emerging in developing countries such as Mexico.

2.7 Main tuna fishing areas

FAO (1993) states that three types of areas attract distant-water fleets:

i) areas of upwellings where deep, cold ocean waters rise to the surface, bringing with them abundant nutrients;

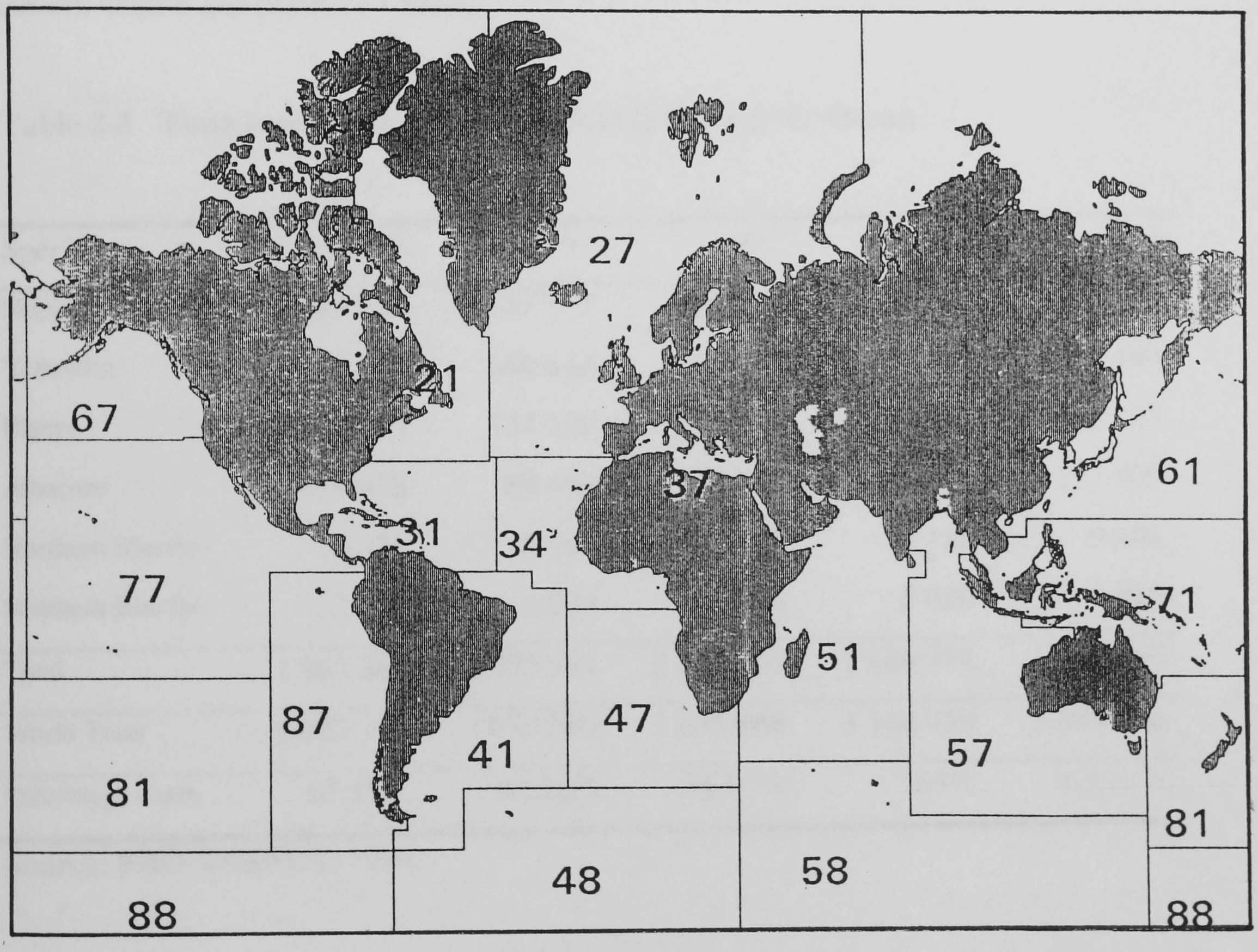
ii) areas with extensive continental shelves; and,

iii) areas where tuna stocks may be found. These areas represent the interest of the present study.

For statistical purposes, FAO has divided the world fishing areas into twenty four major fishing areas (see Figure 2.2). Six areas constitute inland fisheries and eighteen for marine fisheries. The eighteen marine statistical areas encompass waters of the Atlantic, Indian and Pacific Oceans, the Mediterranean and Black Sea, and the Antarctic

Figure 2.2 FAO major fishing areas

Atlantic, northwest-21; Atlantic, northeast-27; Atlantic, western central-31;
Atlantic, eastern central, 34; Atlantic, southwest, 41; Atlantic, southeast, 47;
Mediterranean and Black Sea, 37; Indian Ocean, western, 51;
Indian Ocean, eastern, 57; Pacific, northwest, 61; Pacific, northeast, 67;
Pacific, western central, 71; Pacific, eastern central, 77; Pacific, southwest, 87;
Antarctic, 88, 48, 58.



As far as the tuna and tuna-like species are concerned, they occur throughout the tropical and temperate waters of the world. The largest proportion of catches has been taken from the world's three important fishing areas, i.e. Pacific Ocean, Indian Ocean and Atlantic Ocean.

2.7.1 *Pacific Ocean*

The greatest landings of tuna are from the Pacific Ocean. However, the catches have slightly decreased and levelled off at about 64 per cent of the total tuna landings world-wide (see Table 2.3). Statistically, the Pacific Ocean is divided into six different fishing areas (see Figure 2.1). However, the bulk of the catches are from the southwest, eastern central and northern Pacific.

Table 2.3 Tuna catches (tonnes) by species in the Pacific Ocean

Species	1990	1991	1992	1993	1994
Skipjack	947 978	1 147 615	998 144	1 040 296	1 038 286
Yellowfin	708 775	666 542	723 005	689 148	672 444
Bigeye	162 590	144 139	158 628	133 671	123 925
Albacore	133 858	89 488	135 319	106 901	117 409
Northern Bluefin	6 335	5 764	7 204	9 138	9 494
Southern Bluefin	3 326	2 009	4 795	5 820	5 910
Total	1 962 862	2 055 557	2 027 095	1 984 974	1 967 468
World Total	2 923 118	3 055 969	3 085 868	3 148 459	3 084 006
Percentage share	67.15%	67.26%	65.67%	63%	63.79%

Source: FAO Yearbook, 1996.

Globally, the contribution of the Pacific Ocean to world tuna production has decreased from 67 per cent to about 64 per cent. This decrease can be explained on the one hand by the increase of the Indian Ocean share, and in the other hand, by the decrease in catches of yellowfin, bigeye and albacore tuna. For the management of the tuna resources, the Inter-American Tropical Tuna Commission (I-ATTC) is active in the eastern Pacific (see Section 2.8.1) whilst the South Pacific Commission (see Section

2.8.4) and the Forum Fisheries Agency (see Section 2.8.5) are active in the western part of the Pacific Ocean. The northern Pacific has not yet its own fisheries management organisation for tuna and its establishment may now be necessary.

2.7.2 *Indian Ocean*

The Indian Ocean contributes about 20 per cent of the total tuna landings world-wide as demonstrated on Table 2.4. The Indian Ocean is divided into three fishing areas, i. e. FAO Fishing Areas 51, 57 and 58. Notably, about 75 per cent of tuna landings in the Indian Ocean are from the western part (Area 51).

Table 2.4 Tuna catches (tonnes) by species in the Indian Ocean

Species	1990	1991	1992	1993	1994
Skipjack	222 421	223 624	281 805	249 113	256 883
Yellowfin	186 535	190 773	250 964	328 48	253 691
Bigeye	45 474	46 151	39 164	55 146	64 601
Albacore	28 805	25 956	17 548	15 138	16 118
Northern Bluefin	3	-	-	-	-
Southern Bluefin	10 775	6 946	4 835	4 582	5 060
Total	494 013	493 450	594 316	652 447	596 353
World Total	2 923 118	3 055 969	3 085 868	3 148 459	3 084 006
Percentage share	16.9%	16.14%	19.26%	20.72%	19.33%

Source: FAO Yearbook 1996.

The contribution of the Indian Ocean has increased approximately from 17 per cent to about 20 per cent. This increase is mainly sustained by the increase in catches of skipjack and bigeye tuna. Although the catch of yellowfin in 1994 is greater than that of 1990, it has decreased compared to the 1993 catch.

There is at the moment no active management organisation for tuna and tuna like-species in the Indian Ocean. Although the Indian Ocean Tuna Commission (IOTC) has been established in 1996, it is still not operational as explained in Chapter 6. Similarly

the West Indian Ocean Tuna Organisation (WIOTO) is not yet functional. The *Association Thonière* ended its activities in 1996. The Indo-Pacific Tuna Programme (IPTP) is in its transitory phase and subsequently its activities will be handed over to IOTC.

2.7.3 *Atlantic Ocean*

The Atlantic Ocean contributes about 17 per cent of the world-wide tuna landings as indicated in Table 2.5. Again, the increase in catches of skipjack and bigeye tuna contribute to the increase in the Atlantic Ocean share from 16 per cent to approximately 17 per cent.

Table 2.5 Tuna catches (tonnes) by species in the Atlantic Ocean

Species	1990	1991	1992	1993	1994
Skipjack	135 309	195 171	147 785	171 769	167 468
Yellowfin	169 882	158 042	149 579	144 086	148 756
Bigeye	65 505	71 273	73 282	92 675	104 872
Albacore	68 808	53 621	63 255	68 600	60 439
Northern Bluefin	24 428	25 498	27 667	29 913	36 882
Southern Bluefin	2 311	3 357	2 889	3 995	1 768
Total	466 243	506 962	464 457	511 038	520 185
World Total	2 923 118	3 055 969	3 085 868	3 148 459	3 084 006
Percentage share	15.95%	16.59%	15%	16.23%	16.86%

Source: FAO Yearbook, 1996.

Historically, the Atlantic Ocean is ranked second in contribution to world tuna production. In the mid-1980s, it was overtaken by the Indian Ocean, which has now become second after the Pacific Ocean. The decrease in the Atlantic Ocean contribution was mainly due to the shift of EU vessels to the Indian Ocean after a low yellowfin catch in the region in the beginning of the 1980s. The management of tuna resources in the Atlantic Ocean is executed by the International Commission for the Conservation of the Atlantic Tuna (ICCAT). Due to the lack of enforcement by the fishing countries, the

yellowfin tuna stock of the region has declined sharply despite the regulations administered by the Commission.

2.8 Tuna management regimes in operation

There are a number of international bodies which deal with the scientific study and management of tuna (Joseph, 1977). Because tuna and tuna-like species occur in different parts of the world oceans, the management of the species has been dealt with through a series of regional and international fisheries bodies.

2.8.1 *Inter-American Tropical Tuna Commission* (I-ATTC)

The I-ATTC was created in 1950 by the Convention signed by the governments of the United States and Costa Rica. The area of competence is defined as the eastern Pacific Ocean. The species covered by the Commission are mainly the skipjack and yellowfin tuna. In addition, other species of tuna such as bigeye, bluefin and albacore are studied within the Commission. The main objectives of the Convention are to maintain the population of yellowfin and skipjack tuna and other kind of fish taken by tuna fishing vessels in the eastern Pacific and to co-operate in the gathering and interpretation of factual information to facilitate maintaining the populations of these fish at a level which permits maximum sustainable catches year after year (Marashi, 1996).

The main functions of the Commission are:

i) gathering and interpretation of information on tuna;

ii) conduct of scientific investigation concerning the abundance, biology, biometry, and ecology of yellowfin and skipjack tuna in the area of competence of the Commission, and recommendation of proposals for joint action for conservation.

Although the I-ATTC has managed the eastern tropical Pacific (ETP) tuna fishery since 1950, King (1979) admits that it has never really been capable of managing the fishery. Different problems arose within the I-ATTC pertaining to the management of the tuna resources in the region. Irrespective of the fact that the Commission does have its permanent research staff, Gulland (1978) reported that there is little doubt that economic and political pressures within the I-ATTC have prevented the scientific staff

from performing their task effectively. As a consequence of the growing dissatisfaction amongst the member states, most Latin American nations have withdrawn from I-ATTC, e.g. Mexico withdrew in 1978, followed shortly by Costa Rica in 1979.

2.8.2 *International Commission for the Conservation of Atlantic Tuna* (ICCAT)

The ICCAT was created in 1966. The area of competence is defined as "all waters of the Atlantic Ocean, including the adjacent seas". The species covered by the Commission are the tuna and tuna-like species. The main objective of the Commission is to maintain the populations of tuna and tuna-like species found in the Atlantic Ocean at levels which permit the maximum sustainable catch for food and other purposes (Marashi, 1996).

The main functions of the Commission are:

i) the study of the populations of tuna and tuna-like species;

ii) the collection and analysis of statistical information relating to the current conditions and trends of the tuna fishery resources of the area of competence of the Commission;

iii) recommendation of studies and investigations to the contracting parties.

The ICCAT differs from the I-ATTC in not having a permanent research staff. However, the various problems encountered by both Commissions are quite similar. The distribution of catch among users, the unchecked growth of fishing fleets, the economic conflicts over the fishery are a few of the problems that the Commission has to resolve. Sakagawa (1991) reports that the regulation imposed by the ICCAT has not had a significant effect on the conduct of the fishery, because enforcement by the fishing countries has been weak or non-existent.

2.8.3 *Commission for the Conservation of Southern Bluefin Tuna* (CCSBT)

The CCSBT was established by the Convention signed by Australia, Japan and New Zealand in 1993. The area of operation encompasses the Indian Ocean, Southern Atlantic and South Pacific. The species covered by the Commission is the southern bluefin tuna. The main objective of the Commission is to ensure, through appropriate management, the conservation and optimum utilisation of southern bluefin tuna.

The main functions of the Commission are:

i) collection, analysis and interpretation of scientific and other relevant information on southern bluefin tuna;

ii) adoption of conservation and management measures including total allowable catch (TAC) and its allocation among the members.

Actually, The CCSBT is based on a voluntary trilateral arrangement. Bergin and Haward (1994) opine that the CCSBT is an important step towards meeting obligations under Article 64 of UNCLOS (1982). The recent implementation of the Commission makes it difficult to evaluate its effectiveness. The increasing catches by countries outside the Commission within its area of operation are of great concern to the member States.

2.8.4 *South Pacific Commission* (SPC)

There is no formal international institution responsible for tuna fisheries in the West and South Pacific Oceans. However, there are two regional organisations dealing with tuna fisheries in these two regions: the South Pacific Commission (SPC) and the Forum Fisheries Agency (FFA). The SPC was established in 1947 and the area of operation coincides partly with the FAO Statistical Areas 71 and 77. The species covered by the Commission are all the living marine resources within its area of competence. The main objective of the Commission is to encourage and strengthen international co-operation in promoting the economic and social welfare and advancement of the peoples of the South Pacific region.

2.8.5 *Forum Fisheries Agency* (FFA)

The FFA was established in 1979. The area of operation is the South Pacific region. The species covered by the Forum are all living marine resources and in particular the highly migratory species. The main objectives of the Forum are:

i) conservation and optimum utilisation of the species covered by the Convention;

ii) promotion of regional co-operation and co-ordination in respect of fisheries policies;

iii) securing of maximum benefits from the living resources of the region for their peoples and for the region as a whole and in particular the developing countries; and,

iv) facilitating the collection, analysis, evaluation and dissemination of relevant statistical, scientific and economic information about the resources covered by the Convention.

2.8.6 *Evaluation of the existing regional and international organisations*

An evaluation of the strengths, weaknesses, opportunities and threats of the existing regional and international tuna management organisations is given below. The analysis has been made mainly based on the above mentioned organisations in relation to membership, authority, objectives, funding and participation.

a) **Regional organisation**

(i) Key strengths of the existing regional tuna management regimes include:

- availability of regional scientists within the organisation;
- the knowledge of the region and the ability to perform scientific works;
- good linkages with the member states.

(ii) Some weaknesses which where identified include:

- difficulty to support the organisation financially;
- difficulty to manage the international waters;
- difficulty to impose authority.

(iii) Opportunities identified include:

- similarities of economic, social and political structure between member states;
- ease to harmonise the regional fisheries policy;

- effective participation of the member states.

(iv) Key threats identified include:

- lack of compliance of DWFNs to the established management measures;
- political situation of a given coastal state;
- financial support of the organisation.

b) **International organisation**

(i) Key strengths of the existing international tuna management regimes include:

- the availability of efficient international scientists within the organisation;
- extensive experiences gained from other regions;
- facility to arrange funding for the organisation.

(ii) Some weaknesses which were identified include:

- different interests coupled with different objectives between member states;
- lack of enforcement capabilities;
- difficulty to reach consensus.

(iii) Opportunities identified include:

- management area may encompasses international waters;
- existence of international co-operation;
- relative ease of financial arrangements.

(iv) Key threats identified include:

- reluctance of coastal states to lease their rights;
- lobby by the rich member countries;
- withdrawal of the disadvantaged members.

2.9 Prospects of tuna production

Joseph (1995), based on a simple straight-line extrapolation of current trends has advanced a projection of tuna catches for the year 2000 (see Table 2.6). The projection is to some extent very optimistic considering the status of the majority of the main commercial tuna species. Although the potential production is based on the best available information, the quality of the data is affected by economic, environmental, marketing and biological factors.

Table 2.6 World tuna catches (thousand tonnes), 1993 and projections to 2000

Species	1993	Statistical projection of catches	Biological potential	Probable catches
Skipjack	1 477.0	1 950	1 927	1 650
Yellowfin	1 190.5	1 550	1 440	1 320
Bigeye	282.6	300	283	285
Albacore	193.1	200	193	193
S. Bluefin	14.4	15	14	14
N. Bluefin	38.5	38	38	38
Total	3 196.1	4 053	3 895	3 500

Notes: Projections based on recent trends (statistical projection), potential production based on best available stock-assessment information (biological potential), and expected catches in the year 2000 (probable catches).

Source: WorldFish Report, November 9, 1995.

Based on Table 2.6, catches of skipjack would increase by about 470,000 tonnes and yellowfin by about 360,000 tonnes. Considering the present status of yellowfin world-wide, it is unlikely that the present state of stocks can sustain a further increase. Moreover, as can be seen in Table 2.6, the statistical projection is well beyond the biological potential for all species. It also shows that the actual exploitation rate of tuna resources is near or within the range of the maximum sustainable yield. Furthermore, Marcille (1991) advocates that the future catch trends of the major tuna species depend on a large number of factors some of which are beyond any control, i. e. the seasonal or annual variation in catchability and variations from year to year of the level of recruitment of young fish into particular stocks. In addition, there are factors that will impact upon world tuna fisheries over the next years which can be more or less regulated through national, regional and international levels. Such factors may include the status of the different stocks and their ability to sustain higher catches, the fisheries policy of coastal states related to the exploitation of their resources, and the development of the different fishing techniques and technologies.

At one level, the future prospects of tuna production depend mainly on the status of marine fisheries overall because of the differing productivity of the oceans. It seems the limit to fish catches was reached some years ago with respect to most species in the marine environment. A recent study by Pauly and Christensen (1995) confirms this view in an examination of the proportion of all photosynthesis leading to organic compounds used by fish which are subsequently captured. FAO (1996) state that, overall, since the early 1950s, the proportion of major stocks (the majority of which are demersal species of relatively high priced fish) showing decreasing production has increased from about 10 per cent to 45 per cent of the total number of stocks.

Over the same period, the number of stocks showing an increase in production, has risen from about 30 per cent to about 45 per cent of the total. These changes are reducing the quantity of relatively high value fish available for consumption. The changes are the result of overfishing which, in turn, results from open access and lack of regulation to fish stocks and the resultant excess fishing capacity. This feature applies particularly to tuna fisheries where, despite the extension of EEZs to 200 nautical miles, in most coastal states access to the resources is open. Moreover, the export of excess fleet capacity from DWFNs to the waters of coastal states threatens the sustainability of different fish species.

2.10 Conclusion

This literature review has highlighted significant issues about the characteristics of the major commercial species of tuna and provided insight into the industrial activities relating to the tuna fishing methods of purse seining, longlining and pole and line fishing. Statistical presentations on world tuna production indicate that tuna and tuna-like species stocks are relatively stable at the moment. This does not necessarily mean that as the world demand for tuna increases, significant changes are not likely to occur, but probably not in the near future.

The main utilisation of tuna has been shown to be the canned form, and this is so because of the desirability of canned food in the global fish market. Europe and America continue to represent the world's largest consumers of canned tuna. There are indications that the increasing demand for tuna in the Asian menu, particularly in Japan, China and Indonesia may change consumption patterns.

Effective management of tuna fisheries will demand a drastic change in the organisational structures and improvement in the management capabilities of the different Commissions engaged globally in tuna fisheries management. This review has justified the need for this study in the search for effective tuna fisheries management in the West Indian Ocean environment.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research model

3.1.1 *General overview*

A description of a fishery consists of three basic elements:

i) the input which deals with fishing effort;

ii) the output which refers to the catches; and

iii) the process dealing with the link between input and output in relation to biological processes and fishing activities (FAO, 1989).

In general terms, models as used in fisheries, are simplified descriptions of the links between input data and output data (FAO, 1989). Analytical models in fisheries are closely associated with age-structured models in relation to such concepts as mortality rates and individual body growth rates, which require the age composition of catches to be known.

Holistic models used in fisheries compensate for data inadequacy, especially in the case of limited capability of sampling, when one may not have input data of the quality and quantity required for an analytical model. In reality, irrespective of the type of data collected in fishery research, there is always valuable information to be extracted from it.

Surplus production models use mainly catch and effort data series. Sparre *et al.* (1989) advocate that the simplest way to deal with a multispecies system, such as tuna species, would be to apply the surplus production model in relation to total catch of all species and the total effort by all fleets. The surplus production model is quite relevant to the research methodology of this study, and is therefore examined in greater detail in the subsequent review.

With respect to the activities of WIO tuna purse seiners at the present time, catch and effort data are the most reliable and available data, and consequently, the surplus production model is thought to be most appropriate.

The surplus production model has been used by a number of international commissions, particularly in assessments made by several collaborating tuna agencies, including the International Commission for the Atlantic Fisheries (ICSEAF), the International Commission for the Conservation of Atlantic Tunas, and the Inter-American Tropical Tuna Commission. In most fisheries, surplus production models are used as the stock assessment tool (Hilborn, 1992), probably because despite its simplicity, the model provides better estimates of management parameters than other models that are based on age-structures (Ludwig and Walters, 1985).

A review of the concept of surplus production models was given by Hilborn and Walters (1992). The review shows that surplus model ignores all the complexities of age-structure and spatial structure, but emphasises single species population biomass. Gulland (1983) believes that the surplus production model approach to population dynamics is commonly used in tuna work, in part because tuna are difficult to age, and surplus production models usually do not depend on age distribution. For a fishery where data are uncertain and approximate, such as is the case with the purse seine fishery in the WIO, Nishida (1994) proposes four conditions that should be addressed:

i) to use less age-related data;

ii) to detect extremely inaccurate data and to exclude these data from the analysis;

iii) to develop a simple model; and,

iv) to develop a realistic model that reflects the fisheries.

All these measures are relevant to the methodology of this study, and have been taken into consideration in the choice of the research model.

3.1.2 *Stock assessment approach*

Fish stock assessment aims to describe those processes that link inputs and outputs. The basic purpose of fish stock assessment is to provide advice on the optimum exploitation of aquatic living resources, such as fish. Living resources are limited but renewable, and fish stock assessment can be described as the search for the exploitation level which, in the long term, gives the maximum yield in weight from the fishery (FAO, 1989).

The sequence below, taken from Sparre *et al.* (1989), shows the general procedure of fish stock assessment:

INPUT: FISHERIES DATA (+ ASSUMPTIONS)

↓

PROCESS: Analyses of historical data

↓

OUTPUT: ESTIMATES OF POPULATION PARAMETERS
INPUT :

↓

PROCESS: Predictions of yield for a range of alternative exploitation levels

↓

OUTPUT: OPTIMUM FISHING LEVEL
MAXIMUM SUSTAINABLE YIELD (MSY)

For the purposes of the analyses performed in Chapter 7, the "INPUT" is the catch/effort data collected from the purse seiners fishing in the WIO. The "PROCESS" is the different models used in the analyses such as the Schaefer (1954) and Fox (1970) production models.

The tuna purse seine is a multispecies fishing gear, and therefore the catch is usually composed of many species. In the WIO, the catch is mainly composed of skipjack, yellowfin, and smaller proportions of other tuna species. The catch composition varies in time and space. Gulland (1983) suggests that a description of the

biological interactions between different species can be undertaken. King (1995) shows that the equilibrium yield model may be applied to multispecies fisheries. However, if the individual stocks have different productivities, such as the skipjack and yellowfin tuna in the WIO, the effort required to maximise yield in the mixed stock will overexploit the less productive species, in this case the yellowfin tuna. The implication of this for data analysis is that two separate analyses are required: one for the total tuna resource as a whole; and the second a separate analysis for yellowfin.

3.1.3 *Models used for this study*

This review of research models in fisheries has been edifying with respect to the best approaches to adopt for this study. A collection of models and appropriate software were used to analyse the data, based on the type of data obtained, and the fact that there are certain problems associated with research into tuna purse seine activities. These are:

a) Schaefer production model

Hilborn and Walters (1992) state that the first widely used surplus production model was formulated by Schaefer (1954), which bases the analysis on catch and effort data. Thus, the first analysis in Chapter 7 is based on this production model using the catch and effort data from the WIO tuna purse seiners. When assessing fishing effort in purse seine fisheries, the unit most commonly used is the "fishing day" or "searching day". In the analysis, effort is expressed in fishing days, i.e. days spent at sea minus days on passage, days adrift due to mechanical breakdown or other reasons that result in a cessation of fishing. This may include search time even when no fish was actually caught.

b) Fox production model

Hilborn and Walters (1992) indicate that the Fox (1975) surplus production model is one of the more popular variations on the equilibrium assumption. In the second analysis in Chapter 7, the Fox (1970) surplus production model is used for the same catch and effort data from the WIO purse seiners. The main input data are the same as in the Schaefer model.

Despite the vast use of the surplus production models as tools for fish stock assessment, they present some limitations:

i) they treat the fish stock as a single entity whose weight is all important, when in fact changes in the age structure of the stock may be equally important;

ii) they assume a stable environment. In practice, environmental parameters are rarely stable and unpredictable changes may occur;

iii) they assume that the stock may be extinct for an effort twice of that needed to extract the MSY (particularly for the Schaefer production model).

c) Catch Effort Data Analysis (CEDA)

The third analysis adopted in this study is based on the use of a PC-based software package "CEDA" produced by the Marine Resources Assessment Group Ltd. (MRAG) of the UK. This program is designed to analyse catch, effort and abundance index data, give estimates of current and unexploited stock size, catchability and associated population dynamics parameters. Use of the CEDA package has the further advantage of being applicable for the development of the Pella-Tomlinson (1969) production model in addition to the Schaefer and Fox production models. Details on the use of this programme are given in Chapter 7.

d) Computer program BASICA

One other approach adopted in this study is the use of the computer program BASICA elaborated by King (1986) that enabled the surplus-yield model to be applied. This involves plotting graphical expressions of the various catch and effort data inputs obtained for this study, and also the trends of yield and the yield per unit of effort. Chapter 7 on data analysis demonstrates the usefulness of this research tool.

3.2 Choice of study area

3.2.1 *Biological aspects*

i) Initially, the study area was confined to the EEZ of Madagascar. Within the fisheries master plan elaborated in 1993 by the Malagasy Government, the management of the Malagasy fisheries resources was dealt with under programme No. 8 (Kasprzyk, 1993). Amongst other species, shrimp, lobster and tuna were identified as management

priorities because of the foreign exchange they generate for the country. The management of shrimp and lobster stocks could be dealt with from a national perspective, however, problems arose when attempts were made to manage the tuna resources at the national level. It was then realised that, although tuna are present in the national waters, their management has to be considered at a different level. The extensive migration of tuna stocks in the region and the lack of co-ordinating structures dealing with the exploitation of these resources, are constraints that make it necessary to consider the management of these species at the regional level. Thus, the specific characteristics of the tuna fisheries encouraged the research to be relocated to the regional level of the WIO. The factors that lead to the development of this course of action can be summarised as follows.

a) Tuna and tuna-like species are highly migratory, therefore they are not confined only to the sole EEZ of a given country. As stated by Copes (1987), managing a highly migratory stock such as tuna requires consistent control over the fishery on that stock throughout its whole migration range. It calls for the co-operation of all the adjacent nations through whose maritime zones the fish migrate. Furthermore, Joseph (1977) emphasises that it would do little for the management of a stock of fish if in one part of its range it was subjected to a rigid management control, but when it occupied another part of its natural range it became the object of uncontrolled exploitation.

b) Tuna species migrate extensively in the WIO. In their migration, they pass through national waters of different coastal states of the region and the high seas. The tuna management boundaries should therefore be based on these migration patterns if management of the resources is to be successful.

c) The development of the tuna purse seine fishery in the West Indian Ocean effectively started in 1984 with the shift of EU vessels from the Atlantic Ocean to the Indian Ocean. It demonstrates the mobility and flexibility of purse seine fleets, according to the resource conditions and fishing opportunities. Within the WIO, the tuna purse seiners follow roughly a clockwise movement in their constant pursuit of resources, passing through different national waters and high seas (Figure 5.1).

d) A tuna tagging programme was conducted by Cayré (1990) which shows that the tuna exploited in the western part of the Indian Ocean belong to a single stock. This fact reinforces the need to manage the resources at a regional level.

As a direct result of all these factors, the scope of this study was extended to include tuna fisheries management activities of not only the Malagasy oceanic waters, but the entire West Indian Ocean. To achieve this, the study was extended to include the national waters of Mauritius, Comoros, Seychelles, Mozambique, Kenya, Tanzania, Somalia, the Maldives; and also the high seas.

All the above mentioned special characteristics of tuna fisheries oblige the coastal states of the region to ensure collaboration with a view to effective management of the common resources. The focus on tuna purse seining is because data are readily available.

3.2.2 *Institutional aspects*

The selection of the study areas to conduct the research survey was mainly determined by the importance of fish resources, particularly highly migratory species and fisheries management to the regions under review which include the western Indian Ocean and the South Pacific region. For comparative purposes, several fisheries departments and organisations from other parts of the world were also selected. Apart from states of the West Indian Ocean, pre-determined criteria were used to identify the other relevant states where the questionnaire was sent. Such criteria included the importance of tuna resources in the national economy, experiences in managing highly migratory species and membership of a regional or international fisheries organisation.

i) West Indian Ocean

The West Indian Ocean region is the primary focus of this study. It is very important to have feedback from the coastal states of the region in relation to their perception of the creation of a new fisheries organisation. The existing fisheries organisations have only limited impact on the tuna fishery at the moment. Thus, it is crucial for the coastal states themselves to define the profile of an improved fisheries organisation which they feel can be adapted to the needs of their region. In any case,

their contribution to the actual process from design to implementation would enhance their confidence in the organisation.

ii) South Pacific Ocean

The South Pacific region is well known particularly in the context of the world's tuna resource. In fact, the Pacific region accounts for about 64 per cent of the principal commercial tuna species mentioned in Chapter 2. As stated by Hunt (1997), the future of tuna stocks is of great socio-economic importance to the region because the stocks constitute the region's major renewable resource. The effort of the coastal states of the region to manage their common tuna resource, and therefore to generate benefits for the local population, is now gathering momentum. This has resulted in the establishment of the two main regional tuna organisations, i.e. the South Pacific Commission and the Forum Fisheries Agency (Chapter 2). With regard to purse seine fisheries for tuna, the Palau Arrangement is a typical example adopted by the coastal states of the region. On the one hand, this arrangement can help to conserve the tuna stocks, and on the other, to improve economic returns through licence fees and national fishery development. Thus, the South Pacific Ocean region has acquired an extensive experience particularly in dealing with the regional management of tuna. The experiences gained in institutional building by the coastal states of the region are of interest to the WIO region.

iii) Other regions

In order to make the study area more representative, different fisheries departments and organisations from Africa, Asia, Europe and America were selected. It was essential to gather the maximum possible number and range of opinions from other fisheries organisations in order to enhance the quality of the recommendations of this study.

3.3 Data collection

3.3.1 *Nature of the data*

Brander (1975) states that the need to collect data arises when attempts are made to manage the economic and social activities of a society. It is evident that a wide variety of data and information are required to formulate a management scheme for a given fishery resource. As stated by Sparre *et al* (1989), it is not possible to give a

complete set of general rules of how best to collect data. Each fishery has its own characteristics. Parel *et al* (1973) suggest that the selection of techniques for obtaining a sample depends primarily on the nature of the problem to be studied; the cost and time factors involved; the desired precision and reliability of the results. The main problem tackled in this research is the management of tuna available to purse seiners in the coastal states of the WIO and the high seas. Therefore, the data collected are mainly of two types, i. e. the biological and institutional aspects of the tuna resources of the WIO.

i) In terms of the biological aspect of the tuna purse seine fishery, the best available catch and effort data statistics relating to the tuna purse seiners fishing in the WIO were collected by correspondence with the fisheries institutions in the WIO region as reported in Table 3.1. These were mainly in the form of annual reports and bulletins. The data were cross-checked wherever possible through field visits.

Table 3.1 Tuna catches made by purse seiners operating in the WIO, 1984-1995.

	Yellowfin		Skipjack		Others		Total	
Years	Effort	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
1984	8000	57400	7.17	42800	5.35	1700	0.21	101900	12.73
1985	9900	59600	6.02	65300	6.59	2500	0.25	127400	12.86
1986	8900	58400	6.56	78300	8.79	5300	0.59	142000	15.95
1987	8600	63000	7.32	91200	10.60	5400	0.62	159600	18.55
1988	9900	112500	11.36	97000	9.79	11300	1.14	220800	22.30
1989	11800	88900	7.53	120000	10.16	10900	0.92	219800	18.62
1990	12600	102700	8.15	107150	8.50	11400	0.90	221250	17.55
1991	12337	97611	8.90	112476	9.11	9017	0.79	219104	17.76
1992	14229	97833	6.87	151964	10.67	28421	1.99	278218	19.55
1993	14369	108943	7.58	142279	9.90	25678	1.78	276900	19.27
1994	12610	94610	7.54	154002	11.82	31502	2.49	280114	22.21
1995	14434	107420	7.44	156314	10.25	41983	2.90	305717	21.18

Units: Effort in fishing days; Catch in tonnes; CPUE in tonne per fishing days.

Others: mostly bigeye and albacore.

The catch and effort data statistics originated from three main sources: the Seychelles Fishing Authority (SFA); the *Association Thonière* (AT/COI); and the Indo-Pacific Tuna Development and Management Programme (IPTP). Other complementary sources have been used such as the FAO Fishery Statistics and national statistics from the coastal states of the region.

At the start of the study, an introductory letter was sent to each one of the above mentioned fisheries organisations stating the objectives of the research and the kind of data expected. Although all three organisations were interested in the study and promised their help, they expressed their concern about the confidentiality of certain data. After the formal introduction, an agreement was reached that the statistical data would be made available annually. In addition, the researcher maintained constant communication during the research period with key personnel responsible for providing the data and with other relevant fisheries organisations.

The data from the three sources described below were combined to give the total catch statistics for the purse seiners active in the WIO reported in Table 3.1. It can be seen from the information collected that the commercial catch data are taken from all purse seiners fishing both within and outside the EEZs of the bordering states of the WIO, a condition *sine qua non* for the management of migratory species such as tuna.

1) Seychelles Fishing Authority

The commercial data collected by the SFA were extracted from the logbooks that record the activities of the purse seiners fishing around the Seychelles. The data collected by SFA were summarised and published in the quarterly *Seychelles Tuna Bulletin*, which has been in existence since 1992. Owing to the poor quality of the data relating to catches made by longliners (probably as a result of non-reporting or under-reporting of catches), the Bulletin deals primarily with purse seining activities. Monthly catch and effort statistics for the combined activities of purse seiners are recorded, as well as individual statistics for the French, Spanish and other national fleets.

Fishing vessels are obliged, under the conditions of the fishing agreement with the Seychelles, to return their logbooks to the SFA whilst they are fishing in Seychelles waters. However, not all purse seiners present in the WIO have a licence to fish in Seychelles waters and are under no obligation to report to the SFA. Thus, the data available in the Bulletin represent only a part of the tuna fishing activities in the region.

2) *Association thonière*

Data were also obtained from the *Association Thonière de la Commission de l'Océan Indien* (AT/COI), which is the Tuna Association project within the Indian Ocean Commission. Through its different local fisheries and research services and laboratories which are called *Centres d'Appui National* (CAN), the AT/COI compiles information from the tuna fishing activities in the waters of the member states (Comoros, Madagascar, Mauritius, Reunion and Seychelles). The information is summarised in the periodical *Bulletin Statistique de l'Association Thonière.* Catch and effort data in their respective EEZs are collected by the different CANs of the member states and transmitted to the AT/COI headquarters based in Madagascar. The Bulletin is issued twice a year and embraces only a fraction of the fishing activities in the region, i.e. the fishing activities in the waters of the member states. Thus, the information available is mainly related to the purse seiner activities in the island member states of the WIO, although attempts have been made to include the longliner activities of the region. Again problems of non-reporting and under-reporting of catches by longliners were encountered. Moreover, the production of the Bulletin ceased in 1996 as a consequence of the end of the Tuna Association project.

3) Indo-Pacific Tuna Management and Development Programme

Similarly, data were obtained from the Indo-Pacific Tuna Management and Development Programme (IPTP) based in Sri Lanka. IPTP compiles and disseminates catch statistics for tuna and tuna-like species from the Indian Ocean and the Western Central Pacific off South East Asia. These data are compiled annually and are summarised in the *Indian Ocean Tuna Fisheries Data Summary.* IPTP maintains five major databases that relate to the tuna resources of the Indian Ocean, the data consist of: nominal catches, numbers of fishing boats, catch and effort, length-frequency and transhipment statistics. Although IPTP has a detailed database, inconsistencies in data from individual nations have been discovered. This is due mainly to differences in the

structure of the statistical systems of the nations, which do not always record information at the species level. Furthermore, it is believed that longliners operating under a flag of convenience tend to under-report their catches.

At the end of IPTP, it is assumed that the compilation and dissemination of the catch statistics for tuna and tuna-like species of the Indian Ocean will be assumed by the Indian Ocean Tuna Commission.

ii) To investigate the institutional aspects, a questionnaire survey technique was used (see Appendices C, D). The use of the questionnaire survey technique has been often criticised as an inflexible method due to the pre-specified questions which cannot examine qualitative issues. For example, Kremer (1995) argues that the responses obtained from the questionnaire survey technique incorporate only the issues that preoccupied the researcher when the questionnaire was framed. However, Casely and Lury (1981) maintained that the questionnaire survey is still in use and commonly favoured by sociologists and economists, not least because it costs less. To improve the outcomes from the questionnaire, several precautions were taken.

1) A thorough literature review was undertaken to determine the appropriate definitions and concepts to be included. A research framework was designed to include the desired information. Special care was taken with wording, language (avoiding complexity especially for the non-English speaking countries). To begin with, the questionnaire was drafted deliberately only in English to observe how other non-English speaking countries such as Madagascar, Comoros, Mozambique and Somalia would react. Although it was risky, this disposition was necessary to identify the potential problems of communication which a future organisation might face. The questionnaire was kept as short and as simple as possible to avoid unnecessary burden and misconception. Throughout the drafting stage of the questionnaire, the researcher's supervisor and other staff of the Hull International Fisheries Institute (HIFI) were extensively consulted. Whenever possible, discussions on the form and objectives of the questionnaire with colleagues from the coastal states of the WIO (researching at HIFI) were undertaken. It was important to have their opinions in the matter as their views can influence to a greater or lesser degree the success of the projected fisheries organisation in their respective country.

3.3.2 *Instruments*

The postal questionnaire sent to the various fisheries organisations and departments represents the main channel of data collection in relation to the institutional aspects. Two sets of questionnaire were developed depending on whether the research was targeting a fisheries department or fisheries organisation. The design of the two sets of questionnaires is based on the fact that, generally fisheries departments are directly linked to national government, whilst fisheries organisations associate two or more states. This situation gives rise to rather different views between the two parties. It is important to have the views of both parties regarding fisheries management. Names and addresses of the fisheries organisations were selected according to their relevance with respect to fisheries management. In sending the questionnaire to the selected addressee, a covering letter describing the nature of the research was included.

The questionnaire is divided into several sections. The first section deals with basic information on the responding departments and organisations. Section 2 deals with organisational aims and objectives and planning issues. Sections 3 and 4 seek information on the main activities of these departments and organisations and views for a regional organisation respectively. Section 5 focuses on general views of the departments and organisations, while Section 6 deals with management problems. Finally, Sections 7 and 8 give room for opinion on future prospects and open comments respectively.

It can be seen that data were collected mainly through official documentary statistics of the various fisheries departments and organisations, also through postal questionnaires.

3.4 Return rate of questionnaires

The general picture of the return rate of the questionnaires is given in Table 3.2.

Table 3.2 Questionnaire returns

Region	Questionnaires posted	Questionnaires returned
Indian Ocean	10	7
Pacific Ocean	10	6
Other countries	40	22
Overall	60	35

A total of 60 questionnaires were sent out; 10 to the coastal states of the WIO where the new fisheries organisation would be implemented; 10 to the coastal states of the Pacific Ocean where the prevailing situations are similar to those of the WIO as far as the importance of tuna resources are concerned; and 40 to the other regions where fisheries management is implemented. The questionnaires were returned within a period of three months. The final response rate of 59 per cent shows the level of interest of the study groups to the management of fish resources. Reminder letters were not needed as the main interested parties did reply in time. Although the high response rate expected from the coastal countries of the WIO did not materialise, it was compensated by direct contact and discussion with colleagues from the WIO region. As expected, two of the non-English speaking countries did not reply. This probably shows that it would be important in the future for a new organisation to operate in at least two languages, i.e. English and French.

3.5 Data analysis

The use of the Schaefer and Fox production models, as well as the CEDA package and the computer programme BASICA in the analysis of the documentary statistical data obtained from the different fisheries departments and organisations selected for this study, have already been highlighted.

The data obtained through the questionnaires have been analysed using frequencies and simple descriptive statistics of percentages. The purpose is to present basic relationships of the opinion of the different departments and organisations on the wide range of issues raised in the questionnaires.

CHAPTER FOUR

A DESCRIPTION OF THE MALAGASY TUNA FISHERY

4.1 Introduction

The benefits which coastal states are able to derive from their fishery resources ultimately depend on their ability to formulate and implement rational plans for their exploitation and utilisation (Hamlisch, 1988). The Malagasy Government, like the majority of the governments of the coastal states of the WIO, is fully aware of the benefits which can be derived from its fish resources and has taken several measures and established them in the Malagasy Fisheries Master Plan. Although the coastal states of the WIO differ in many respects, the necessity to secure benefits from the exploitation of fish resources is common to the region. Thus this chapter, relating to tuna resources and their management, could have been carried out in any country of the region and the outcomes should be to some extent similar allowing considerable basis for generalisation. Three countries in the region are relevant in this regard, i.e. Seychelles, Madagascar and Kenya. The Seychelles have the advantage of being situated in the middle of the best tuna fishing grounds in the WIO and also are the location of the West Indian Ocean Tuna Organisation and the Indian Ocean Tuna Commission. The main strategic advantage of Kenya lies in the fact that it is situated on the African continent and consequently the prevailing situations of the country would be generally similar to other coastal countries in the continent. Moreover, tuna activities in the country have increased lately since the emergence of Mombassa as a transhipment port for the tuna purse seiners fishing in the WIO.

The choice of Madagascar is based on several factors which can be summarised as follows:

i) the willingness of the country to generate benefits from its fisheries resources as displayed in the Malagasy Fisheries Master Plan.

ii) the relative development of the tuna industry in the country. Although tuna fishing follows a migratory cycle, tuna activities are permanent in the country due to the presence of the tuna canning factory *Pêche et Froid de l'Océan Indien* (PFOI).

iii) the implementation of the *Association Thonière* which is a tuna project initiated by the coastal states of the WIO in the country. This project has played a pioneer role in the development and management of tuna resources in the region; and,

iv) finally, as the author is a Malagasy, his extensive knowledge of his country will aid the actual implementation of the research proposals.

This chapter reviews the Malagasy fisheries sector as a whole and the tuna fishery in particular in order to identify problems in the exploitation of the tuna resources common to all the coastal states of the region, and consequently the generation of common benefits from these resources. The majority of the WIO coastal states rely on foreign fishing companies to exploit the tuna resources occurring in their respective EEZ through various forms of fisheries agreements. It is therefore important to analyse these fisheries agreements and propose an improved form of exploitation if necessary.

4.2 General information

Madagascar, the fourth biggest island in the world, is situated in the western part of the Indian Ocean and about 430 km east of Mozambique. It has a total land area of 587,040 sq. km and a coastline of about 5,000 km as shown in Figure 4.1. The continental shelf extends over 114,000 sq. km and the EEZ is of 376,800 sq. nm. The east coast of the country is exposed to strong winds, while the west is relatively protected and thus more important to fisheries.

An expansion of the Malagasy EEZ is expected assuming a successful resolution of the international disputes with France in relation to the status of small islands such as Bassas da India, Juan de Nova and Tromelin Island. Actually, Madagascar has claimed these islands which are *de facto* part of its territory but at the moment administered by France.

The Malagasy population was estimated in 1995 to be 13.7 million people, with a rate of increase of 3.19 per cent *per annum.* The Gross Domestic Product (GDP) is currently estimated at US$ 10.4 billion and *per capita* Gross National Product (GNP) at US$ 230.

Agriculture, including fishing and forestry, is the mainstay of the economy, accounting for over 30 per cent of GDP and contributing more than 70 per cent to total export earnings. The economic objectives of the government are aimed at attaining nutritional self-sufficiency, restoring the balance of payments, creation of employment and improvements of living standards of the population.

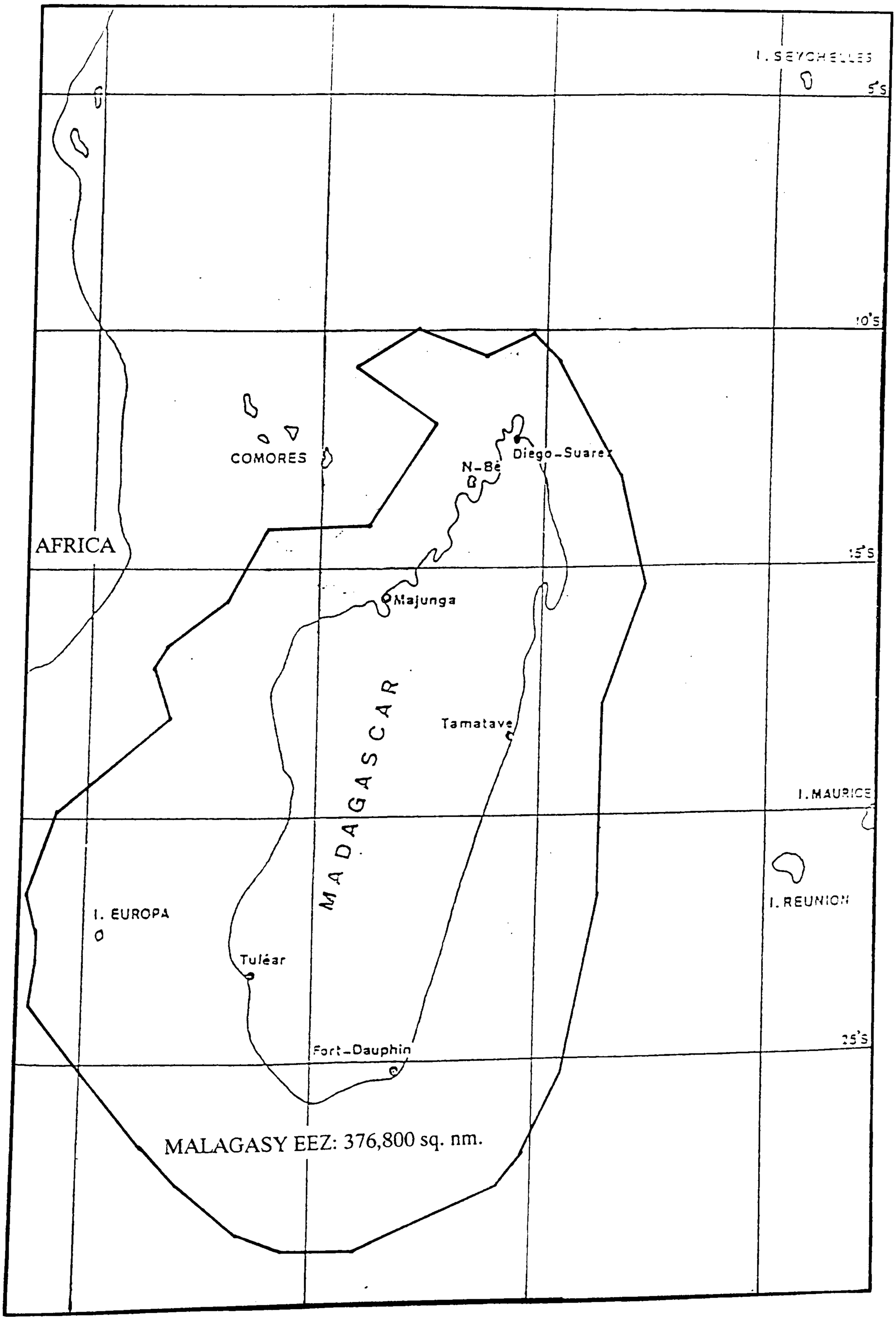
The development of the national fisheries is favoured by the following:

i) 2,000 sq. km of irrigated rice fields favourable for rice cum fish culture;

ii) 1,600 sq. km of natural lakes and rivers for fish farming and inland fishing; and,

iii) 3,000 sq. km of mangroves, a nursery zone for many marine species.

Figure 4.1 Madagascar and its EEZ



4.2.1 *Impact of the Law of the Sea*

Madagascar, like all coastal states in the WIO, is a signatory to the United Nations Convention on the Law of the Sea (UNCLOS, 1982). By the Ordinance No. 85-013 on 16 September 1985 establishing the boundaries of the Maritimes zones of Madagascar, the Malagasy Government confirmed its adherence to the provisions of UNCLOS. This compliance gives Madagascar sovereign rights over the living resources to be found in its EEZ. However, Madagascar has duties regarding the conservation and management of these resources which requires it to promote the objective of optimum utilisation of the living resources in its EEZ by determining the allowable catch, its own capacity to harvest, and the surplus, when it does not have the capacity to harvest the entire allowable catch. UNCLOS requires the country to give other nations access to this surplus within the arrangements of the terms and conditions of access.

Fishery activity in the country is regulated by Governmental Decree No. 94-112 which is related to the general organisation of fishing activities; this was approved on 18th February 1994. This decree aims essentially to regulate fishing and aquaculture activities and to define the judicial regime of licensing and specify the legal framework with regard to foreign fishing vessels (Info-pêche, 1994). The main ideas defined in the above mentioned decree include:

i) priority to the development of the national fleet without discouraging the use of foreign vessels when it is necessary;

ii) the establishment of licence fees for both fishing and collection vessels;

iii) the management of fish resources; and

iv) in the artisanal fishery, the limitation of the power of engines in individual vessels to 50 HP.

The Decree 92-112 divides fishing vessels into four categories which include: (i) Malagasy-owned fishing or support vessels; (ii) Malagasy-chartered fishing or support vessels; (iii) foreign-owned, Madagascar-based fishing or support vessels which land their entire catch in the country; and, (iv) foreign fishing vessels which do not fit into the foregoing categories. Different fishing royalties are applied to each category of fishing or support vessel. There are currently in the country about 200 laws and regulations

(Andrianaivojaona *et al.*, 1992) relating to fish resources. In reality, these laws are the subject of ongoing review. Various recommendations have been made by Canal-Forgues (1994) and the related decrees and ordinances are either being prepared or awaiting ratification by Malagasy parliament.

4.2.2 *Other international fisheries developments*

In addition to UNCLOS, there are several international developments related to fisheries relevant to the Malagasy fisheries sector. These are examined in the subsequent review:

1. The FAO World Conference on Fisheries Management and Development, which was held in Rome from 27 June to 6 July 1984, drew attention to the fact that successful exercise of national authority to extract greater benefit from fish resources depends upon the ability of coastal states to manage their resources more effectively (Marashi, 1996). To this end, a management regime through a licensing system was established in Madagascar. All fishing or support vessels must have a licence in order to fish in Malagasy waters. It is believed that foreign fleets still engage in unlicensing fishing activities in Malagasy waters. As stated by Beddington and Rettig (1983), the principal rationale is that licences are necessary for foreign vessels if they are to be controlled. Although provisions have been made to control foreign vessels in the Malagasy waters, this is still difficult due to lack of means of surveillance. This problem impedes the country benefiting fully from the exploitation of national fish resources. To tackle this problem, the country will have to implement an efficient and effective Monitoring, Control and Surveillance (MCS) programme. A more realistic approach for the management of tuna resources and maintaining cost-effectiveness would be a regional approach of MCS.

2. The United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil, from 3 to 14 June 1992. Of particular relevance was Section C which relates to "sustainable use and conservation of marine living resources of the high seas". UNCED notes that there are problems of unregulated fishing, overcapitalisation, excessive fleet size, vessel reflagging to escape controls, insufficiently selective gear, unreliable databases and lack of sufficient co-operation between states

(UNCED, 1992). The Conference recommended in accordance with UNCLOS (1982), the institution of bilateral and multilateral co-operation for management of high seas resources such as tuna. Thus, to implement the recommendations of the Conference, Madagascar and other states in the region should initiate co-operative management of the common tuna resources.

3. There is also the Agreement for the implementation of the provisions of UNCLOS relating to the conservation and management of straddling and highly migratory fish stocks. Two major features of the Agreement are the emphasis it places on an ecosystem-based approach, and the central role it confers to the establishment of international institutions at a regional or sub-regional level. The Agreement provides detailed guidelines for international co-operation which underline the central role to be played by regional and sub-regional organisations or arrangements, comprising states that have a "real interest" in the fisheries concerned (Thébaud, 1996). As Madagascar is already signatory to UNCLOS, it is of great importance that the country accepts the Agreement and ratifies it with minimum delay. As far as the management of the tuna resources of the region is concerned, it is necessary to set up a regional fisheries organisation incorporating the WIO coastal states.

4. The FAO Code of Conduct for Responsible Fisheries was adopted by FAO in 1995. The Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity (Marashi, 1996). Although the Code is voluntary, states and all those involved in fisheries are encouraged to apply and support it. In Article 7, the Code sets out the principles which should govern the management of fish resources. Again, a great deal of emphasis was placed by the Code on regional and sub-regional fisheries organisations. It reinforces the need for the coastal states of the WIO to co-operate through regional fisheries organisation for the management of their common tuna resources.

5. The Indian Ocean Tuna Commission (IOTC) was established in 1996, but up to the present time, is not yet functional. Membership of the IOTC is open to both coastal and non-coastal states and this may lead sooner or later to a situation of conflict. The management of tuna resources in the eastern tropical Pacific by the Inter-American Tropical Tuna Commission is a typical example (Joseph, 1977; King 1979).

4.3 The Malagasy fishery sector

With an annual fish production of about 120,000 tonnes, the Malagasy contribution to world fish production is small. Nevertheless, at the national level, the fishery sector occupies an important place in the Malagasy economy, both in terms of foreign exchange earnings and food supply for the national market. Fish exports account for about 13 per cent of the total export earnings of the country. The national *per capita* consumption of fish rose from 4.9 kg/year in 1960 to 7.4 kg/year in 1990. The sector employs about 69,000 people directly in fisheries activities. It is assumed that some additional 6,700 persons are engaged in the distribution and processing of fish, and there is a dependency ratio of 8:1 which means that about 550,000 persons rely on fisheries. This is about 4 per cent of the population. The potential of the Malagasy waters is estimated at about 450,000 tonnes (Andrianaivojaona *et al.*, 1992), and therefore the actual production would be expected to increase if the fishery was effectively managed.

4.3.1 *Fisheries institutions and planning objectives*

a) Fisheries objectives

The Malagasy fisheries objectives were formulated by the Government according to the prevalent situations and requirements of the country. Generally, the choice of these objectives is based on political, economic, social and nutritional considerations.

The overall objectives formulated by the Government for the fishery sector fixed in the Malagasy Fisheries Master Plan (Kasprzyk *et al.*, 1993) are:

i) to give priority to the development of the domestic fisheries and the national fishing fleets;

ii) to increase the net foreign exchange earnings;

iii) to generate employment and to contribute to the betterment of the living conditions of the fishing communities; and,

iv) to improve the domestic supply of fish to compensate for the country's protein deficit.

At first sight, it seems that there are conflicts between these objectives. For example, it would be difficult to increase the net foreign exchange earnings and to improve the domestic supply of fish simultaneously. In Madagascar, this problem is reduced by the fact that each fishery contributes to a specific objective. Notably, the tuna fishery is expected to contribute to foreign exchange earnings, whilst other fisheries, such as those based on the less valuable species, may contribute to the domestic fish supply.

b) Fisheries institutions

Since 1957, the Malagasy fishery sector has been administered by two different services: marine fisheries were under the authority of the service of livestock, while freshwater fisheries were under the service of forestry. In line with the development of the fishery sector, the Malagasy Government combined the two services and created in 1985 the *Direction des Ressources Halieutiques* (DRH), i. e. Directorate of Fisheries which covers marine and freshwater, as well as aquaculture.

By the Decree 85-127 dated 3 May 1985, the Directorate of Fisheries is responsible for the application of the state policies in all matters related to fisheries and aquaculture. Its role therefore involves data acquisition, planning, legislation, enforcement and development. Production is directly attributed to the private sector. Since its creation, the Directorate of Fisheries has been under the authority of the Ministry of Agriculture and Rural Development. In 1996, the Malagasy Government stressed once more the importance of the fishery sector to the country by creating an independent Ministry of Fisheries.

Apart from the Ministry of Fisheries, several agencies are involved directly or indirectly with the fishery sector. They include the Ministry of Scientific Research through its National Centre for Oceanographic Research (CNRO); the Ministry of Higher Education; the Ministry of Transport which is responsible for the port

infrastructures; the Ministry of Planning which is responsible for national planning, and; the Ministry of Defence which is responsible for monitoring, control and surveillance of national waters. There are sometimes overlapping jurisdictions between these different Ministries. To overcome this problem, a *Commission Interministerielle de la Pêche et de l'Aquaculture* (CIPA) which is an Interministerial Fisheries Commission has been set up. Although the mandate and functions of CIPA have been revised recently (Canal-Forgues, 1994), its main operational focus at the present time includes:

i) the proposition of policies regarding the exploitation and management of fisheries resources;

ii) the co-ordination and preparation of management plans for the different fisheries resources; and,

iii) the proposition of different legal instruments related to fisheries and aquaculture.

It is worth mentioning that at the moment, the CIPA has only a consultative role. Revision of the composition of its members and its main operational focus is necessary to improve the effectiveness of the CIPA. With such a revision, the CIPA could play a greater role in the formulation of national fisheries policy and constitute a fisheries management institution at the national level.

4.3.2 *The fisheries subsectors*

The Malagasy fisheries are constituted by marine and freshwater species. The freshwater species represent a tiny part of the total catch as shown in Table 4.1. The total production has increased steadily due mainly to marine catches from the traditional fishery. In fact, fishing activities in Madagascar are classified into three main categories, i.e. traditional, artisanal and industrial fisheries.

i) The traditional fishery is defined as all fishing activities realised without use of mechanised boats. It may include individual or groups of fishermen using different fishing techniques such as hand line, beach seine and trap.

ii) The artisanal fishery is characterised by the use of mechanised boats of engine power less or equal to 50 HP. This fishery is mainly constituted by small shrimp trawlers.

iii) The industrial fishery includes all fishing vessels with engine power exceeding 50 HP. There are mainly two distinct industrial fisheries in the country: the shrimp industrial fishery and the tuna industrial fishery. Whilst the former is conducted mainly by Malagasy-owned fishing vessels, the latter is exclusively carried out by vessels from DWFNs.

With the continuous development in the fishing technologies, it is necessary to review these definitions, particularly the legal upper limit on the engine power in the artisanal fishery. For safety reasons at sea, it may be preferable to increase the engine power available in this fishery.

Table 4.1 Nominal catches (tonnes) of fish of Madagascar

Species	1989	1990	1991	1992	1993	1994
Cyprinids	8580	9000	6900	6000	6600	6600
Cichlids	18040	19000	18000	18000	19600	19600
Freshwater fishes	3595	4000	2830	3500	3800	3920
Tuna-like fishes	8510	10000	8000	8000	10000	10000
Marine fishes	50000	51500	52703	59128	62907	65090
Marine crabs	1020	1200	960	849	1085	1300
Tropical spiny lobsters	321	310	442	554	358	390
Natantian decapods	7305	9195	10230	9469	9659	12214
Cephalopods	60	90	160	180	200	200
Marine molluscs	90	106	320	314	350	350
Marine turtles	30	25	25	25	20	20
Sea cucumbers	110	203	600	423	450	1800
Total	97661	104629	101170	106442	115029	121484

Source: *Direction des Ressources Halieutiques* (Madagascar), 1995.

Based on the estimated potential of the Malagasy fisheries resources, the actual production could triple, mostly from the traditional fishery. The capture of marine fishes has increased consistently and represents about 50 per cent of the total catch. This

increase can be maintained only if on the one hand an improvement in fishing techniques and fishing gears is introduced, and on the other hand an effective management of the resources is applied.

The catch of tuna-like fishes is an estimation due to the discrepancies between the figures reported in the national statistics and those remitted by the DWFNs. The resolution of these differences can be achieved by two developments: (i) improvement in the national statistical systems and; (ii) an obligation to embark an observer in every fishing vessel. This latter option has always been a point of dissent between the country and the various DWFNs. The catch of other species has remained stable or slightly increased apart from the Cyprinids and marine turtles. The rise in sea cucumber production in 1994 can be attributed either to better statistical coverage or the opening of new markets for exportation.

4.4 Tuna fishery activities in Madagascar

Tuna fishery activities in Malagasy waters are defined in the Malagasy Fishery Master Plan. The plan recommended a better integration of the exploitation of tuna resources in the national economy. To this end, four different actions have been proposed:

1) continuation of a commercial licensing system until national fleet capacity is developed. The current Government view is that it is important for the country at first to take advantage of the tuna resources passing through its waters using a licensing system and thereafter build up the national fleet;

2) development of Antsiranana as the main tuna base in the WIO. To take full advantage of the tuna activities in the region, the Malagasy Government believes it is necessary to attract fleets from DWFNs and encourage them to use the national facilities by offering better services. To this end, the country has improved port infrastructure through development of Antsiranana;

3) continuation of research activities related to tuna species, particularly those involved with the definition of the tuna fishing grounds and fishing techniques applied to the region; and,

4) widening and strengthening regional co-operation with a view to harmonising the politics of management and control over the exploitation of the tuna resources. The Government of the country takes the view that management of tuna resources should be initiated at a regional level.

In relation to these actions, the main tuna activities in Malagasy waters include purse seining, longlining, tuna processing and transhipment. The bulk of these activities are at the moment carried out by foreigners, with minor participation of Malagasy nationals.

4.4.1 *Purse seine activities*

Purse seine activities in Malagasy waters effectively started in 1986 following the fisheries agreements signed with the European Union. The first agreement provided for licences to be issued to 40 EU purse seiners per year to fish in Malagasy waters against financial compensation (see Appendix G). Presently, the fourth agreement, which is valid up to May 1998, entitles 42 EU purse seiners and 16 longliners to fish simultaneously in Malagasy waters. Apart from the EU/Madagascar fisheries agreements (see Appendix B), there are other agreements negotiated for licences on an individual vessel basis from Russia, Liberia and Japan.

The main management measures applied to the fishery are summarised below:

i) the tuna purse seine fishing activities in the country are regulated by the government through a system of licensing;

ii) the fishing vessels have to maintain a logbook in which is recorded the nature, time and position of all fishing operations in Malagasy waters;

iii) the captain of the fishing vessel has to communicate his position before and after leaving the Malagasy EEZ; and,

iv) an observer can be placed on board during fishing activities in the Malagasy waters. This condition has always been difficult to implement.

4.4.2 *Longline activities*

Longline activities in the Malagasy waters are carried out exclusively by fishing vessels from Japan, Korea and Taiwan. Apart from the licence fees paid in compensation for fishing rights in the Malagasy EEZ, little is known about the activities of these fishing fleets. The difficulty of monitoring the longline fishing activities lies in the fact that they do not tranship their catch in local ports. This makes it difficult to collect catch and effort data from these fisheries and consequently hinders work on stock evaluation. The management measures applied to the longline fisheries are similar to those of the purse seine fisheries. Invariably, the enforcement of these management measures is more difficult in the longline fisheries due to the problem of non-reporting of their activities. There is an urgent need to initiate and enforce tighter controls over the longline fishing activities in Malagasy waters.

4.4.3 *Canning factory*

The tuna canning factory "*Pêche et Froid de l'Océan Indien*" is a joint-venture company between France and Madagascar. It started its activities in 1990. The shore-based facilities comprise a modern canning factory with a capacity of 50,000 tonnes *per annum*; a can-making complex; and a fish meal factory. Due to its association with "Pêche et Froid" of France, the tuna canning factory is vertically integrated consisting of a fishing fleet, production unit and marketing organisation. The factory supplies the European market. The Malagasy participation is through the 65 per cent holding by private local investors. The main economic benefit to the country is through employment of Malagasy nationals.

4.4.4 *Transhipment activities*

In Madagascar, transhipment activities take place in Antsiranana. The government implemented measures to attract fishing vessels operating in the region to come to Antsiranana for transhipment. The amount of tuna transhipped increased steadily until 1994 (SFA, 1995) and decreased thereafter due to the emergence of Kenya as a competing transhipment base. In fact, there are three main transhipment ports in the

WIO, i.e. Victoria (Seychelles), Antsiranana (Madagascar) and Mombassa (Kenya). The decision by a purse seiner to use one of these three ports depends on several factors such as: proximity of the fishing zone; competitive price of ports and other facilities; and efficiency and rapidity of services. Actually, the three ports do not have a common strategy; on the contrary they are in constant competition, which must be of benefit to the purse seiners. To generate the optimum benefits, the operational similarities of these three ports should be identified, and these should serve as a basis for a regional strategy in relation to the transhipment activities in the region.

4.4.5 *Other secondary activities*

The other main secondary activities include ship chandlery, bunkering services, and vessel repair. These activities have a direct connection with the transhipment base. The more the tuna fishing vessels use the national port for transhipment, the greater will be the second activities, and *vice versa*; and the better the services offered, the greater will be the number of vessels to use the base facilities. The current policy of the country is to attract a large number of purse seiners to use the national facilities. This would facilitate the data collection needed for management purposes and increase the benefits generated from the fishery. Moreover, compared to the other two existing ports of the WIO, Madagascar has major advantages which can be summarised as follows:

- Existence in Antsiranana of *Societé d'Etudes de Carénage, Réparation et Entretien Naval* (SECREN), the biggest shipyard in the WIO region. This is important for the fishing fleet active in the region as they need regular repair and maintenance.
- Existence in Antsiranana of *Compagnie Salinière de Madagascar* (CSM), the biggest salt producer company in the Indian Ocean. As a form of preservation, purse seine vessels use a lot of salt to conserve their catches. Thus, it is important for the fishing fleet active in the region to have a constant supply of salt close to their fishing areas. The production of CSM can supply all the fishing fleets active in the WIO.
- Existence in Antsiranana of the tuna canning factory *Pêche et Froid de l'Océan Indien*. With its capacity of 50,000 tonnes per year, the PFOI presents a great market for the tuna catches in the region.
- Availability of inexpensive and efficient manpower.

Despite the above mentioned advantages, it can be argued that Madagascar should also increase investment in order to improve services so as to compete more effectively with the other ports of the region. High fuel prices and the costs of crew transfer are some of the problems which the Malagasy Government has to tackle in order to improve the competitiveness of the port.

4.4.6 *Constraints affecting development*

The development of the tuna industry in Madagascar depends partly on the state of the resources occurring in its EEZ. As tuna resources are not confined only to the Malagasy waters, the state of the resources in other parts of the WIO is also of great importance. Apart from the state of the resources, there are specific constraints which can be summarised as follows:

i) Purse seine activities

Purse seine activities are well established in the country. However, it is known that there are foreign illegal fishing activities in the Malagasy EEZ, but without the means for surveillance, it is not possible to estimate how much. The existence of these illegal fishing activities on the one hand reduces the benefits which could accrue to the country, and on the other hand limits the development of the purse seine activities. A regional approach to Monitoring, Control and Surveillance (MCS) of the fishing activities in the region might be a possible means of alleviating this problem.

ii) Longline activities

The problem of illegal fishing activities applies to the longline fishery. In addition, longline fishing vessels are well known for non-reporting of their catches. Although there are more longliners active in the Malagasy waters than purse seiners, still little is known about the longline activities. The Government view is that an obligation to report their catches shall be initiated and included in the conditions of licensing agreements. Mandatory transhipment through a national port could also improve control over the longline activities. Coupled with the impositions of prohibition of transhipment at sea, these measures might be an effective tool in the management of the longline activities. Likewise, a regional approach of MCS similar to that of purse seine activities might help.

iii) Canning factory

The establishment of the canning factory in Antsiranana was determined mainly by the availability of tuna resources in the region, low labour costs in the country and special tax exemptions to the factory due to its status as *zone franche*. The decline of one or all of these conditions may lead to a closure of the cannery.

It is therefore vital for the future of PFOI that these conditions remain stable. The predominance of Thai products in the canned-tuna market and the advent of the Uruguay Round are other significant problems that the PFOI has to face. In fact, because of the general tariff reductions granted to ACP countries, Madagascar will over a period of ten years from 1995, lose the preferential tariffs it had in its main export markets under the Generalised System of Preferences (GSP) scheme and under the Lomé Convention and, consequently, the competitive advantage offered by these schemes. However, Lemercier and Bonzon (1995) suggest that, in the short to medium term, the outcome of the Uruguay Round will have a neutral impact on the market opportunities available to African countries. Essentially, the diminished advantage of the Lomé concessions by the European Union could have an increasingly negative impact on the export performance of Madagascar, particularly for canned tuna. Therefore, over time, Madagascar has to market its products in an increasingly competitive environment.

4.5 International fisheries agreements

There are three broad approaches that a state with fishery resources may take toward foreign participation in its fisheries (Haywood and Palfreman, 1994). These are:

(i) to prohibit or discourage any foreign participation;

(ii) to grant access to wholly foreign operations (licensing); and,

(iii) to permit foreign access only in association with national partners (joint-ventures) or national operations.

These must be seen as broad categories, not as uniquely defined choices. None is truly exclusive; even a policy to exclude foreign participation will have exceptions dictated by the need for foreign inputs and markets, the presence of expatriate skills, and the difficulty of defining and controlling the activities prohibited to foreigners. Each of the three might be properly described as an option for the policy of a coastal state towards foreign participation in its fisheries.

4.5.1 *Commercial licensing agreements*

Access agreements concluded following the advent of UNCLOS (1982) may be governed by bilateral agreements, licences, contracts or some combination of the three. However, agreements for commercial licensing of foreign fishing operations against payment of fees or other economic benefits were the measures most commonly adopted by the majority of coastal states. Particularly in the African, Caribbean and Pacific (ACP) countries, policy choice has been predominantly directed towards European Union third party fisheries agreements related to commercial licensing. For these countries, commercial licensing represents less risk than either national fishing operations or joint-ventures. In fact, fees can be structured to provide a known and steady income which comes off the top of the operation (i.e. it is not susceptible to financial manipulation through hidden profit taking) and is not susceptible to commercial risks; it is a rent paid directly to the coastal state's government and can be used for development or other purposes at that government's discretion. A related advantage of commercial licensing is that the coastal state's financial commitment is minimal whereas development of national capacity normally requires considerable capital.

Customarily, EU/ACP third party fisheries agreements have provided financial compensation by way of rent to the ACP state concerned. So far, the EU has contracted 17 third party fisheries agreements with ACP states. More recently, in an agreement with Argentina, provision is made for joint-ventures, joint enterprises and temporary commercial associations, rather than merely financial compensation, as in the previous EU/ACP third party agreements.

The redeployment of the French and Spanish tuna fleets in the Indian Ocean in 1984 has opened up new opportunities for the Malagasy tuna fishery. Within the fisheries sectoral objectives fixed by the government, the tuna subsector has to contribute mainly to stabilising the national economy through an increase in net foreign exchange revenue. Moreover, as a signatory state to UNCLOS, Madagascar is obliged to allow third country vessels access to any fisheries resources which its own vessels cannot fully exploit. Therefore, the first option which is to prohibit foreign participation in the exploitation of its tuna resources has to be excluded.

At the present time, commercial licensing is the system adopted by the Malagasy Government as far as the exploitation of the tuna resources is concerned. Mainly, it consists of agreements for commercial licensing of foreign fishing operations in the Malagasy waters against payment of fees. Although the country has contracted different fisheries agreements with different partners, that with the European Union is the most important to date. Actually, the EU has contracted different types of fisheries agreements all over the world in order to secure access for its fishing vessels to the main fishing grounds. Particularly, with the ACP states, of which Madagascar is a member, the EU has contracted mainly financial compensation agreements, i. e. the EU pays for access to fish stocks and vessel owners pay for fishing licences.

The views on these fisheries agreements are diverse, depending on the EU or ACP side of the analysis. Abada (1996) has outlined the main points of criticisms against the management of fish stocks as: the gathering of information and statistics on the impact of fishing activities; inadequate monitoring of catch conditions; poor use of finance and technical assistance programmes; and violation of both domestic and international legislation in the fisheries field. In this study, the analysis is based on the experiences gathered from the application of the EU/Madagascar fisheries agreements (see Appendix B).

The EU/Madagascar fisheries agreements are based on the co-operation between the EU and the ACP states as provided for in the provisions of the Lomé IV Convention in relation to the development of fisheries signed in Lomé in 1984. Title III (Article 58) of the Convention states that "the ACP states and the Community recognise the urgent need to promote the development of fishery resources of ACP states both as a

contribution towards the development of fisheries as a whole and as a sphere of mutual interest for their respective economic sectors". Considering this Article 58, the EU/ACP fisheries agreements should be a mechanism to develop the fisheries of the ACP states. However, the constant violation of the conditions of the agreements by the fishing vessels, the excessive lure of profit to the detrimental effect on the fish stocks, and the negative impact of these agreements on artisanal fishing communities are some of the problems which the ACP states have to cope with.

Some of the relevant details of the provisions and applications of the EU/Madagascar fisheries agreements can be stated as follows:

i) the management of its fish resources is one of the prime concerns of a coastal state. As the protocol shown in Appendix B reveals, it is valid for a period of three years, making it impossible for the country to apply a management regime such as yearly TAC. A yearly protocol might be preferable instead;

ii) the amount of the total contribution should be revised and based on the effective catch in the Malagasy waters and the international market price of tuna. An efficient national data collection system has to be established specifically for tuna species;

iii) the fishing zones where EU vessels are not permitted to fish should be extended from 2 nautical miles to 12 nautical miles. This disposition will protect the inshore artisanal fishermen from the activities of foreign vessels; and,

iv) the conditions governing fishing activities by EU vessels in Madagascar's fishing zone as indicated in Appendix B should be genuinely complied with.

The merits and demerits of the above licensing agreement can be summarised as shown below:

- Merits:

i) produces a steady income not subject to commercial risks;

ii) rent paid to Government and can be used for development;

iii) can be set up quickly and discontinued quickly;

iv) can provide information on the resource;

v) can give rise to some training and technology transfer; and,

vi) can provide local development and supply of protein.

- Demerits:

i) no overall development of national fisheries;

ii) conflict with local fishermen;

iii) open to dishonest reporting systems;

iv) runs against ideas of permanent sovereignty over national resources; and,

v) unsatisfactory as the long-term or sole approach.

4.5.2 *Joint-venture agreements*

A fishery joint-venture can be defined as an association of two or more partners who share risks and benefits of a joint commercial use and development of marine living resources (Infofish, 1984). The attraction of joint-ventures is as a means of development. The joint-venture allows a coastal state to participate in an industrial enterprise according to its capacities without first having to master the technical and managerial skills needed to run it. The capacities of local managers and technicians may be increased as a result, gradually allowing greater participation.

The development objective is consistent with another advantage of joint-ventures, that of complementarity. The different skills, costs, and markets of two countries or companies may be combined to maximum advantage. This is easily seen where a country can offer resources, shore facilities and low-cost labour, and a foreign company possesses capital, management and market access.

There have been mixed experiences in the field of joint-ventures, and this has resulted in a situation where they are not common. Three cases of joint-ventures are worth reviewing in this study; Senegal, Solomon Islands and Madagascar.

(1) Senegal/France

With regard to Senegalese processing joint-venture agreements, France features strongly in most of the successful company enterprises. The *Intercontinental Conserverie* (Interco) tuna cannery being a significant example along with the French owned *Pêche et Froid* (PEF) tuna cannery which is entirely French managed.

(2) Solomon/Japan

The Solomon joint-venture agreements with Japan (through Taiyo Fisheries Company) consists of harvesting, canning and marketing of tuna. Although the company shows considerable losses and has commercial debt mainly in foreign currency, it is nevertheless a major source of employment and, potentially, a major contributor to foreign currency earnings.

(3a) Madagascar/Japan

In 1973, a joint-venture between Madagascar and Japanese company Kaigai Gyogyo Kabushiki Kaisha (KGKK) was formed. It was the country's first experience in dealing with its tuna resources. Although the fishing activities were successful, the exploitation ended in 1975 due to problems not related to the tuna resources. Some conclusions can be drawn from this brief experience:

i) the expected transfer of technology derived from the establishment of the joint-venture was not satisfied. The fishery did stop when the Japanese partner left the country. The Malagasy side did not benefit from the advanced Japanese technology;

ii) in addition to the difference in objectives, other difficulties arose with regard to differences in culture, values and languages. The Japanese desire to gain access to Malagasy waters, and the interest of Madagascar to develop its national tuna industry, both collapsed; and,

iii) the development of national tuna industry based on experiences acquired from the joint-venture was a failure. This was mainly due to lack of infrastructure and failure to acquire foreign technology.

(3b) Madagascar/France

A second joint-venture experience was started in 1990. The Malagasy processing joint-venture agreements with *Pêche et Froid de l'Océan Indien* (PFOI) reflects an example of success when the foreign partner is fully committed. The French share in the joint-ventures is controlled by PFOI which owns and operates 14 tuna vessels. Thus, due to its association with PFOI, the company is vertically integrated, i.e. fishing fleet, production unit and marketing organisation. Additionally, because of its association with PFOI, the company has the advantage of being able to draw on the expertise of the French company in production techniques, quality control/assurance, product development, management and so on.

The merits and demerits of the above joint-ventures can be summarised as follows:

- Merits:

i) can involve rapid development;

ii) can introduce capital finance;

iii) can introduce technical and management expertise;

iv) can lead to transfer of technology; and,

v) can give the host country greater control over development of its natural resources using external assistance.

- Demerits:

i) differences in objectives with the private partner who is interested in profits, and the government's interest in social objectives;

ii) differences in culture, values and language;

iii) trust difficult to achieve;

iv) possibilities for financial manipulation; and,

v) difficulties of proper control.

4.6 Impact of tuna fisheries on the national economy

Since the development of the tuna fisheries in the WIO, Madagascar has taken every possible step to extract the maximum benefits from the tuna resources occurring in its national waters. The benefits generated have so far been mainly financial and economic in nature. The impact of these benefits on the national economy is very important with regard to foreign exchange earnings and employment. Broadly, the impact that the tuna fisheries has on the national economy can be divided into two main groups, i.e. direct and indirect impact.

4.6.1 *Direct impacts*

The present EU/Madagascar fisheries agreements run from 21 May 1995 to 20 May 1998. The protocol allows 42 purse seiners and 16 longliners to fish simultaneously in Malagasy waters. The increase in the number of the longliners from 8 to 16 is the main difference compared to the previous protocol. Financially, this protocol, as shown in Appendix B, can generate for the country substantial income as shown below:

i)	Financial contribution (for three years)			ECU 1,350,000
ii)	Scientific programme			ECU 375,000
iii)	Training			ECU 450,000
iv)	Licence fees:	a) purse seiners	1,500 * 42 * 3	ECU 189,000
		b) longliners	500 * 16 * 3	ECU 24,000
v)	Fees on tuna catch		20 * 9,000 * 3	ECU 540,000
	TOTAL (for three years)			ECU 2,928,000

Thus, Madagascar expects in compensation an amount of ECU 2,928,000 for three years or ECU 976,000 per year for allowing 42 EU purse seiners and 16 EU longliners in its waters. This gives approximately ECU 16,800 per year per vessel or US$ 19,000 per year per vessel.

In reality, the amount which Madagascar receives is less than the figures stated above. This is mainly due to the fact that the budget of "Training" is administered by the EU; the total licence fees depend on the number of vessels requesting a licence, which is usually less than the figure authorised in the agreements; and the fees on tuna catch are frequently less than they could have been due to the under-reporting and non-reporting of the total catch extracted from the Malagasy waters.

Apart from the European Union, Madagascar has signed other fisheries agreements mainly with Japan, Korea and Taiwan. These agreements are based on commercial licensing and the fishing royalties are reported in Table 4.2. Although the conditions of fishing are similar to those of the EU vessels, the agreements are based purely on the

commercial point of view and consequently the licence fees are different. Generally, the fishing licences are issued for a period of one year but renewable.

Table 4. 2 Scale of fishing royalties for other fishing vessels

Gross Registered Tonnage (GRT)	Monthly royalties in US$	
	Tuna purse seiners	Tuna longliners
Less than 100	3 000	2 000
100 to 199	3 000	2 500
200 to 299	4 000	3 000
300 to 399	4 000	4 000
400 to 499	4 250	4.000
500 to 599	4 250	4 000
600 to 699	4 250	4 000
700 to 799	4 250	4 250
800 to 899	4 500	4 250
900 to 999	4 500	4 250
1000 to 1199	4 500	4 500
1200 to 1299	4 800	4 500
1300 to 1399	4 800	4 500
1400 to 1499	4 800	4 500
More than 1500	5 000	4 500

Source: *Direction des Ressources Halieutiques*, Madagascar.

For the purpose of comparison, it is assumed that the same fishing vessel acquires a licence under these two options: the EU fisheries agreements, and the other countries fishing agreements. The majority of the EU fishing vessels are within the category 800 to 1,200 GRT; therefore this category is taken as a reference point.

Based on Table 4.2, a purse seine fishing vessel with GRT lying between 800-1,200 under the other fisheries agreements has to pay a licence fee of US$ 4,500 per month, i. e. US$ 54,000 per year. Compared to a licence fee paid under the EU agreements of US$ 19,000 per year for a vessel with the same characteristics, it is

obvious that financially, the other fisheries agreements are more advantageous to the country than the EU fisheries agreements.

It is important for the country to revise the financial compensation under the EU agreements. As suggested by Hunt (1997), the usual method employed to extract the resource owner's share of the rent is a fee based on the expected value of catch. A typical example is in the South Pacific region where the Japanese currently pay a fee of about five per cent of expected value to fish under bilateral fisheries agreements with coastal states in the region. Under multilateral agreements such as with the United states, the fees can be higher, up to 14 per cent of the value of the tuna caught (Hunt, 1997).

4.6.2 *Indirect impacts*

The indirect impacts of the tuna fishery in Madagascar are numerous, they include economic, social, political and even cultural aspects. Some of these impacts are difficult to quantify. However, according to a study conducted by the *Association Thonière* in 1995, the tuna purse seine activities in the country generated in 1994 a total of US$ 13,187,000 from the different activities and services, and created about 1,176 jobs. Compared to the annual financial compensation of US$ 820,000 under the EU/Madagascar fisheries agreements, the indirect impacts are financially greater than the direct impacts. Therefore, the country should direct its policy towards the improvement of the services it offers to attract a greater number of purse seiners, subject to being able to ensure that agreements are properly drawn up and implemented.

4.7 Strategic options for the exploitation of tuna

4.7.1 *Commercial licensing*

Since the shift of the EU fishing vessels to the Indian Ocean in 1984, the strategic measures on the exploitation of tuna resources adopted by the majority of the coastal states of the region is the licensing system. Consequently, the coastal states of the region have concluded different fisheries agreements with the EU. These agreements first concluded with the EU in the period since 1984 are called "classical agreements" or

"first-generation". Owing to increasing criticisms of the "first-generation" agreements, there is a tendency within the EU to end this type of agreement and introduce a new type, the so called "second-generation" agreements. This type of agreement is often based on the creation of joint enterprises and joint-ventures between EU vessel owners and fisheries interests in the coastal states. The first of this type of agreement was signed with Argentina in 1993. It is assumed that the "second-generation" agreements will be applied in replacement of the "first-generation" in the WIO in the near future.

Some comments have to be made in analysing the "second-generation" agreements. The "first-generation" agreements were criticised because, amongst other things, they lacked provisions on management of fish stocks and effective control and enforcement against violation of the clauses of the agreement. This situation has resulted in the overfishing of several fish stocks. Thus, the "first-generation" agreements, far from developing the fisheries of the coastal states, diminished the opportunity to generate trade, create employment, and reduced the resources available to local fishermen through the dislocation of fishing operations. Moreover, the agreements provide for no overall development of the national fisheries sector.

Although the "second-generation" is a new type of agreement, it is questionable whether the same problems as in the "first-generation" will not persist. The problem is that at least one motive for the agreements, whether "first-generation" or "second-generation" is the reduction of excess EU fishing capacity by displacing the EU vessels to the waters of the various coastal states. As it is now, the EU fisheries agreements are not for the long-term benefits of the coastal states.

In the short term, fisheries agreements negotiated between Madagascar and other third parties, whether the EU or other countries, will remain the *modus operandi.* However, those agreements should be placed in the context of North-South co-operation and the terms should be genuinely complied with. Changes in these fisheries agreements which provide for Madagascar to develop an export capability are potentially of great benefit to the country when introduced in conjunction with actions which will result in capital investment, training, and market development.

4.7.2 *Joint-ventures*

As mentioned earlier, Madagascar had a rather unsuccessful experience in relation to joint-ventures. In spite of this experience, the attraction of joint-ventures as a way of attaining rapid development of a local tuna fishery through transfer of technology remains great. Moreover, the introduction of the so-called "second generation" agreement by the EU may influence the country to adopt joint-ventures as a form of exploitation of its tuna resources in the medium term.

4.7.3 *National fleet*

The creation of a national fleet is the primary objective of the Malagasy Government as far as the tuna fishery is concerned. However, this is a slow and complicated process. Various technological and financial problems have to be resolved in order to secure the development of a local tuna fishery. The problems include the lack of suitable craft, gear, trained skippers and crew; lack of investment support from financial institutions; competition from established tuna fishing nations; inadequate managerial and marketing skills and so on.

In conclusion, the exploitation of tuna in Malagasy waters may follow the timing below:

i) in the short term: continuation of commercial licensing system with improved terms and conditions. This is only a palliative solution.

ii) in the medium term: creation of joint-ventures whether through "second-generation" agreements with the EU or with other tuna fishing countries.

iii) in the long term: creation of a national fleet which would be integrated vertically in the process from catching to marketing. It is believed that an integrated multinational co-operative organisational structure between all the countries of the coastal states of the West Indian Ocean, would have to emerge to carry out the task of doing business with both EU and other countries for the effective management of tuna resources in the region. This is one of the objectives of this study.

CHAPTER FIVE

TUNA MANAGEMENT BOUNDARIES IN THE WEST INDIAN OCEAN

5.1 Introduction

In the Indian Ocean, fisheries for tuna and tuna-like species operated at a relatively low intensity until the early 1980s (FAO, 1990). However, the status of these stocks is not well-known. Ardill and Sanders (1991) state that several resources in the southwestern Indian Ocean are fully exploited, and most coastal countries recognise that some form of management is required to prevent overexploitation. However, up to the present time, there is no effective regional management scheme for the tuna fishery in the WIO. Each island and coastal state is exploiting its own tuna fishery or negotiating its own fisheries agreements without consideration of regulations implemented or enforced by other countries sharing the common resources. Although the majority of these states, through various programmes have tried to manage tuna resources in their respective waters, the overall results have not been promising. Likewise, experiences have shown that a unilateral approach to tuna fisheries management and development initiated by an individual state can not always bring real benefits for the state. Moreover, as stated by Hardin (1968), the tragedy of the commons is unavoidable in a common resource unless centralised public control, backed by coercive power, is established to discipline the users of the resources. To avoid this problem, a greater co-operation between the coastal states of the region regarding the control and management of the shared resources has to be initiated.

The fundamental issues with regard to the management boundaries of tuna in the WIO that need to be addressed are to:

i) define the spatial boundaries of the tuna stock occurring in the WIO;

ii) identify the bordering coastal and island states in whose waters tuna pass during migration;

iii) examine the fishery sector of each identified coastal and island state;

iv) highlight the different forms of exploitation of tuna by these coastal and island states.

5.2 *Tuna tagging*

The history of the use of tagging for applied fishery investigations dates back a century (Ricker, 1975). In fact, tagging has been widely used to study the migratory behaviour of fish resources, particularly tuna species. It can also be used to gain a better knowledge of fish population structures and their behaviour. Various tuna tagging programmes have been conducted locally such as in the Mozambique Channel (Romanov and Silva, 1993) and in the Maldives (Rochepeau, 1991). Despite the relative success of these programmes, there were constraints due to the migratory patterns of the tagged tuna. A more extensive tagging programme was undertaken by the Regional Tuna Project (AT/COI) in the West Indian Ocean in 1988 and 1989 (Cayré and Ramcharrun, 1990). The results of the tagging showed that:

i) tunas exploited by industrial and artisanal surface fisheries in the western part of the Indian Ocean belong to a single stock;

ii) tunas in the WIO follow a northwards migratory flow between the Mozambique Channel and the Somali basin;

iii) the Comoros Islands area has a migratory flow of tunas occurring all year round; and,

iv) La Reunion Island is a summer resting zone for tunas.

Although this study has contributed to the knowledge of the tuna fisheries of the region, the tagging programme was hindered by several technical problems such as the inadequacy of the research vessel and the inexperience of the crew. These factors should be taken into account in the future if the success of the tagging programme is to be enhanced. Moreover, at the 6th Expert Consultation on Indian Ocean Tunas held in Colombo, Sri-Lanka in 1995, the proposals for a large-scale programme for tagging yellowfin tuna of the Indian Ocean have been reviewed and broken up into three pilot studies:

i) pilot tagging study in a coastal artisanal fishery;

ii) pilot tagging experiment from a longline vessel;

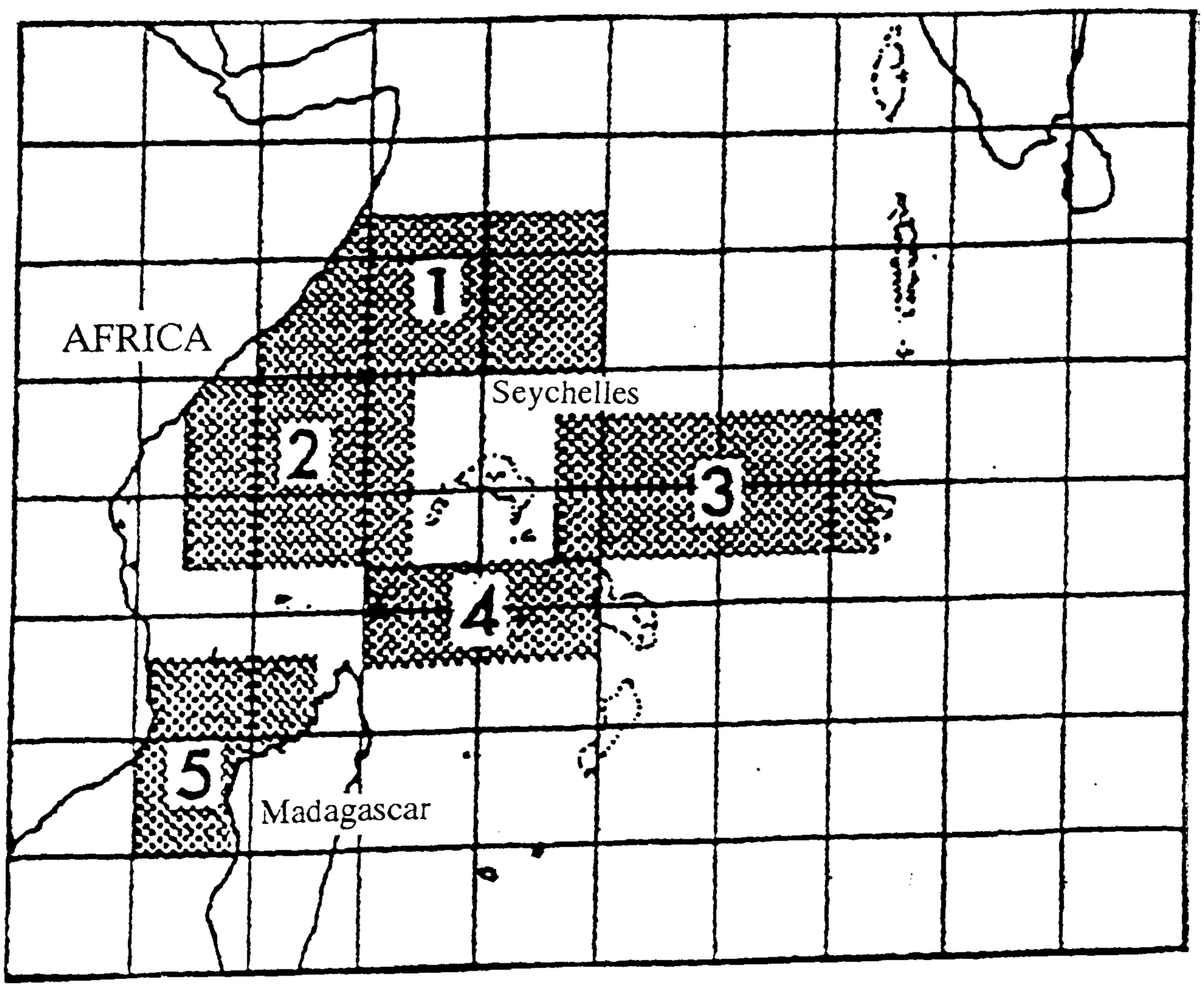
iii) pilot tagging experiment from a purse seine vessel.

The main objective of the programme has been to improve the understanding on stock structure of the yellowfin, its biological characteristics and stock status in the Indian Ocean. Although the programme is still in its project phase, it should have the support of the coastal states of the Indian Ocean and could be implemented as soon as possible.

5.3 *Fishing patterns*

At the beginning of the tuna purse seine fishery in the region, the fishing areas were confined to the Seychelles. As the fleet grew, five main purse seine fishing areas have been developed in the West Indian Ocean as demonstrated by Hallier (1993) and Marsac (1993) in Figure 5.1.

Figure 5.1 The five main purse seine fishing areas of the WIO



(1) Somali basin (North-Equator)

(2) West Seychelles

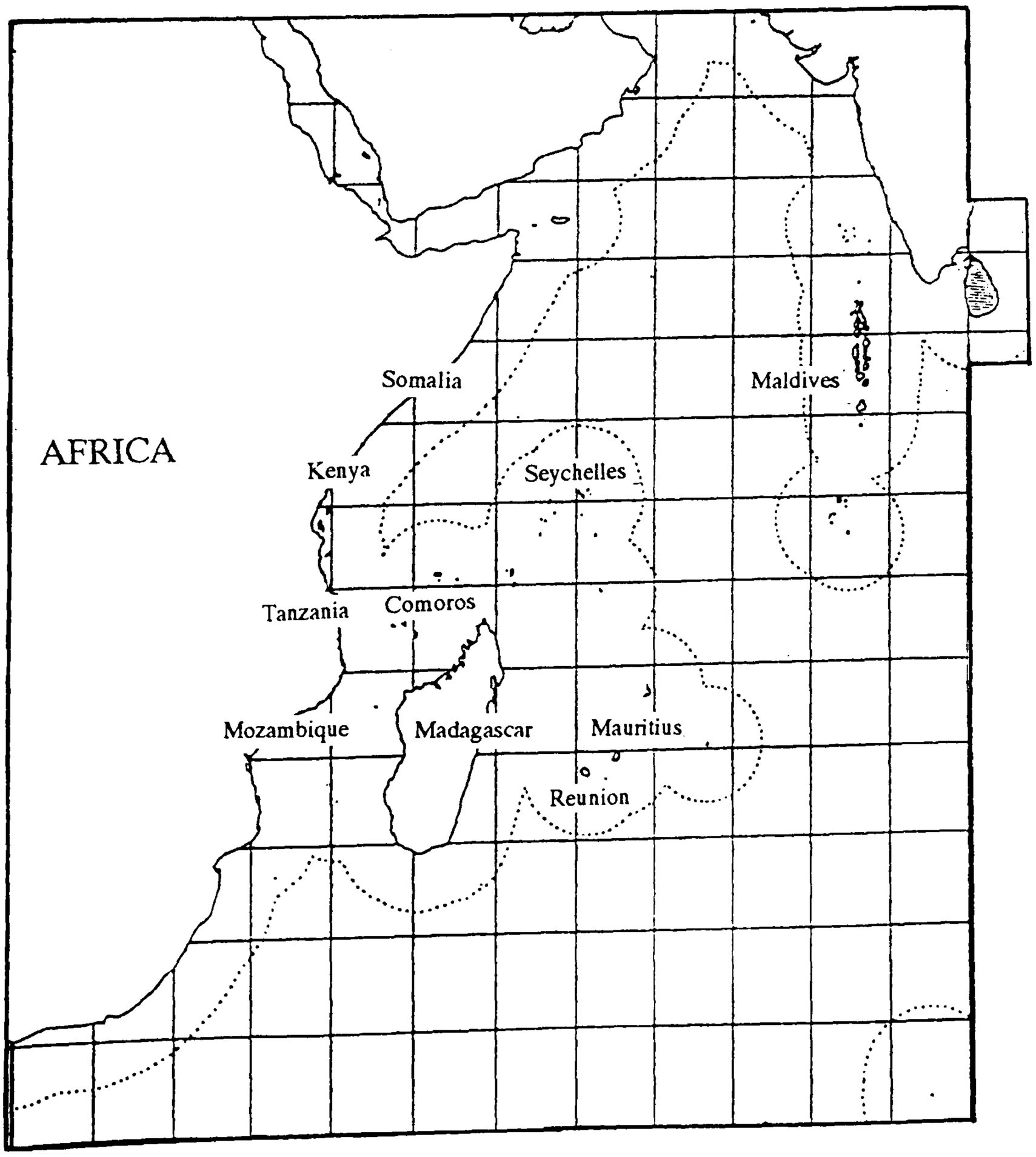
(3) East Seychelles

(4) South Seychelles

(5) Mozambique Channel

Sweenarain (1992) identifies three main seasonal fishing grounds for the WIO tuna purse seine fishery i.e.: the Somali basin from August to November; the south equatorial region from November to February and July; and the Mozambique Channel from March to June. The fishing operations within these fishing areas are relatively different from each other and depend mainly on whether the area is favourable for "log" or "free" schools purse seine fishery. Hallier (1994) identifies the Somali basin as an area for log school catch and the East Seychelles for free schools. Geographically, the fishing areas and the management boundaries areas extend mainly from 5° N to 20° S in latitude and 40° E to 75° E in longitude. These fishing areas encompass national waters of the following coastal states: Madagascar; Mozambique; Mauritius; Seychelles; Comoros; Kenya; Tanzania; Somalia; and Maldives as shown in Figure 5.2. These coastal states should therefore form the nucleus of any future fisheries management institution dealing with the management of tuna resources of the region.

Figure 5.2 West Indian Ocean (51)



5.4 The bordering states

Of the nine states bordering the WIO, four are located on the African mainland, i.e. Mozambique, Tanzania, Kenya and Somalia; and five are island states, i.e. Mauritius, Madagascar, Comoros, Seychelles and Maldives. All these states are signatory to the United Nations Conference on the Law of the Sea (UNCLOS, 1982) and therefore bound by the rights and duties pertaining to it. Moreover, they all have claimed their EEZs (see Table 5.1) and hence are obliged to allow foreign access to resources not being utilised at the national level.

The main marine fishery profiles of the identified and combined bordering states of the WIO can be summarised as follows:

- total EEZs: up to 2,000,000 sq. nm;
- national catches are estimated at about 840,000 tonnes (FAO, 1996);
- total tuna and tuna-like catches is 758,405 tonnes (FAO, 1996);
- total tuna purse seiners active in the region, 49 (SFA, 1995);
- total tuna purse seiner's catches: 306,000 tonnes (SFA, 1995).

These figures show the importance of the tuna purse seine fishery in the WIO. About 40 per cent of the total tuna production of the region is caught by this fishery. The remainder are either caught by the longline fishery or by artisanal fisheries from the coastal states. This trend justifies the purpose of this study.

5.5 *Island states*

i) The Comoros

The Comoros archipelago consists of four islands that have a total land area of 2,236 sq. km., and are located to the north of the Mozambique channel. Three of these islands form part of the Federal Islamic Republic of Comoros; the fourth island is a territorial dependency of France. The Comoros have an estimated EEZ of about 72,600 sq. nm.

Fish production is estimated at about 13,500 tonnes and tuna and tuna-like species account for 9,600 tonnes (FAO, 1996). Most of the fish production is from large oceanic pelagic fish caught by artisanal fishing methods such as handlines, troll lines, basket traps and nets. Coastal resources are considered to be heavily exploited. Although the country has no national commercial fishery, it has concluded a fisheries agreement with the EU. Under this agreement, 40 EU purse seiners are allowed to fish in Comoros waters against payment of financial compensation.

As the Comoros Islands area appears to be the place where a migratory flow of tuna occurs all year round, the excessive exploitation of tuna resources in this zone will affect the exploitation in waters of all the neighbouring countries. Thus, the integration of the country into any new fisheries organisation will be beneficial not only to the country itself but to the region as well. The country is already a member of different fisheries organisations such as IOFC, AT/COI, WIOTO.

ii) Madagascar

Because of the strategic nature of Madagascar in this study, Chapter 4 has been devoted exclusively to the description of tuna fisheries activities of the country.

iii) Maldives

The Maldives are composed of twenty atolls with a total land area of 298 sq. km. The country has a large EEZ of about 279,700 sq. nm., with a population of about 220,000 of which 20,000 are fishermen, the fishery sector is of great importance to the country. Indeed, the *per capita* fish consumption is one of the highest in the world and amounts to 130 kg/year. Thus, the contribution of fish to animal protein intake was about 96.2 per cent in 1990.

As far as the tuna fishery is concerned, the Maldives has a large, traditional live bait pole-and-line fishery. Thus, tuna fishing is one of the most important economic activities next only to tourism and trade in the country. Over 88 per cent of the total fish production is derived from tuna and tuna-like species including skipjack, yellowfin,

kawakawa, frigate tuna and bullet tuna. In 1994, the total tuna landings reached a record level of nearly 90,000 tonnes (FAO, 1996). The Maldives represents a good example for the WIO coastal states regarding a vertical integration in the exploitation of tuna resources. The country participates fully in the exploitation of its tuna resources from harvesting, processing to marketing. All of these activities are under the management of Maldivian staff and therefore the Maldives retains all the financial benefits, not by a foreign company as in other states. This vertical integration was made possible due mainly to the clear government fisheries policy objectives as follows:

i) sustainable development of fishery resources for increasing production and exports;

ii) enhancing income and living standards of fishermen;

iii) diversification of catch to species other than tuna; and,

iv) tapping the potential of the EEZ and development of small scale fisheries.

In addition, in the formulation of its long term development plan up to the year 2000, emphasis was placed on fisheries management, improvement of technology and research, strengthening infrastructure, enhancement of food supply and nutritional standards of the population, development of manpower and encouraging private sector investment in development of infrastructure and marketing.

Despite the development efforts of the government of Maldives, there is some concern over skipjack catch rates and sizes, both of which have declined in recent years (Anon, 1995a). Although the country has a low level of foreign participation in the tuna industry, the activities of foreign vessels in other parts of the region interact with the national fleets. Thus a regional approach to management of the tuna resources is necessary to the Maldives and consequently the integration of the country in any fisheries organisation for the coastal states of the WIO is indispensable.

iv) Mauritius

Mauritius is composed of several islands with a total land area of 1,850 sq. km. The Mauritian EEZ is about 344,500 sq. nm. The total population is just over one million. The Mauritian economy is mainly based on sugar, manufacturing and tourism.

Fish production is estimated at about 19,000 tonnes of which tuna accounts for 8,800 tonnes. The Mauritian inshore waters are considered to be overexploited. Inshore fishermen are being encouraged to shift their operations out to the open sea. To this end, several attempts have been made to develop a longline tuna fishery, but these have not led to the development of a sustained fishery. Nevertheless, Mauritius has developed a surface tuna fishery and at the present time operates three purse seiners.

The success of the country generating benefits from its tuna resources can be attributed to:

i) the participation of the country in tuna purse seine fishing;

ii) the fisheries agreements concluded between the EU and Mauritius;

iii) the utilisation of Port Louis as a tuna transhipment base for the Asian longliners;

iv) the implementation of two tuna canning factories, i.e. the Mauritius Tuna Fishing and Canning Enterprises Ltd., and the King foods, which has ceased its activities at the moment.

Although the vertical integration patterns in the exploitation of tuna resources are quite similar to those of the Maldives, foreign participation in Mauritius is more significant and thus may have an impact on Gross Domestic Product (GDP). Mauritius is a member of several fisheries organisations such as WIOTO, IOMAC, IPTP, AT/COI and IOFC. The integration of the country into any fisheries organisation in the WIO region is fundamental for the rational management and development of the tuna fishery.

v) La Reunion

The case of La Reunion is different from the other countries of the WIO mainly due to the fact that it is a French Department. Although La Reunion has a particular status, its fishery policy is substantially based on French fishery policy which in turn is based on the EU Common Fishery Policy (CFP). Consequently, it is difficult to define the status of La Reunion as a coastal state in the WIO; on the contrary, it is mostly a DWFN because its fishery policy is based on the CFP. The inclusion of La Reunion as a member of the new fisheries organisation in the WIO has to be considered carefully. This is because it could present an avenue for a DWFN to actively participate in any new fisheries organisation.

vi) Seychelles

The Seychelles are composed of some 100 islands with a total land area of 455 sq. km and a total population of 73,850 in 1994. The EEZ of Seychelles extends to over 393,000 sq. nm. and encompasses the best tuna fishing grounds in the WIO.

The fishery sector has played an important role in the nation's social and economic development. The Seychelles fishery sector is mainly divided into two distinct categories: the artisanal fishery which is entirely local, and the industrial fishery which is exclusively foreign.

The dedication of the country to generating the maximum benefits from its tuna resources can be seen through the government efforts to develop the tuna fishery, and this can be summarised as follows:

i) the conclusion of fisheries agreements between the EU and Seychelles;

ii) the conclusion of fisheries agreements with other countries such as Mauritius, Panama, Japan, Liberia;

iii) the implementation of the canning factory-the Indian Ocean Tuna Cannery Ltd.;

iv) the creation of the WIOTO and the accommodation of the IOTC.

The Seychelles have a strategic position in the WIO as virtually all tuna purse seiners operating there have licences to fish in Seychelles waters (Michaud, 1996). Irrespective of its strategic position, the Seychelles are active in the development of a regional approach to tuna resources management. This disposition is expressed in the main objective of the Seychelles government which is resource management to maximise the benefits from the fishery sector in order to increase its contribution to national economic, social and nutritional goals (Boullé, 1991). The inclusion of the Seychelles in any new fisheries organisation for the WIO coastal states is therefore crucial.

5.6 *Mainland states*

i) Kenya

Kenya has a relatively narrow EEZ of about 34,400 sq. nm. The fishery sector is mainly dominated by inland fisheries where the bulk of catches are from Lake Victoria. The marine fisheries, predominantly the artisanal fishery, contribute moderately to the total fish production. The possibility of increasing the marine catch based on the artisanal fishery is limited due to the fact that the inshore fishery resources are considered to be almost fully exploited.

The Kenyan fisheries policy (Ardill and Sanders, 1991) aims to increase production from all aquatic resources to the maximum sustainable yield; to improve nutritional standards; to improve rural incomes; and to generate foreign currency earnings by promoting exports. Regarding the offshore fishery, it is believed that there are illegal fishing activities going on in the Kenyan waters, but the country lacks capacity for surveillance and enforcement.

Although the level of participation of inland fisheries is high compared to marine fisheries in the national economy, there is a great potential to develop the offshore fishery in the country. Moreover, the recent development of Mombassa as a third transhipment port for the purse seiners around the WIO may present a great opportunity for the country to develop its tuna fishery. Thus, the involvement of Kenya in any new fisheries organisation will help the country to take advantage of its offshore resources.

ii) Mozambique

Mozambique has a land area of over 800,000 sq. km and a coastline of 2.500 km along the Mozambique Channel, and the Mozambican EEZ is about 163,900 sq. nm. The fisheries objectives formulated by the government include the improvement of the domestic supply of fish; the increase of net foreign exchange earnings; and the raising of the standard of living of the fishing communities (Tembe, 1991). In fact, fish is the major source of animal protein in the country. The fish potential in the three main marine

fishing areas of the country was estimated at 200,600 tonnes in 1990. The total production is estimated at 102,000 tonnes which is well below the maximum potential. Apparently, some species such as shrimp and crab are considered to be overexploited, and consequently the increase in their landings is very limited.

Although Mozambique has concluded a fisheries agreement with the EU, the possibility of increasing its involvement in the tuna fishery in the foreseeable future is quite remote. This is mainly due to the poor condition of the infrastructure of its principal port coupled with a lack of any incentive policy for the diversification of industrial production. The country would likely increase its share of the benefit generated from the tuna resources through a regional management approach of the fishery.

iii) Somalia

The unsettled political situation in Somalia at present, has hampered the efforts made to obtain data from the country. As far as tuna resources are concerned, it is recognised that in Somali waters, the Somali Basin is one of the main purse seine fishing areas in the WIO. Hallier (1991) has shown that the Somali area is particularly important for tuna "log" school fishing. It is known that EU fishing vessels are active in the Somali area despite the fact that a fishing agreement has not yet been concluded. In this respect, the country would benefit from a regional management approach of the tuna resources occurring in the WIO.

iv) Tanzania

Tanzanian marine fisheries contributed about 13 per cent of the total national fish production of 343,000 tonnes in 1994 (FAO, 1996). Furthermore, it is believed that the nearshore fishing grounds are close to being fully exploited. All the same, there is a great potential for the development of the offshore fisheries. In fact, the EU is keen to conclude a fisheries agreement for tuna with Tanzania. The agreement has apparently been delayed by the Tanzanian authorities because of the lack of resources for monitoring and compliance. Regardless of the non-conclusion of the agreement, EU vessels continue to fish in Tanzanian waters. Essentially, the inclusion of the country

into any fisheries organisation in the WIO will reduce the cost of monitoring and compliance, and consequently will increase its share of the common resources.

Without exception, a conclusion of this thesis is that all of the identified coastal states of the WIO can improve the benefits generated from the exploitation of the tuna resources occurring in their respective waters through the creation of a new regional tuna management organisation. However, there are problems and constraints which have to be overcome before setting up the organisation. In any case, adherence and effective participation on the part of the member states is a prerequisite for the viability of any projected tuna management organisation. This issue will be dealt with in the concluding chapter of this thesis.

5.7 Common features of the bordering states

All the coastal states reviewed have at least one thing in common: the tuna resources occurring in the WIO. Although the profile of fisheries, administration and financial resources vary throughout the region, there is an increased awareness of the necessity to manage the common resources at a regional level.

Ardill and Sanders (1991) have identified the common elements in fisheries policy throughout the WIO region which are mainly to seek:

i) maximum sustainable utilisation of resources;

ii) increased foreign currency earnings;

ii) maximum use of employment opportunities;

iv) enhanced well-being of the rural fishing communities; and,

v) maximised revenues and other benefits from foreign fishing.

These fisheries policies are rather general. Barber and Taylor (1990) emphasise the necessity to clearly define goals and supporting objectives before instituting any management scheme. Thus, it is important to review the existing national fisheries policies of each country. This is particularly true with regard to the tuna fishery, which is regionally owned. It is fundamentally necessary to harmonise existing national fisheries policies and particularly those related to tuna resources; uncoordinated, scattered efforts in that matter will not yield greater benefits to any of the states concerned individually.

5.7.1 *Compliance with UNCLOS*

All of the identified coastal states of the WIO are signatory to UNCLOS (1982) and consequently, they are subject to the rights and duties pertaining to it. However, as far as the tuna resources are concerned, Part 5 of UNCLOS is of great importance, and particularly its Article 57 stating the breadth of the EEZ; Articles 61-62 regarding the conservation and utilisation of the living resources, and Articles 63-64 touching on the management of straddling and highly migratory species.

i) Part 5 of UNCLOS: Article 57

"The Exclusive Economic Zone shall not extend beyond 200 nautical miles from the baseline from which the territorial sea is measured" (UNCLOS, 1982). Within its EEZ, the coastal state may exercise, *inter alia*, sovereign rights over the exploration, exploitation, conservation and management of all natural resources including fisheries. In conformity to this Article, the coastal states of the WIO have had claims to their respectively EEZ which are shown in Table 5.1.

Table 5.1 Limits of territorial seas and EEZs

State	Territorial sea in nautical miles	EEZ in nautical miles
Comoros**	12 (1982)	200 (1982)
Madagascar*	12 (1985)	200 (1985)
Maldives*	12 (1975)	200 (1976)
Mauritius**	12 (1978)	200 (1977)
Seychelles**	12 (1977)	200 (1977)
Kenya**	12 (1971)	200 (1979)
Mozambique*	12 1976)	200 (1976)
Somalia**	200 (1972)	200 (1972)
Tanzania**	12 (1989)	200 (1989)

* Country is signatory to the UN Law of the Sea Convention

** Country has ratified/acceded/succeeded (to) UN Law of the Sea Convention

As shown in Table 5.1, seven out of the nine coastal states have declared their EEZs prior to the event of UNCLOS in 1982. Six of them have ratified the Convention so far. This situation shows the importance accorded by these states to their fish resources.

ii) Part 5 of UNCLOS: Articles 61-62

"The coastal state shall determine the allowable catch of living resources in its exclusive economic zone" (UNCLOS, 1982). The Article also states that the coastal state has the duty to determine proper conservation and management of the living resources with the object of maintaining the maximum sustainable yield. The coastal state has also the duty of making scientific data about its fish stocks available through competent regional or international organisations. However, the fulfilment of these duties poses a particular problem for a migratory species such as tuna.

In Article 62, "the coastal state shall promote the objective of optimum utilisation of the living resources in the EEZ without prejudice to Article 61" (UNCLOS, 1982). "The coastal state shall determine its capacity to harvest the living resources of the EEZ. When the coastal state does not have the capacity to harvest the entire allowable catch, it shall, through agreements or other arrangements and pursuant to the terms, conditions, laws and regulations referred to in paragraph 4, give other states access to the surplus of allowable catch, having particular regard to the provisions of Article 69 and 70, especially in relation to the developing states mentioned therein" (UNCLOS, 1982).

The majority of the coastal states of the WIO, that do not have the capacity to harvest the entire TAC in their respective waters, rely on foreign fishing fleets to exploit their tuna resources. This form of exploitation necessitates provisions on foreign fishing in the national fisheries legislation or regulations. Moreover, as provided for in Article 62 (4) of UNCLOS, nationals of other states fishing within the EEZ of a coastal state shall comply with the conservation measures and with the other terms and conditions established in the laws and regulations of that coastal state. Although these laws and regulations have to be consistent with UNCLOS, legislation regarding the states' requirements for foreign fishing fleets may vary from one country to another. Tables 5.2 and 5.3 give a summary of penalties applied by the island and mainland states of the WIO for unauthorised foreign fishing in their respective waters.

Table 5.2 Penalties for unauthorised foreign fishing (Island states)

State	Fines	Imprisonment	Forfeiture
Comoros	FCFA 10 to 80 million Double for second offence within 5 years	No	Vessel, gear and catch: court shall order
Madagascar	80,000 to 400,000 of Special Drawing Rights	No	Vessel, gear and catch: confiscated
Maldives	R 100,000 to 1,000,000 or other sum not exceeding vessel cost	No	Gear and gains from catch : confiscated
Mauritius	Rm 200,000	Up to 5 years	Vessel, gear and catch: seized
Seychelles	Rs 10,000	Up to 2 years for breach of licence conditions	Vessel gear: court may order Gear: court shall order

Source: FAO Legislative Study **57** (1996)

The provision of imprisonment is absent in UNCLOS and consequently should be excluded in national legislation. Article 73 (2) of UNCLOS provides that "Coastal state penalties for violations of fisheries laws and regulations in the EEZ may not include imprisonment, in the absence of agreements to the contrary by the states concerned, or any other form of corporal punishment". However, Mauritius and Seychelles still have it in their fisheries legislation. These two countries will have to revise their legislation according to the requirements of UNCLOS.

Table 5.3 Penalties for unauthorised foreign fishing (Mainland states)

State	Fines	Imprisonment	Forfeiture
Kenya	Sh 50,000 to 500,000	From 6 months to 2 years	Vessel, gear and catch: court may order
Mozambique	From M 100,000,000	No	Gear and catch: forfeited on decision Secretary of Sate for Fisheries
Somalia	From Sosh 10,000 to 50,000,000	No, on first offence	Vessel: court may order on second offence Gear and catch: court may order
Tanzania	From US$ 250,000 up to US$ 500,000	From 6 months to 2 years	Vessel, gear and catch: court shall order on conviction

Source: FAO Legislative Study **57** (1996)

Apart from Mozambique, all of the mainland states of the WIO still have the provision of imprisonment in their legislation. To conform with the UNCLOS, these states will have to review their legislation and amongst other amendments should eliminate the provision of imprisonment.

The fines imposed by the coastal states of the WIO for unauthorised foreign fishing are shown in Table 5.4.

Table 5.4 Fines imposed by the coastal states

State	Currency	Exchange rate/US$	Fines in US$
Comoros	Franc CFA	445	22,500-180,000
Madagascar	(SDR)	0.73	110,000-548,000
Maldives	Rufiyaa	11.77	8,500-85,000
Mauritius	Mauritian rupee	20.68	9,670
Seychelles	Seychelles rupee	5.26	2,000
Kenya	Kenyan shilling	54.8	912-9,124
Mozambique	Metical	11,125	8,990
Somalia	Somali shilling	2,620	4-19
Tanzania	(US$)	1	250,000-500,000

Apart from Madagascar and Tanzania, the remaining countries have expressed their fines in their local currency. The ever frequent devaluation of the local currency of these coastal states has reduced the minimum amount of fines to a paltry sum of US$ 4. To overcome this problem, the provision of fines in hard currency is suggested.

iii) Part 5 of UNCLOS: Articles 63-64

The provisions of these two articles are very significant to the coastal states of the WIO as a whole, as they are related to regional management of resources. In fact, where the same stock is found in more than one coastal state, the states must co-operate for the conservation and development of the stocks, whether directly or through regional organisations. In the case of the high seas, coastal states and DWFNs are bound to conserve and manage stocks through co-operation. Furthermore, the Agreement for the Implementation of the Provisions of the UNCLOS 1982 Relating to the Conservation and Management of Straddling and Highly Migratory Fish Stocks reinforces the Convention and charges the coastal and fishing states to agree upon measures for the conservation of stocks and, with respect to migratory species, their optimum utilisation.

5.7.2 *Vertical integration*

Existing possibilities for an effective vertical regional integration of tuna fishery in the WIO are mostly challenged by four issues, i. e. the sustainability of the tuna resources, the resurgence of Asian competitors in canning products, the international market price of tuna, and the regional fisheries policy adopted. These four linked issues are likely to dominate the future of the tuna fishery of the WIO. Nevertheless, the region is advantaged by the existence of the four processing tuna canneries which combined have a potential of more than 100,000 tonnes/year as shown in Table 5.5.

Table 5.5 Tuna canneries in the West Indian Ocean

	Madagascar	Maldives	Mauritius	Seychelles
Start of operation	1991	1976	1972	1987
Ownership	Joint-ventures Madagascar/France	Maldives Industrial Fisheries Company	Joint-ventures Japanese/Mauritius	Joint-ventures France/Seychelles
Annual Product Capacity	20,000 tonnes (1994)	12,000 tonnes	25,000 tonnes (1994)	15,000 tonnes (1995)
Cold storage capacity	3,000 tonnes	750 tonnes	3,000 tonnes	2,000 tonnes
No. of employees	700	1,000	1,300	570
Main export market	France/Europe	Europe	UK/Europe	UK/Germany/ France
Source of raw material	French/Spanish purse seiners	Local fishermen	French/Spanish purse seiners Mauritian purse seiners	French/Spanish purse seiners
Future plans for expansion	50,000 tonnes	-	35,000 tonnes	30,000 tonnes
Other type of products	Fish meal	Salt dried Smoke dried Fish meal	3,000 tonnes of loins	-

Source: World Tuna Trade Conference (1995).

Apart from the Maldives, all of the tuna canneries in the region were established under a joint-venture system. They were mainly formed as a result of the DWFNs policy to transfer their processing facilities from Europe to low-cost countries in proximity to the newly developed tuna fishing grounds. Thus, the viability of these canneries is more or less dependent on the readiness of foreign partners to continue the joint-ventures. Moreover, under the Lomé Convention, products from these canneries are eligible to totally free and unlimited access to EU markets. This will not be the case as a result of the Uruguay Round and the GATT. Competition from Asian products, especially those from Thailand will likely hit hard on these canneries in the future.

5.8 Constraints of regional tuna fishery development

Although the majority of the coastal states of the region aspire to improve the benefits derived from their tuna resources by setting up national fleets, there are still some constraints they will have to overcome:

5.8.1 *The problem of open access*

FAO (1993) emphasises that the single most important issue that must be resolved in dealing with the current massive waste in fisheries is controlling open access. Although different measures such as UNCLOS (1982) have been adopted to eliminate this process, open access continues to exist in many fisheries. Furthermore, Jackson (1994) states that the consequences of open access include overfishing, overcapitalisation, declining catches, degradation of the environment, dangerous and damaging fishing methods, and other undesirable developments. All of these signs have started to appear in the tuna fishery of the WIO where the lack of co-ordination between coastal states is the greatest stumbling block.

The problem of open access is not a new one. Baland and Platteau (1996) have analysed the question of open access. They have concluded that in an open access situation, every fisherman is forced to follow the myopic rule, i.e. by comparing average instantaneous returns to the rental price of a boat, even though he may well be aware that he is contributing to reducing the future stock. This situation is driven by the fact that the fisherman is not guaranteed to reap the future benefits of any immediate restraining measures.

5.8.2 *The tragedy of the commons*

Hardin (1968) states that one of the prominent metaphors in environmental and natural resource science is the "tragedy of the commons". He added that rational individuals, exercising their rationality on behalf of their own short-term interests, cause systemic irrationality. Thus, a variety of models or games have been devised to examine individual and collective behaviour in different types of social dilemmas as Rapoport and Chammah (1965) stresses that the most basic is the two-person prisoner's dilemma. The

main idea in the prisoner dilemma is the way individual choices are made by the players to influence their payoffs. In fact, the situation of countries sharing the same resources such as tuna resembles the prisoner's dilemma game. Suppose the players in a game are countries exploiting a common tuna resources and the countries know that there is an upper limit to the amount of total fishing effort (F) to be applied to the fishery without fear of overexploitation. It therefore follows that as a form of exploitation, the countries sell licences to DWFNs. Both countries know that they will receive long-term benefits if they can sell licences equivalent to $F/2$ respectively. However, due to the high value of tuna, more DWFNs want to buy further licences. The situation facing each coastal state is either to restrict or not to restrict the number of licences. If both countries adopt the "restrict" strategy, the tuna fishery shall be sustainable for future generations.. If, however, they both choose the "no restrict" strategy, the fishery will be overexploited and the DWFNs will leave the region. If only one country restricts, its benefits will be lesser than the other as portrayed in Figure 5.2. There are four possible combination of outcomes. Country A chooses strategies in the row labelled "Restrict" and "No restrict", and country B chooses strategies in the column labelled "Restrict" and "No restrict".

Figure 5.2 Prisoner's dilemma game

Country A

Country B	Strategies	RE	NO
	RE	S, S	W, B
	NO	B, W	T, T

RE = Restrict; NO = No restrict

B = Best; S = Second best; T = Third best; W = Worst

The first letter in the payoff matrix is the payoff destined to country B, while the second letter is to country A.

Analysing the payoff matrix, it is clear that in hoping to maximise its payoff to the "Best", the country has to adopt its dominant strategy of "No restrict". Although it would be better for both countries to adopt the strategy of "Restrict" than "No restrict". It is to be expected that both countries will follow their dominant strategies of "No restrict".

The main problem with the prisoner's dilemma is the fact that it is rather pessimistic, i.e. generally, the players fail to co-ordinate their actions to improve their payoffs. However, as explained by Baland and Platteau (1996), an important result of repeated prisoner's dilemma game theory is as follows: if individuals know one another well, can observe one another's behaviour, and are in continuous interaction with one another, then any pattern of collective behaviour, including co-operation, can be sustained, which will make each individual better off than under universal circumstances. Communication between the players can reverse the pessimistic outcome of the prisoner's dilemma. Invariably, applied to the coastal states of the WIO, great communication has to be initiated at first before eventual negotiation for the implementation of a regional scheme.

5.9 Strategies for regional development

The strategies for regional development of the tuna fishery in the WIO are numerous and depend mainly on the issues raised below:

i) National development plan

The development of the tuna fishery at national level depends mainly on the fisheries policy of each individual state. The fisheries policies of the coastal states of the WIO vary greatly. The Maldives and the Comoros stand for the development of artisanal fisheries. Mauritius and Seychelles develop their commercial fisheries whilst the remaining are in favour of the licensing system. This issue will be examined in greater details in the concluding chapter.

ii) Terminate the open access

As stressed by FAO (1993), at the present time, open access continues to exist within the common property zones of most coastal states as well as on the high seas. This is particularly true in the WIO region where the majority of the coastal states are lacking on effective means of MCS. Taking advantage of the situation, various DWFNs are active in the region with or without licences. Thus, it is crucial for the future of the tuna fishery of the WIO region to terminate this open access regime as soon as possible. A regional approach to MCS should be initiated. This suggestion is further highlighted in the concluding chapter.

iii) Prevention of the tragedy of the commons

As stated by Copes (1987), because fish stocks are common property, they are easily exploited by harvesters competing for catches without regard for the impact on stock regeneration. To prevent this problem associated with a common property regime, one solution might be the limitation of the number of fishing units to the fishery and the effort they put in. Again, this recommendation will be examined in greater details in the concluding chapter.

CHAPTER SIX

ORGANISATIONAL THEORIES, SYSTEMS AND THE FISHERIES ORGANISATIONS OF THE WEST INDIAN OCEAN

6.1 Introduction to organisational theory

An understanding of the nature and functioning of the different fisheries organisations operating around the WIO can be enhanced by examining some general issues regarding the various organisational theories; the different approaches to the study of organisations; the different organisational systems; ways of measuring performances in organisations; and how these issues can be explored in order to propose a suitable organisational framework for the effective management of tuna fisheries in the WIO.

Critical theorists conceptualise formal or complex organisations as structured systems of relations and practices determined by the mode of production and corresponding framework of socio-political institutions which it generates (Burnell, 1980). In essence, organisation is seen as a product of the general economic structure of a particular social formation of which it is a constituent unit (Reed, 1985). This means that there is usually a framework of relationships between the various units based on control of the means of production and labour (Reed, 1985).

Many different definitions of organisation exist. In all these definitions, Kast and Rosenzweig (1970) have identified certain fundamental elements of an organisation as:

i) goal-oriented behaviour which is directed towards objectives which are more or less understood by members of that group for the achievement for a particular purpose;

ii) psychosocial systems which refers to people working and co-operating together in interdependent relationships;

iii) technological systems dealing with the use of knowledge and techniques to accomplish specific tasks;

iv) an integration of structured activities suggesting that people will have to work together.

It is therefore obvious from these definitions that goals and values are one of the integral subsystems of any organisation. Also, organisations are comprised of individuals whose behaviour within the organisation will be influenced by a number of social and psychological issues such as motivation, incentives, culture, role etc. The knowledge and techniques possessed by individuals can be used to transform inputs and outputs. The structure element of an organisation involves the ways in which the tasks of that organisation are divided and co-ordinated.

The integrated systems definition of an organisation stresses that any organisation is an open, sociotechnical system composed of a number of subsystems, receiving inputs of energy, information and materials from the environment, and transforming these before returning them to the environment as outputs (Kast and Rosenzweig, 1985).

Morgan (1986) has portrayed organisations as political systems with rules as a means of creating and maintaining order among their members. Elements of political rule found in organisations include:

i) autocracy, where power is held by an individual or small group and supported by control of critical resources, property, tradition etc.;

ii) bureaucracy, where rule is exercised through the rule of law;

iii) technocracy, where rule is exercised through knowledge, expertise and problem-solving ability;

iv) co-determination, where rule is executed by opposing parties through joint efforts aimed at meeting common interests;

v) democracy, where rule is carried out through democratic processes and equal rights.

It is clear that organisational politics plays a vital role in the way any organisation functions.

Pfeffer (1981) has identified the rational choice model; the bureaucratic model of decision-making; the decision process model; and the political models as useful theories in explaining organisations. Bolman and Deal (1991) gave the structural frame; the human resource frame; the symbolic frame; and the political frame as different aspects of organisational theories.

It can therefore be concluded that organisations have purposes which may be explicit or implicit; attract participants; acquire and allocate resources to accomplish goals; use some form of structure to divide and co-ordinate activities; and rely on certain members to lead or manage others (Morgan, 1986).

6.2 Approaches to the study of organisations

Astley and Van de Ven (1983) have given four views of organisation and management. These are:

i) the natural selection view;

ii) the collective-action view;

iii) the system-structured view;

iv) the strategic choicc view.

These perspectives provide useful focus to the different approaches used in studying organisations today. There are two levels in an organisation:

i) the macro level (dealing with populations and communities); and,

ii) the micro level (dealing with individuals).

Seen from the voluntaristic orientation, individuals within an organisation are autonomous, self-directed, proactive, and serve as organisational change agents. But from the deterministic orientation point of view, emphasis shifts from individuals to the structural properties of the context within which action unfolds, and the behaviour of the individual is seen as determined by, and in reaction to, structural constraints that are vital to the life, stability and control of the organisation (Astley and Van de Ven, 1983).

The natural selection view of an organisation assumes that in terms of structure, environmental competition defines organisational boundaries, and this is determined by economic and technical factors. In effect, the economic context determines the direction and extent of organisational growth. The organisational behaviour here is random, natural or economic but environmentally determined. This view suggests the role of the manager is inactive. Aldrich (1971) opines that the natural selection theory of organisation works much better for small, powerless organisations operating in environments with dispersed resources than for large, politically well-connected

organisations operating in environments with concentrated resources. This has some useful implications for the organisational management of tuna resources in the WIO.

The collective-action view postulates that communities or networks of semi-autonomous partisan groups do interact to modify or construct their collective environment, rules and options. Therefore, an organisation can be seen as a unit of collective-action which serves the purpose of controlling, liberating and developing the actions of individuals. The managerial role is interactive, and change can come through collective bargaining, conflict negotiation, and compromise through partisan and mutual adjustment. This view has far-reaching implications for the regional management of common tuna fisheries in the WIO which are likely to generate negotiations, conflicts, compromise and certainly interaction among the coastal states of the region.

The strategic-choice view is another organisational theory advanced by Astley and Van de Ven (1983). It incorporates elements of action theory, contemporary decision theory, and strategic management theory. Its main assumption is that people and their relationships are deliberately organised as part of the socialisation process in order to serve the choices and interests of people in power or positions of authority. Managerial role is proactive, and the structure and environment of the organisation are simply devised to give meaning to the interests of people in authority. It can be said that the strategic-choice theory is authoritarian in nature.

Finally, the system-structural view as proposed by Astley and Van de Ven (1983) incorporates systems theory, structural functionalism and contingency theory. It argues that in an organisation, roles and positions are hierarchically arranged to achieve efficient functioning of the system. In practice, it means roles are divided and integrated and adapted to subsystems to produce changes in the environment, the technology and resources needed, as well as determining the organisational size. The contingency theory as an aspect of the system-structural view, is very relevant in the search for a suitable organisational structure for the management of tuna resources in the WIO, and therefore requires more elaborate discussion.

6.3 Organisational systems and the contingency approach

Organisations are seen by several authors as composed of subsystems with clearly identifiable but permeable boundaries which separate them from their environment (Kast and Rosenzweig, 1985). Therefore, organisations receive inputs, transform them in some ways, to generate outputs which are returned to the environment. The contingency view of organisation seeks to understand the relationships within and among subsystems as well as between the organisation and its environment so as to define patterns of relationships under varying conditions and in specific circumstances (Berrieu, 1976).

Organisations are also seen as composites of strategic, co-ordinative and operating subsystems. At the strategic level, the organisation faces some uncertainties in terms of inputs from its environment over which it has little or no control (Kast and Rosenzweig, 1985). In these circumstances, the managerial role would be to reconcile the operating and strategic levels. In effect, the strategic and co-ordinative subsystems "buffer" the operating subsystems of the organisation from environmental influences.

The technical subsystem refers to the knowledge required for the performance of tasks. It deals with the facilities used to transform inputs to outputs. The technical subsystem is directly related to the organisational environment, and has an important impact on the goals and values of the organisation (Morgan, 1985).

The psychosocial subsystem consists of individuals in relation to other behaviour, motivation, status, role relationships, group dynamics and influence network (Kast and Rosenzweig, 1985). It can be affected by environmental factors as well as by technological elements and structure of the organisation.

The structural-managerial subsystem of an organisation deals with the ways in which the tasks of organisations are differentiated and integrated in order to achieve the organisational roles of goal-setting, planning, designing, monitoring, controlling, and evaluating in relation to the organisational environment (Morgan, 1986; Kast and Rosenzweig, 1985).

In conclusion, the systems approach to organisational studies focuses on the inter relationships among subsystems and how they influence the environment. An organisation is therefore seen as a subsystem in its broader environment, serving a goal-oriented purpose; using people, knowledge, techniques, equipment and facilities; with people working together on integrated activities; people relating to each other in an orderly and co-ordinated manner; with a manager or leader planning and controlling the overall endeavour (Kast and Rosenzweig, 1985).

The contingency theory has been identified as the most appropriate organisation theory relevant to the achievement of the objective of finding a suitable organisational fisheries management strategies for the coastal states of the WIO. The contingency theory believes that organisations are open systems that need careful management to satisfy and balance internal needs and to adapt to environmental circumstances (Morgan, 1985).

Organisations, like organisms, consist of interacting subsystems, multivariate in nature, and operate differently in varying conditions and circumstances. The contingency views are directed at providing suitable organisational designs and managerial actions most appropriate for specific situations (Kast and Rosenzweig, 1973). It is important to observe that Schreyogg quoted by Donaldson (1982) argues that the contingency-design approach to the study of organisations tends to neglect the political processes and the historically specific institutional settings.

The suitability of the contingency approach for the purpose of this study lies in the fact that it recognises the complexity involved in managing modern and diverse organisations such as the organisations engaged in fisheries activities of the WIO, and the need to focus more attention on patterns of relationships among these independent organisations whose goals, strategies, policies, structures and managerial roles are quite different. The best way to approach the study of the fisheries organisations in the WIO would be to understand the inter relationships within subsystems of these organisations, from which a suitable proposal or an integrated organisational framework for the collective management of tuna resources of the region can be derived.

6.4 Measurement of organisational performance

Kast and Rosenzweig (1985) explain that two fundamental issues are involved in every organisation:

i) accomplishing goals for efficient resource utilisation leading to productivity; and,

ii) providing a climate that enhances the well-being of participants.

Therefore, organisational performance can be assessed based on the results from the success of individuals and groups in achieving relevant goals; and how well the organisation provides a climate satisfactory to the people involved. In effect, according to Kast and Rosenzweig (1985):

performance = effectiveness, efficiency, and participant satisfaction.

Productivity is therefore a measure of the efficiency of any organisation in terms of how efficiently it can convert inputs to outputs.

Based on the views highlighted above, the performance of the fisheries organisations in the WIO, and the regional organisation to be proposed in the concluding chapter for the effective management of tuna resources in the WIO, will have to be assessed on the basis of productivity. As Kast and Rosenzweig (1985) explain, productivity in any organisation is the output per unit of input. In broader terms, it means the output of goods and services per hour of labour. In relation to fisheries management, it means the measure of efficiency in the utilisation of resources at organisational, societal and individual levels to maximise benefits to the fishermen, communities and member states of the WIO region.

6.5 Fisheries organisations of the West Indian Ocean

The formation of regional fisheries organisations in the WIO is a relatively recent development, most probably due to the fact that the importance of fisheries in the national economies vary considerably from country to country (Michaud, 1996). It was only by the middle of the sixties that some fisheries programmes were carried out in the region by FAO. This led to the creation of the first fisheries organisation in the region in 1967.

Joseph (1995) shows that there are currently several international organisations dealing with data collection, research, and management of tunas in various areas of the world, and others are in the process of creation. In the WIO, different fisheries organisations have been set up in an attempt to develop programmes for the management of the fish resources of the region.

The existing and current fisheries organisations of the WIO can be broadly divided into two categories, i.e. international and regional fisheries organisations. The word "regional" is used in this context to mean some kind of collaboration or co-operation among the coastal states of the region only. Consequently, "international" is used when collaboration includes states from outside the region.

6.5.1 *International fisheries organisations*

(a) <u>The Indian Ocean Fisheries Commission (IOFC)</u>

The IOFC was established in 1967 under Article VI(1) of the FAO Constitution by Resolution 2/48 of the Forty-eight Session of the FAO Council. It was the first fisheries Commission to be established in the Indian Ocean. In setting up the Commission, the Council noted that the Indian Ocean was an area as yet inadequately served by international fishery bodies, and that the need for collective action for the development and rational utilisation of the fishery resources of the area has to be established. The long-term institutional arrangements for the management of tuna in the Indian Ocean has been discussed by the IOFC since its First Session in 1968 (Kambona and Marashi, 1996). Its membership is open to all member nations and associate members of FAO,

and presently, they number about 44 countries. Although the Commission has not been very active, ten sessions have been convened since its creation, and the last was held in Kenya in November 1994 (FAO, 1996).

Objectives:

The objectives of the IOFC as set out in paragraph 2 of its statute are:

i) to promote, assist and co-ordinate national programmes over the entire field of fishery development and conservation;

ii) to promote research and development activities in the area through international sources, in particular through international aid programmes; and,

iii) to examine management problems, with special emphasis on the management of off-shore resources.

Activities:

The creation of the IOFC opened new perspectives for the management of fisheries resources in the Indian Ocean region as a whole and particularly in the western part. It served as an instrument for collection and diffusion of resource information and for the initiation of other management institutions. For these purposes, four subsidiary bodies have been created within the Commission, and they are:

i) the Committee for the Development and Management of the Fisheries Resources of the Gulfs;

ii) the Committee for the Development and Management of Fisheries in the Bay of Bengal;

iii) the Committee for the Development and Management of Fisheries in the Southwest Indian Ocean; and,

iv) the Committee for the Management of Indian Ocean Tuna.

The two latter Committees are of special interest to this research due to the fact that their areas of competence overlap with the tuna management areas for the new fisheries organisation to be proposed.

Outputs:

- Review of the state of knowledge of the inshore, off-shore and oceanic fisheries of the Indian Ocean as well as the status of fishery statistics in the region.
- A variety of feasibility studies related to fisheries in the region have been conducted.
- The IOFC has laid down basic principles to effectively manage off-shore resources at a regional level.
- Systematic convening of workshops and sessions.

The future of the IOFC has been discussed during its Tenth Session held in Mombassa, Kenya in 1994. Suggestions have been made to modify the function of the IOFC by transforming it into a body devoted to fisheries science and research, as well as the collection and dissemination of fisheries data. This modification is mainly needed within the function of the IOFC itself. Different changes have occurred since its first implementation. Notably, the decreasing participation of its members may hamper the future of the IOFC.

(b) The IOFC Committee for the Management of Indian Ocean Tuna

The Committee for the Management of Indian Ocean Tuna was established in 1968 at the First Session of the IOFC. Its membership consists of Australia, India, Indonesia, Japan, Korea, Sri Lanka, Tanzania and USA. Again, the long-term institutional arrangements for the Indian Ocean tuna have been discussed during the First Session of the Committee held in 1970. In 1980, at the Sixth Session of the IOFC in Australia and reported by Kambona and Marashi (1996), the membership of the Committee was made open-ended so that any member of the IOFC could become a member of the Committee.

Objectives:

The main objective of the Committee was to assist the IOFC in its consideration of the steps required to introduce management measures for heavily exploited stocks of tuna when these measures are found necessary. However, in 1980, the terms of reference of the Committee were revised and aimed at:

i) to review the state of the stocks of tuna, particularly in relation to the level of exploitation and its likely development;

ii) to consider the boundaries of the area that have to be taken into account in any management of tuna, bearing in mind particularly the movement of fish and fishing vessels;

iii) to review measures that might be considered for the planning, management and development of the tuna fisheries and to suggest the administrative and other actions that would be required to put such measures into effect; and,

iv) to consider arrangements for ensuring the continuation and co-ordination of the necessary research and the continuing re-assessment of the state of the stocks.

Activities:

The main activities of the Committee are:

i) the review of the state of tuna resources and the need for management measures;

ii) acquisition of substantial information on the trends of tuna fisheries in the region; monitoring the tuna fishing activities, particularly the driftnet fishing, inducing the ban of this fishing technique in 1992 in the Indian Ocean;

iii) the preparation of the long-term institutional arrangements for the management of tuna in the Indian Ocean, leading to the creation of the Indian Ocean Tuna Commission;

iv) the systematic convening of sessions during which recommendations on different aspects of tuna fisheries were addressed such as biological information, stock assessment, tagging and interaction among fisheries in relation to various species of tuna.

Outputs:

- Acquisition of substantial information on the state of tuna and the trends of tuna fisheries in the region.
- Reports of several expert consultations and workshops on various aspects related to tuna species of the region.
- Transfer gradually of its scientific programmes to the Indo-Pacific Tuna Development and Management Programme started from 1982.
- The Committee, amongst other things has recommended the reduction of the Indian Ocean tuna longline fishery. However, the question of management of tuna and some form of proper arrangements was never off the agenda of the Committee (Kambona and Marashi, 1996).

(c) The IOFC Committee for the Development and Management of Fisheries in the Southwest Indian Ocean (SWIO)

The SWIO is one of the four subsidiary bodies implemented within the IOFC specially for the countries in the western part of the Indian Ocean. The SWIO has carried out a number of major regional activities mainly through the FAO/UNDP Regional Fisheries Development and Management Project for the Southwest Indian Ocean (SWIOP) (Marashi, 1993).

The SWIOP started its activities in 1981, and terminated in 1991 because no funding was available for further extension. The project members included Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia and Tanzania. It was funded by UNDP and executed by FAO.

Objectives:

The main objective of the SWIOP was to assist the member states to achieve self-sufficiency in the development and management of their marine fisheries.

Activities:

The execution of the project was broken down in three different phases namely:

i) Preparatory phase (1981-1983). The main activities were the acquisition of baseline data on the marine fisheries of the member states; introduction of fish aggregating devices (FADs) to the region; implementation of different regional workshops related to fisheries including monitoring, control and surveillance in the exclusive economic zones.

ii) Second phase (1984-1985). Priority was given to the technological aspects of fisheries development.

iii) In addition to activities related to gear technology, fish processing, statistics and resource studies, the project concentrated on fisheries legislation, MCS, institutional structure and the identification and preparation of national technical assistance projects.

iv) Third phase (1986-1991). The main activities included the establishment of fisheries statistics baseline, identification of technical assistance needs, project preparation, regional co-ordination and exchange of information.

v) Fisheries sector studies have been carried out in each member state.

Outputs:

- Publication of different reports on multidisciplinary management studies on priority fisheries.
- Completion of fisheries resource studies, cost-and-earning studies of industrial fishery elements, and socio-economic studies of traditional fishery activities.
- At its Sixth Session held in Antananarivo, Madagascar in 1990, the IOFC Committee for the Development and Management of Fisheries in the Southwest Indian Ocean stressed the need for future support to the development and management of fisheries in the Southwest Indian Ocean. To this end, new terms of reference for the Committee have been adopted in the Tenth Session of the IOFC which include the promotion of proper utilisation and conservation of the living resources of its area of competence, by the development and management of aquaculture and fishing operations and the improvement of related processing and marketing activities in conformity with the objectives of its members (FAO, 1996).

(d) The Indo-Pacific Tuna Programme (IPTP)

The IPTP was created and established in 1982 to respond to the need for co-ordination and implementation of tuna fishery development as well as management of the resources in the Indian and Pacific Oceans. The IPTP is an inter-regional tuna programme under the auspices of the Indian Ocean Fishery Commission and the Indo-Pacific Fisheries Commission. Funded by UNDP, Japan Trust Funds and contribution from member states, the programme membership is open to member nations and associate members of FAO. The IPTP was expected to terminate at the end of 1996 and its activities would be carried out thereafter by the Indian Ocean Tuna Commission.

Objectives:

The main objectives of IPTP are the establishment of a self-sustaining tuna data centre for the Indian and Pacific Oceans; the co-ordination of tuna-related activities; and the assistance to member states in the preparation of long-term management plans for tuna species.

Activities:

i) In addition to the collection and dissemination of tuna statistics to the member states, IPTP acts as well as a scientific body in organising expert consultations on Indian Ocean tunas on behalf of the IOFC.

ii) The ongoing activities of IPTP are to modernise and upgrade the existing computer network, provide support to data acquisition and processing systems in participating countries, stimulate and support small-scale and ocean-wide tagging programmes, and diffuse data to administrators, scientists and industry in appropriate formats.

iii) Co-operate and co-ordinate activities with other organisations and FAO regional projects.

Outputs:

- Computer database containing information on fishing effort, catches and size composition of tuna species in the Indian Ocean and Pacific off Southwest Asia.
- Regularly published summaries of data on tuna species; different tuna-related reports documents; and recommendations on fisheries research and development.
- Activities of tuna management and development bodies in the Indian Ocean being co-ordinated through the programme.
- At the moment, IPTP is still carrying out its main activities until the effective establishment of the IOTC.

(e) The Indian Ocean Tuna Commission (IOTC)

The IOTC is the eventual outcome of the IOFC Committee for the Management of Indian Ocean Tuna in the form of a management-oriented body to replace the existing arrangements on the termination of IPTP. At the Hundred and Fifth Session of the FAO Council held in Rome on November 1993, the agreement for the establishment of the IOTC was adopted (Kambona & Marashi, 1996).

After long consultations and negotiations since 1986 under the aegis of the FAO, the agreement entered into force on March 1996 after the reception of the tenth instrument of acceptance by the Director-General of the FAO. The ten first signatories

of the Commission to date are: Eritrea, India, Korea, Madagascar, Mauritius, Pakistan, Seychelles, Sri-Lanka, United Kingdom and the European Union. At the First Session of the IOTC held in December 1996, the recognition of Seychelles as its base was agreed on, among other things.

Objectives, functions and responsibilities:

The objectives, functions and responsibilities of the Commission described under the Article V of the IOTC Agreement are as follows:

i) the Commission shall promote co-operation among its members with a view to ensuring, through appropriate management, the conservation and optimum utilisation of stocks covered by the Agreement, and encouraging sustainable development of fisheries based on such stocks;

ii) in order to achieve these objectives, the Commission shall have the following functions and responsibilities, in accordance with the principles expressed in the relevant provisions of the United Nations Convention on the Law of the Sea:

- to keep under review the conditions and trends of the stocks and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks and to fisheries based on the stocks covered by the Agreement;
- to encourage, recommend, and co-ordinate research and development activities in respect of the stocks and fisheries covered by the Agreement, and such other activities as the Commission may decide appropriate, including activities connected with transfer of technology, training and enhancement, having due regard to the need to ensure the equitable participation of members of the Commission in the fisheries and the special interests and needs of members in the region that are developing countries;
- to adopt, in accordance with Article IX and on the basis of scientific evidence, conservation and management measures, to ensure the conservation of the stocks covered by the Agreement and to promote the objective of their optimum utilisation throughout the Area;
- to keep under review the economic and social aspects of the fisheries based on the stocks covered by the Agreement bearing in mind, in particular, the interests of developing coastal states;

- to consider and approve its programme and autonomous budget, as well as the accounts for the past budgetary period;
- to transmit to the Director-General of FAO reports on its activities, programme, accounts and autonomous budget on such matters as may be appropriate for action by the Council or the Conference of FAO;
- to adopt its own Rules of Procedure, Financial Regulations and other internal administrative regulations as may be necessary to carry out its functions; and,
- to carry out such other activities as may be necessary to fulfil its objectives as set out above;

iii) the Commission may adopt decisions and recommendations, as required, with a view to furthering the objectives of the Agreement.

6.5.2 *Regional fisheries organisations*

(a) *L'Association Thonière* (AT/COI)

The AT/COI is a sub-regional tuna project, initiated by the island countries of the WIO and implemented within the framework of the Indian Ocean Commission (COI). Madagascar, Comoros, Seychelles, Mauritius and La Reunion have joined, their interests being to exploit their tuna resources and consequently formed the Tuna Association.

Funded by the European Development Fund and by the member states, the AT/COI was planned for three years starting from its establishment in 1986. At the end of the project, the participating countries felt the necessity to continue and strengthen the programme, and consequently, the project was extended for another further years, and then terminated its activities in 1996.

Objectives:

Initially, the main objective of the AT/COI was to help the member states to develop their tuna fisheries. Its main goals were the conduct of tuna experimental fishing; formation and training of regional fishermen; and creation of a regional scientific database on tuna species. The extended phase of the project had an objective mainly to

ensure the long-term optimal utilisation of tuna resources. There are in addition four secondary objectives:

i) to promote better consultation and co-ordination between the member states of the COI through an improved programme of collection, exchange and analysis of fisheries statistical data;

ii) to improve the efficiency of the artisanal fishery by the introduction of new fisheries techniques and to support the marketing of fisheries products;

iii) to set up a serious programme of training for those nationals responsible for the fisheries sector; and,

iv) to help those involved in the fisheries development sector.

Activities:

During the first phase (1987-1991), the main activities revolved around the use of a chartered purse seiner. Various operational problems with the project vessel reduced some of the planned activities. Despite these problems, experimental fishing using purse seine, pole and line with live-bait techniques were carried out. Scientific programmes for the collection of tuna statistics, studies of tuna biology, tuna tagging, oceanographic and biological studies of the tuna environment have been conducted.

In the second phase (1991-1996), eight scientific operations were executed in joint collaboration between the French Scientific Research Institute for Development through Co-operation (ORSTOM) and member states through their National Support Centres (CAN). The eight operations consisted of: collection and analysis of regional tuna statistics; tuna population dynamics; behaviour and migrations of tuna; biology of tunas; oceanographic and biological environment of tunas; fish aggregating devices and drifting logs; sea-mounts and tunas; and southern Indian Ocean albacore.

Outputs:

- Increase of the general knowledge on tuna stocks of the western part of the Indian Ocean and their biology.
- Development of sub-regional and regional co-operation between the member states and other coastal states in the Indian Ocean.

- Standardisation of the procedures for entering and verifying the tuna fisheries data within the AT/COI member states using the software "ORSTHON", which was developed in the Seychelles.
- Constitution of oceanographic and biological environment of the West Indian Ocean tuna through creation of the "Western Indian Ocean Environmental Database", the automatic sea surface temperature gauge network, and the ORSTOM's remote sensing receiving station.
- Deployment of fish aggregating devices in the sub-region covered by the project.
- Several short-term workshops and training have been organised.

(b) The Western Indian Ocean Tuna Organisation (WIOTO)

Initiated by the Seychelles, the WIOTO is an independent intergovernmental fishery body. Although the WIOTO was established in 1991 and came into force in 1994, it is still not functional at the moment. The membership of the organisation is open to the coastal and funding states, and possibly will include Comoros, India, Kenya, Madagascar, Maldives, Mauritius, Seychelles, Sri Lanka, and Tanzania. Presently, Seychelles, Mauritius, Comoros and India are the only members. The Convention for the implementation of the WIOTO has been waiting for ratification by the national parliaments since 1991 for the other potential members.

Objectives:

The main goal of WIOTO as defined in Article 2 of the Convention of the Organisation is to promote co-operation and co-ordination among its members. Its objectives include:

i) harmonisation of policies with respect to tuna fisheries;

ii) relations with distant water fishing nations;

iii) fisheries surveillance and enforcement according to arrangements which may be concluded;

iv) fisheries development, in particular, development of fishing capacity of members and fish technology, processing and marketing;

v) access to exclusive economic zones of members according to arrangements which may be concluded.

Expected activities:

The main activity shall be the data collection and analysis of the tuna fishery in the region, and its socio-economic impact. Furthermore, enforcement and surveillance of foreign fleets working in the region shall be dealt with by the WIOTO.

Expected outputs:

- Preparation and negotiation of the various fisheries agreements on behalf of the member states.
- Regional fisheries development plan, including Monitoring, Control and Surveillance (MCS).

6.5.3 *Other fisheries related organisations*

(a) The Indian Ocean Marine Affairs Co-operation (IOMAC)

IOMAC is a regional organisation initiated by Sri Lanka, where fisheries are included in its mandate. Its main objectives include the creation of awareness regarding the Indian Ocean and its potential for the economic development of the Indian Ocean states; the adoption of a strategy to enhance national development of the Indian Ocean states; and a policy of integrating ocean management through co-operative international and regional action, with particular emphasis on technical co-operation among developing countries (Kwiatkowska, 1990). To this end, IOMAC provides consultative forums for the Indian Ocean states and other interested states for reviewing the economic uses of the Indian Ocean and its resources, and identifies areas of further co-operation.

Despite the fact that its membership is open to any coastal or hinterland state of the Indian Ocean, IOMAC has not yet come into full operation. Eight ratifications are required for it to become functional. At the moment, only six countries have ratified the Agreement.

(b) The Fisheries Society of Africa (FISA)

Established in Kenya, FISA aims to (i) promote interaction between fishery scientists, technicians and policymakers; and (ii) generate greater awareness of the importance and dissemination of information on the strategies for rational utilisation, conservation and management of aquatic resources of Africa. After several postponements, the first Congress of the Society was held in Kenya in August 1995. The FISA has not been very active since its establishment.

(c) The Western Indian Ocean Marine Science Association (WIOMSA)

Established in Tanzania in 1991, WIOMSA aims to increase regional capacity in marine science and technology, particularly in the western part of the Indian Ocean. As a non-governmental organisation, WIOMSA is dedicated to promoting and fostering the educational, scientific and technological development of all aspects of marine sciences and technology throughout the WIO region. After six years of existence, the first General Assembly was held in Kenya in May 1997.

The activity of the WIOMSA is based mainly on exchange and training of regional scientists working on different aspects of fisheries.

Concerning principally the two latter organisations, i.e. FISA and WIOMSA, their implementation in English speaking countries may be one of the problems that hampers active participation from countries such as Madagascar or Comoros which speak French, and Mozambique whose language is Portuguese. This particular feature has to be weighted in choosing the headquarters for the fisheries organisation to be proposed in this study.

6.6 Patterns of international tuna organisations of the WIO

The objectives, activities and outputs of the Tuna Committee of the Indian Ocean Fisheries Commission (IOFC), the Indo-Pacific Tuna Programme (IPTP), and the Indian Ocean Tuna Commission (IOTC) have been examined earlier in this chapter. These are the main international tuna fisheries organisations of the WIO. It is useful to present a

brief comparative analysis of the three organisations in relation to some of issues highlighted earlier on organisational systems and theories.

Table 6.1 shows the nature of the environment; organisational work; nature of authority; negotiation of regulatory measures; procedure for reporting and enforcement; and communication systems.

Table 6.1 ***Patterns of international tuna organisations of the WIO***

	IOFC/Tuna Committee	IPTP	IOTC
Headquarters	FAO, Rome	Colombo, Sri Lanka	Mahé, Seychelles
Nature of environment	Moderate rate of change: relative low development of artisanal fisheries; national tuna activities	High degree of change: dynamic technological, status of stocks and market conditions; development of purse seine fishing	High degree of change: dynamic technological, status of stocks and market conditions; development of purse seine fishing
Organisation of work	Rough division of job responsibilities according to a functional and hierarchical pattern	Relatively well defined scientific jobs arranged in hierarchical pattern	Jobs well defined and accomplished by sub-commissions
Nature of authority	Consultative and advisory	Limits of authority and responsibility not well defined.	Vested with management
Negotiation of regulatory measures	No mandate to conserve and manage tuna resources	Advisory mandate in conservation and management measures of tuna resources	Vote by a two-thirds majority of members, conservation and management measures binding on members
Reporting and enforcement procedures	No provision	No provision	By member states
Communication systems	Rather vertical from FAO; Sessions and workshops	Sessions, workshops and ad hoc meetings; vertical from FAO and horizontal from member states.	Members provide information to the Commission; scope, form and intervals are decided by the Commission and approved by members

There are interesting variations among the organisations on the issues under examinations. For instance, the IPTP has no provision for reporting and enforcing procedures. This is also applicable to the IOFC/Tuna Committee.

All the organisations seem to follow a structured, hierarchical and systems approach. The IOFC/Tuna Committee plays a consultative and advisory role, whereas the IOTC has managerial role. No definite nature of authority can be attributed to the IPTP.

According to Burns and Stalker (1964), there are two formally contrasted forms of management system, i.e. mechanistic and organic management systems. Broadly, a mechanistic management system is appropriate for stable conditions whilst the organic form is appropriate for changing conditions. Based on these criteria, the IOFC/Tuna Committee would be classified as using a mechanistic management system and the IOTC as using an organic management system. Burns and Stalker (1973) state that the two forms of system represent a polarity, not a dichotomy, and thus there is an intermediate stage between the two extremities. The IPTP would be classified as an intermediate management system. However, in spite of these differences, Burns and Stalker (1973) have stressed the appropriateness of each system to its own specific set of conditions.

6.7 Patterns of regional tuna organisations of the WIO

Two regional organisations engaged in fisheries activities in the WIO previously discussed are: *l'Association Thonière* (AT/COI) and the West Indian Ocean Tuna Commission (WIOTO). Table 6.2 shows the patterns of organisational framework of the two main regional fisheries organisations.

Table 6.2 ***Patterns of regional tuna organisations of the WIO***

	AT/COI	WIOTO
Headquarters	Antananarivo, Madagascar	Mahé, Seychelles
Nature of environment	High degree of change: dynamic technological; status of stocks and market conditions,; tuna purse seine development	High degree of change: dynamic technological; status of stocks and markets conditions; tuna purse seine development
Organisation of work	Clearly defined by the member states	Clearly defined by the member states
Nature of authority	No management authority; scientific and advisory role.	Partially vested with management authority; management of fisheries agreements on behalf of member states
Negotiation of regulatory measures	No regulatory mandate	Conclusion between member states and delegation from them.
Reporting and enforcement procedures	No provision	From members states
Communication systems	Communication is both vertical and horizontal (member states and the organisation) Meetings	Communication is both vertical and horizontal (member states and the organisation) Consultations and negotiations; meetings, workshops

There are variations on their reporting and enforcement procedures. AT/COI has no provision in this regard, and also has no regulatory mandate. In addition, it has no management authority, but rather performs scientific and advisory role. On the other hand, both organisations have dynamic technological environment in the development of tuna fisheries.

Applying the classification by Burns and Stalker (1964), both organisations may be categorised as operating organic management system. This may be one of the reasons why the WIOTO is not active up to the present time.

6.8 Conclusion

This chapter has highlighted the organisational nature of the regional as well as the international organisations engaged in fisheries activities in the WIO. It can be seen that they all pursue their different objectives and mandates, with very little co-operation and co-ordination between them and their activities. Effective management of tuna fisheries in the region would require a body or an organisation that would co-ordinate and harmonise the objectives and activities of all these organisations. This is the main object of this study, and an organisational framework that would address this vital issue is proposed in the concluding chapter.

CHAPTER SEVEN

ANALYSIS OF DATA AND DISCUSSION OF RESULTS

7.1 Introduction

Some of the documentary statistical data collected from the Seychelles Fishing Authority (SFA), the *Association Thonière de la Commission de l'Océan Indien* (AT/COI), the Indo-Pacific Tuna Management and Development Programme (IPTP), and the various fisheries departments and organisations have already been integrated into discussions made in the previous chapters. In this chapter, data analysis is based on two sources:

i) documentary statistical data on tuna fisheries activities of the various fisheries organisations of the WIO conducting research on the biological elements of tuna resources;

ii) data obtained through the questionnaires on a wide range of organisational issues.

Whereas the biological data were analysed using the models and procedures described in Chapter 3, the questionnaire data were presented in tabular form and analysed using percentages.

7.2 Biological data analysis

7.2.1 *Estimation of maximum sustainable yield (MSY) of tuna exploited by purse seiners*

Different surplus production models have been developed to estimate the MSY and the corresponding effort f(MSY). The models have been improved in many ways to make them more realistic, and the Schaefer (1954) and Fox (1970) production models are still the most widely used. For the tuna resources available to the purse seiners in the WIO, the available time series runs from 1984 to 1995. However, problems arose when the time series 1984-1987 was included in the analysis. It is apparent that this period

marks the beginning of the purse seine activity in the region. According to Gulland (1983), there is often a period in the first few years of a fishery when the catches per vessel tend to increase inordinately because efficiency increases as the fishermen learn the best grounds to fish, and the best way to adjust their gear in relation to the peculiarities of the local stocks and conditions. He added that the effect is likely to be particularly noticeable and cause particular difficulties in analysis in the case of fleets of advanced mobile vessels moving into a new area or on to a new stock.

Another possible explanation for the 1984-1987 anomaly, is that as this period corresponded to the beginning of activity in the tuna purse seine fishery, the data collection systems might not have been functioning effectively and thus the statistical coverage was incomplete, i.e. non-reporting and under-reporting catches by DWFNs vessels may well have occurred. Furthermore, the majority of the EU fisheries agreements had been concluded with the coastal states of the region in the late 1980s. For example, with Madagascar in 1986, Comoros and Mauritius in 1988. Thus, the EU purse seiners were not under obligation to report their catches to the coastal states. The inclusion of the catch data from the 1984-1987 period causes particular difficulties in the analysis, and as suggested by Nishida (1993), it is important to detect the extremely inaccurate data and exclude them from the analysis.

a) Schaefer production model

The first analysis is based on Schaefer production model. The calculation procedure is shown in Table 7.1 using the Formula 7.1.7.

b) Fox production model

The second analysis is based on Fox production model. The calculation procedure is also shown in Table 7.1 using the Formula 7.1.10.

Table 7.1 The calculation procedure for MSY and f(MSY) for the WIO tuna purse seiners.

Year	Yield	Effort	Schaefer	Fox model
i	*y*(*i*)	*f*(*i*)	model *y*/*f*	ln (*y*/*f*)
1988	220800	9900	22.3	3.1
1989	219800	11800	18.62	2.92
1990	221250	12600	17.55	2.86
1991	219104	12337	17.76	2.87
1992	278218	14229	19.55	2.97
1993	276900	14369	19.27	2.95
1994	280114	12610	22.21	3.1
1995	305717	14434	21.18	3
Schaefer	Intercept (*a*)			22.8864
	Slope (*b*)			-0.000241
	MSY	$-a^2/(4b)$		543295
	f (MSY)	$-a/(2b)$		47477
Fox	Intercept (*c*)			3.1725
	Slope (*d*)			-0.0000157
	MSY	$-(1/d)\exp(c-1)$		557763
	f(MSY)	$-1/d$		63524

The surplus production models estimate maximum sustainable yield (MSY) from the input data:

f(*i*) = effort of year *i*, where *i* = 1, 2, ..., n.

(*y*/*f*) = yield per unit of effort in year *i* = 1, 2,..., n.

(*y*/*f*) may be derived from the yield, *y*(*i*) of year *i* for the entire fishery and the corresponding effort, *f*(*i*), by:

$$(y/f) = y(i)/f(i),\ i = 1, 2, \ldots, n. \qquad (7.1.1)$$

For the calculation of MSY, Schaefer (1954) suggested a linear model for expressing yield per unit of effort as a function of effort (Sparre *et al.* 1989):

$$\text{Schaefer}: \quad y(i)/f(i) = a + b\,f(i) \qquad \text{if } f(i) \leq -a/b \qquad (7.1.2)$$

$y(i)/f(i)$ is not defined if $f(i) > - a/b$

The intercept, a, must be positive. It is the (y/f) value obtained just after the first boat fishes on the stock for the first time.

The slope, b, must be negative if (y/f) decreases for increasing f as shown in Figure 7.1.

Fox (1970) introduced an alternative model, which gives a straight line when the logarithms of (y/f) are plotted on effort:

$$\text{Fox : } \ln (y(i)/f(i)) = c + d\, f(i) \qquad (7.1.3)$$

Both models conform to the assumption that (y/f) declines as effort increases, but they differ in the sense that the Schaefer model implies an effort level for which (y/f) equals to zero, namely $f = -a/b$ (see Figures 7.1 and 7.3) whereas for Fox:

$$y(i)/f(i) = \exp (c + d\, f(i)) \qquad (7.1.4)$$

(y/f) is greater than zero for all values of f as shown in Figures 7.2 and 7.4.

To estimate the MSY for both models, it is necessary to rewrite the equations 7.1.2 and 7.1.4 in expressing the yield as a function of effort:

$$\text{For Schaefer : } y(i) = a\, f(i) + b\, f(i)^2 \qquad (7.1.5)$$

The graph of equation 7.1.5 (see Figures 7.1 and 7.3; Tables 7.3 and 7.4) is a parabola and it takes its maximum value for:

$$\text{f(MSY)} = -0.5\, a/b \qquad (7.1.6)$$

and the corresponding maximum sustainable yield becomes:

$$\text{MSY} = -\, 0.25\, a^2/b \text{ or } -\, a^2/(4b) \qquad (7.1.7)$$

$$\text{For Fox : } y(i) = f(i) \exp (c + d\, f(i)) \qquad (7.1.8)$$

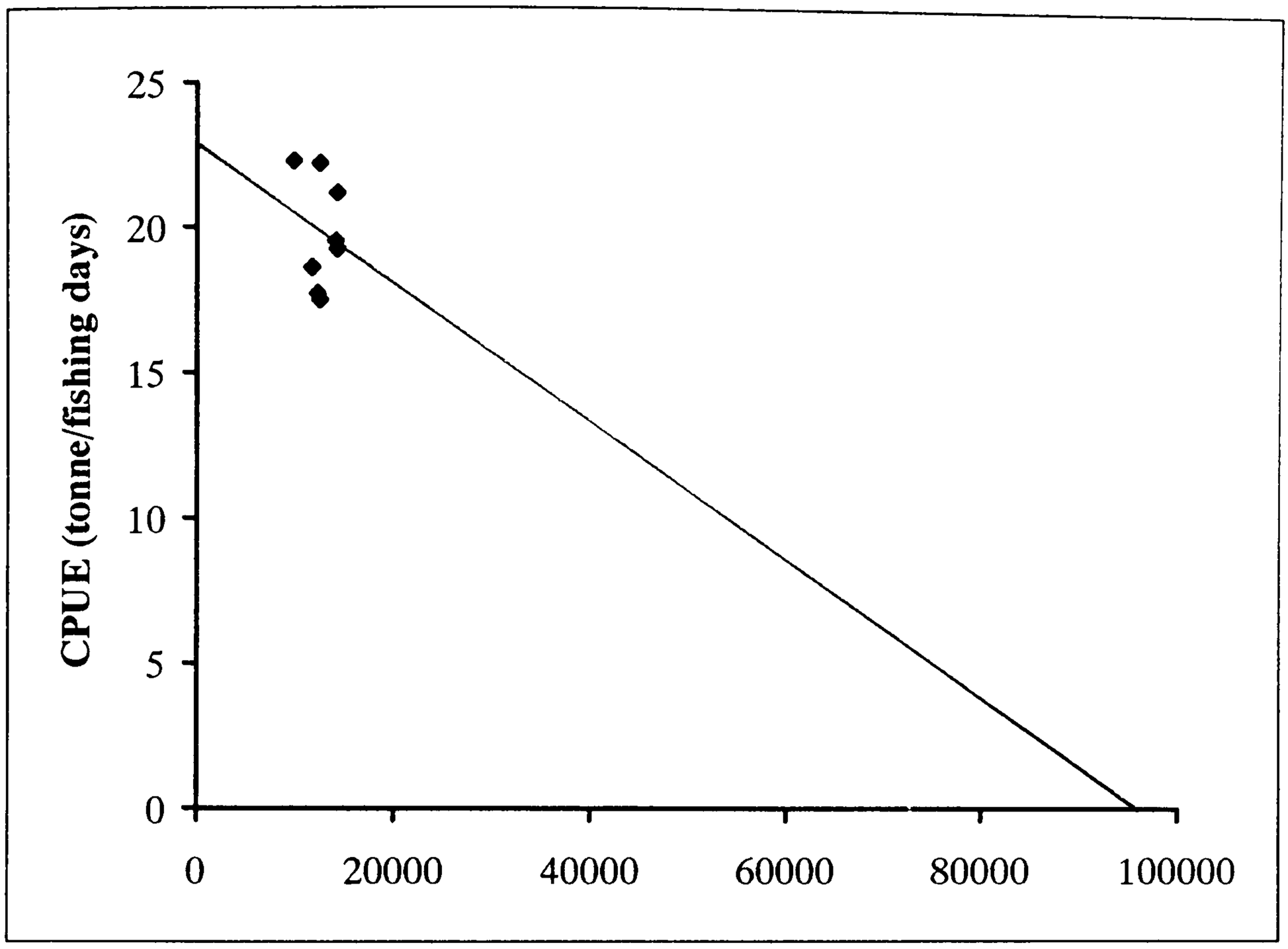
The graph of equation 7.1.8 (see Figures 7.2 and 7.4; Tables 7.3 and 7.4) is a parabola and it takes its maximum value for:

$$\text{f(MSY)} = -\, 1/d \qquad (7.1.9)$$

and the corresponding maximum sustainable yield becomes:

$$\text{MSY} = -(1/d) \exp (c - 1) \qquad (7.1.10)$$

Figure 7.1 The Schaefer production model illustrated by the tuna purse seine fishery of the WIO



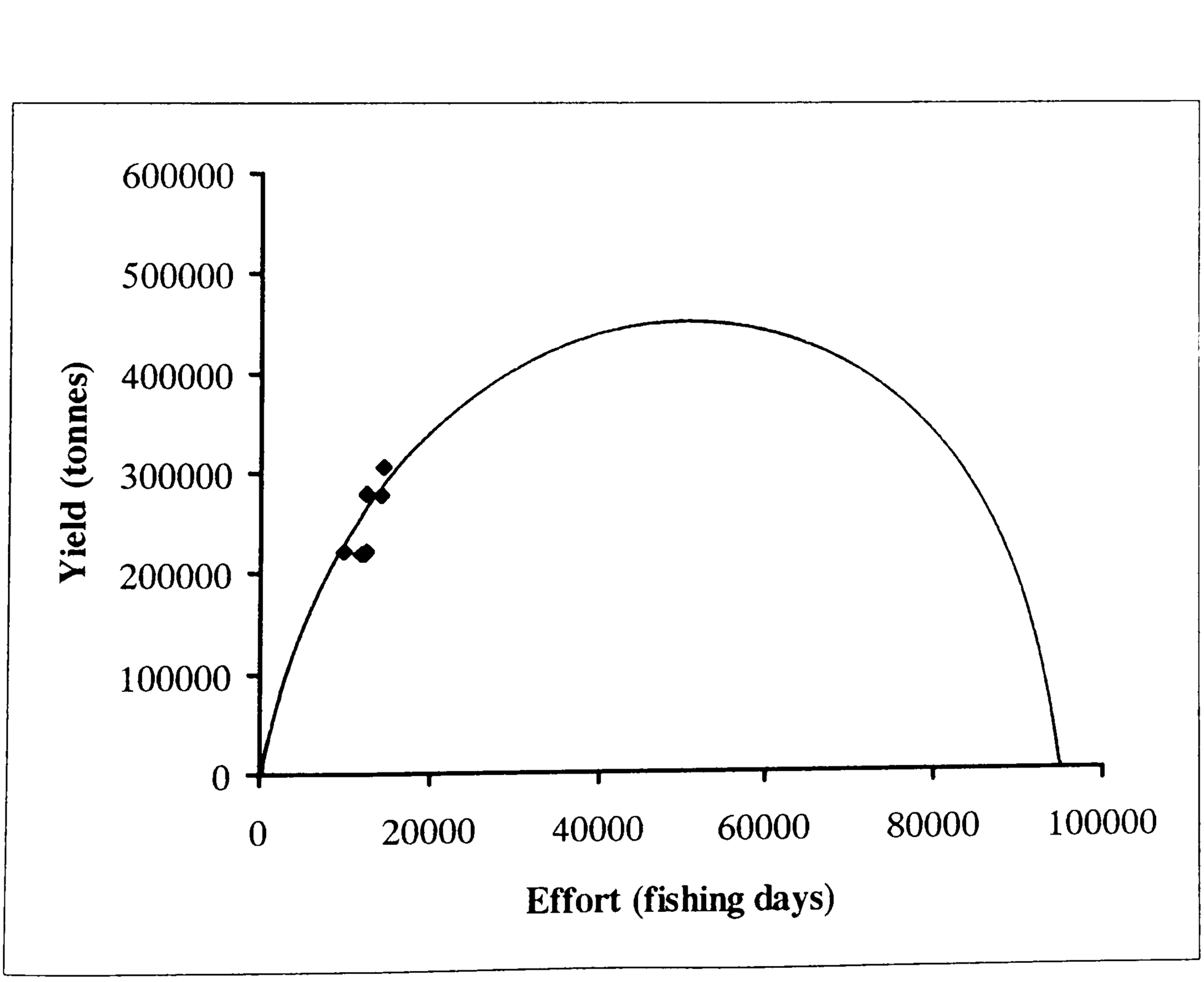
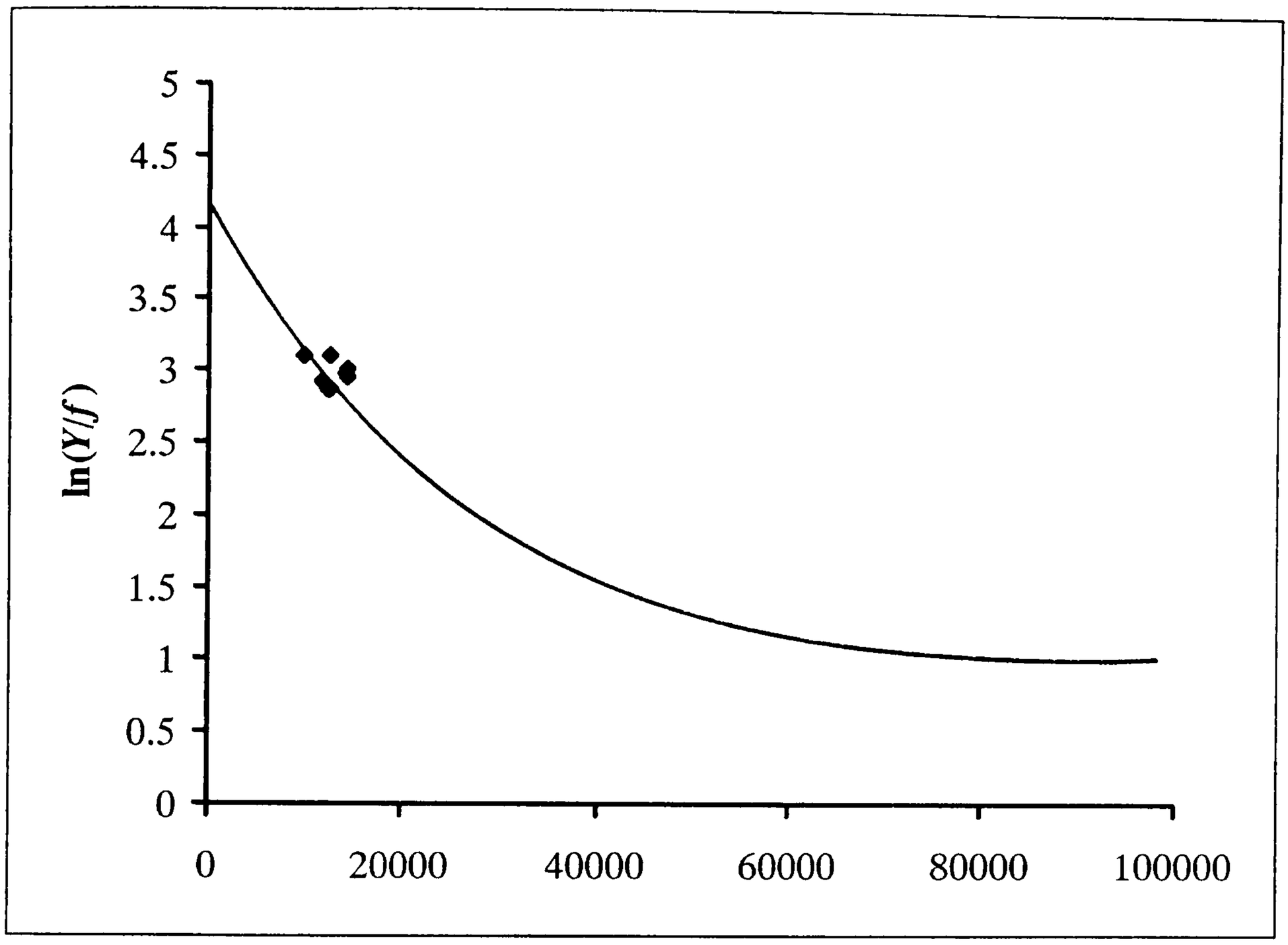
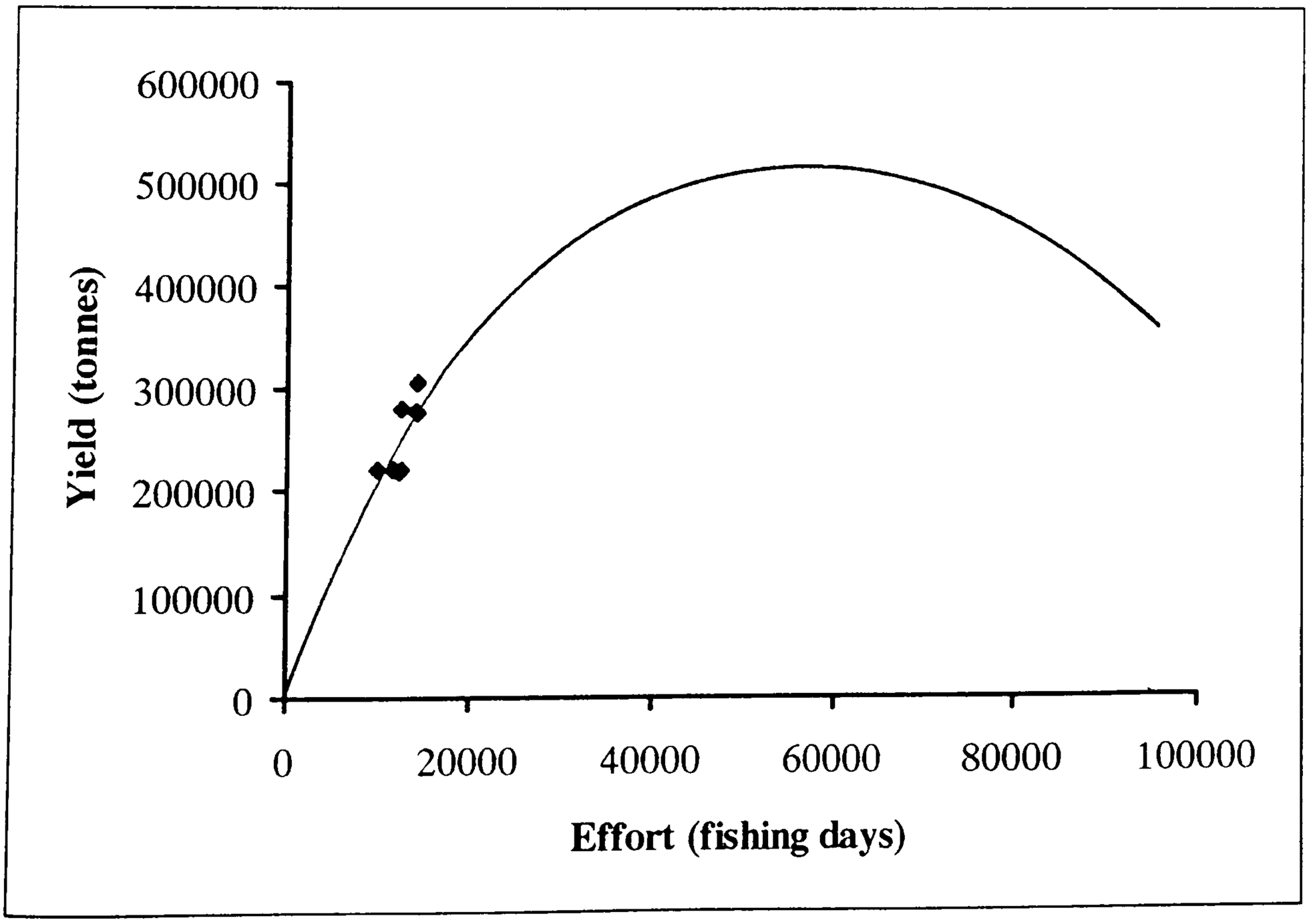


Figure 7.2 The Fox production model illustrated by the tuna purse seine fishery of the WIO





c) Catch Effort Data Analysis (CEDA)

The third analysis is based on the use of the program CEDA. The Pella-Tomlinson surplus production model within the program CEDA gives the best fit using the "generalised least squares" error model. The Pella-Tomlinson surplus production model specifies a relationship between stock size and production. It has however an extra parameter, z (shape parameter), which allows the symmetry of the Schaefer model to be deformed. The commercial catch data were fitted to the three production models; however only when using data from the period 1988-1995 was it possible to derive MSY.

The input parameters used in the analysis were:

i) Initial proportion

The initial proportion shows the degree of exploitation of the stock before the start of the data set. Its value should lie between 0 and 1, where: "0" applies for a stock almost completely exterminated before the current data set began, and "1" for a negligible prior exploitation. For the WIO tuna purse seiners, the exploitation started in 1984. However, the time series 1984-1987 were excluded from the analysis. Thus, there was exploitation before the analysed time series 1988-1995. It is considered that the exploitation rate prior to the analysed time series is more or less negligible and therefore, the initial proportion value should be less than "1", and for the analysis, the value of "0.9" has been chosen.

ii) Time lag

In the CEDA package, it is possible to incorporate a time lag L into the models, linking biomass production with the stock size L years previously. The values of L should lie between the default of zero and a maximum of the age at recruitment. The purse seine catches in the WIO are mainly constituted by skipjack and yellowfin. It is therefore necessary to determine the maximum age at recruitment of each of these species. Several authors (Shabotiniets, 1968; Stequert, 1976) have estimated the size at first maturity of skipjack in the Indian Ocean to be between 40 and 50 cm. This size fits with the age of 3 to 4 which can be taken as the maximum age at recruitment. Thus, for skipjack, the time lag should lie between "0" and "4". For the yellowfin, the age compositions of catches are different depending on whether fishing is made on log or

free schools. As stated by Hallier (1994), more than half the catch of the WIO purse seine fishery is made on log schools. Consequently, the bulk of the yellowfin catch are juvenile. Nishida (1995) shows that in the Indian Ocean, purse seiners catch mainly yellowfin from age 0 to age 2 in log schools. Thus, for the tuna purse seine fishery, where the catch is a mixture of species of skipjack and juvenile yellowfin, the value of 2 should be optimal.

iii) Shape parameter

This is particular to the Pella-Tomlinson production model. The shape parameter z allows mainly the symmetry of the Schaefer model to be deformed. For example, when $z < 1$, the peak occurs to the left of $k/2$, where k is the carrying capacity or the unexploited population size, and *vice versa*, when $z > 1$, the peak occurs to the right of $k/2$. The choice of z depends mainly on biological grounds of the analysed species. For the purposes of the present analysis, the default value of 1 has been used, i.e. similar form to the Schaefer model.

After entering and fitting the input parameters into the Pella-Tomlinson production model, the results are reported in Table 7.2. Several investigations have been performed to examine the sensitivity of the fit and the estimated parameters to the three input parameters, i.e. initial proportion, time lag and shape parameter.

d) Computer program BASICA

The fourth analysis is based on the use of the computer program BASICA. As with the three previous methods, only when using the time series 1988-1995 was it possible to derive the MSY and f(MSY) as shown in Table 7.2.

7.2.2 *Results*

The results of the four different methods used to calculate the MSY and f(MSY) for the tuna resources exploited by the purse seiners in the WIO are shown in Table 7.2.

Table 7.2 Comparison results of the four different methods for tuna

Models and programs	MSY (tonnes)	f(MSY) (fishing days)
Schaefer model	543295	47477
Fox model	557763	63524
CEDA	488534	-
BASICA	542246	47359

Table 7.2 shows the results of the estimated maximum sustainable yield (MSY) and the corresponding fishing effort f(MSY) for the tuna available to purse seiners in the WIO. The estimated MSYs ranges from 488,534 tonnes to 557,763 tonnes and f(MSY) between 47,359 to 63,524 fishing days. Based on these results, the actual exploitation rate of 305,717 tonnes can be said to be below the estimated MSY.

7.2.3 *Estimation of maximum sustainable yield of yellowfin exploited by purse seiners*

In this analysis, the same methods used to estimate the MSY and the corresponding effort f(MSY) of the tuna available to purse seiners in the WIO have been employed for yellowfin.

a) Schaefer production model

The first analysis is based on the Schaefer (1954) production model. Although the catch refers to yellowfin alone, the fishing effort represents that directed towards all combined species. This situation is due to the fact that it is difficult to obtain a rational separation of effort in a fishery that essentially involves different species.

The same problems arose when the time series 1984-1987 was included in the analysis. This fact proves the necessity to exclude the time series 1984-1987 and to analyse apart the time series 1988-1995 using the surplus production models. The calculation procedure is shown in Table 7.3 using the formula 7.1.7.

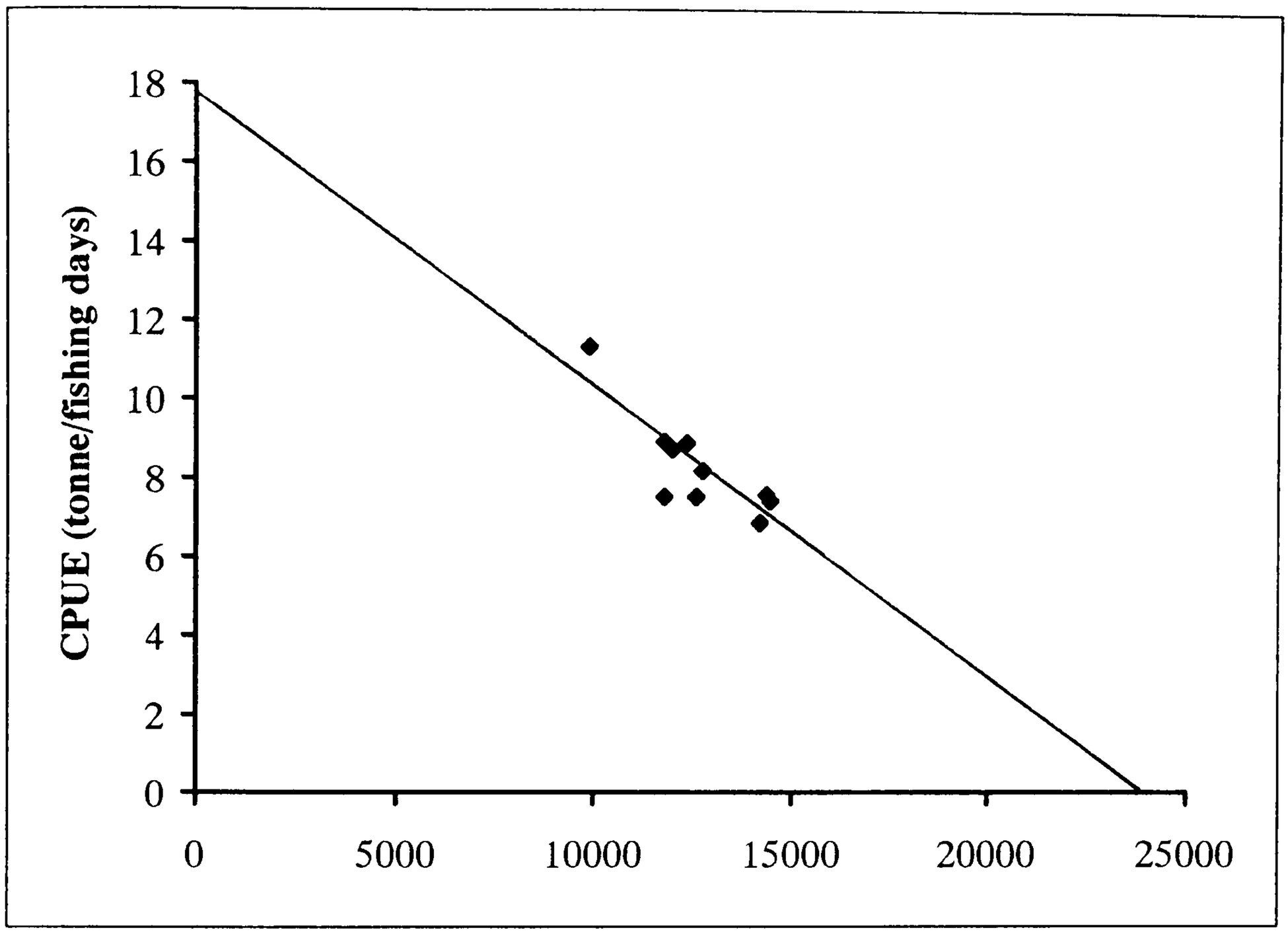
b) Fox production model

The second analysis is based on Fox (1970) production model. Similar to the previous analysis, only the time series 1988-1995 can be fitted into the Fox model. The calculation procedure is shown in Table 7.3 using the formula 7.1.10.

Table 7.3 The calculation procedure for MSY and f(MSY) for the WIO yellowfin tuna purse seiners

Year		Yield	Effort	Schaefer model	Fox model
i		*y*(*i*)	*f*(*i*)	*y*/*f*	ln (*y*/*f*)
1988		112500	9900	11.36	2.43
1989		88900	11800	7.53	2.01
1990		102700	12600	8.15	2.09
1991		97611	12337	8.9	2.06
1992		97833	14229	6.87	1.92
1993		108943	14369	7.58	2.02
1994		94610	12610	7.54	2.01
1995		107420	14434	7.44	2
Schaefer	Intercept (*a*)				17.8713
	Slope (*b*)				-0.0007587
	MSY		$-a^2/(4b)$		105238
	f(MSY)		$-a/(2b)$		11777
Fox	Intercept (*c*)				3.1074
	Slope (*d*)				-0.00008
	MSY		-(1/*d*) exp(*c*-1)		101780
	f(MSY)		-1/*d*		12731

Figure 7.3 The Schaefer production model illustrated by the yellowfin tuna purse seine fishery of the WIO



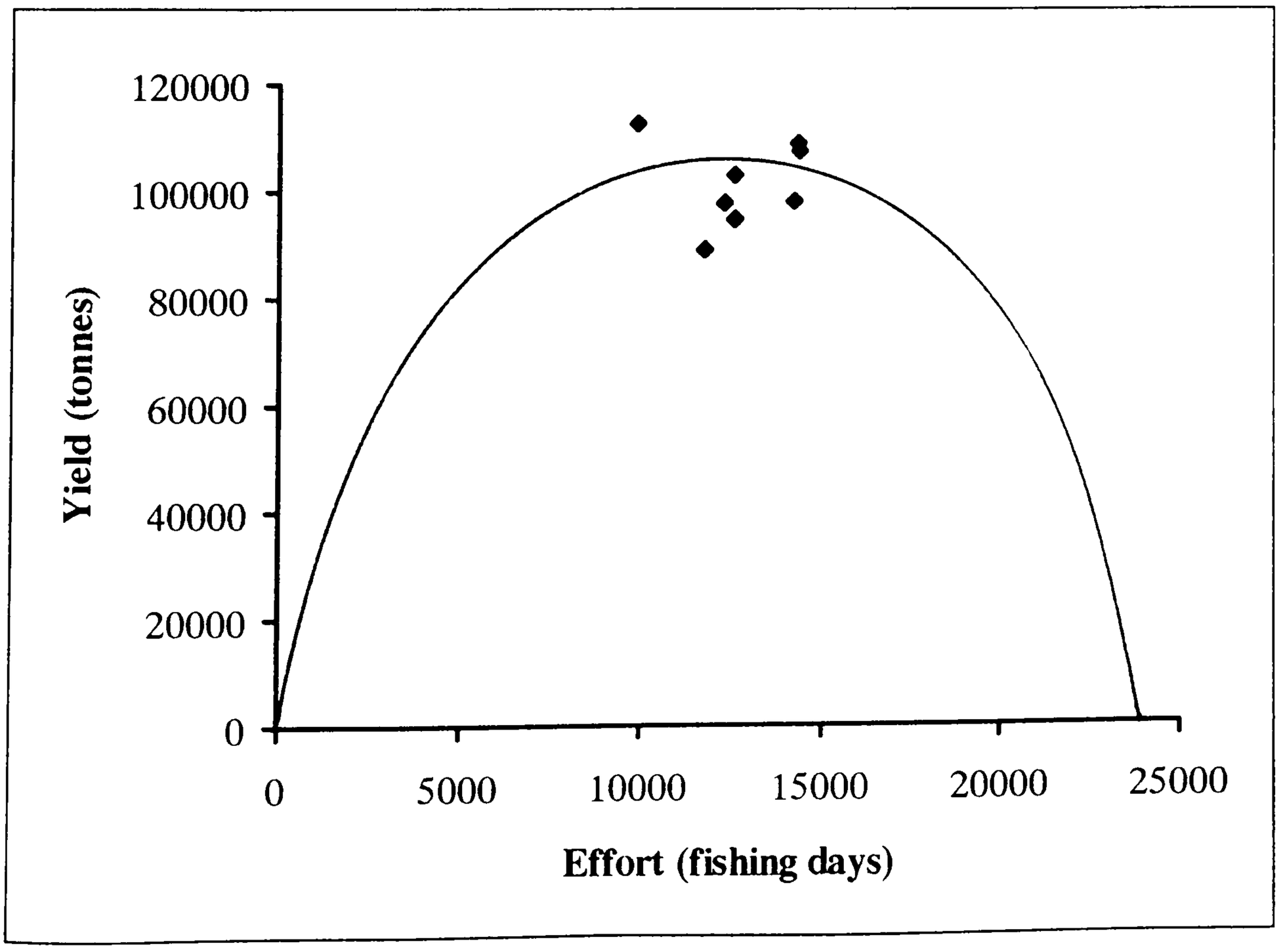
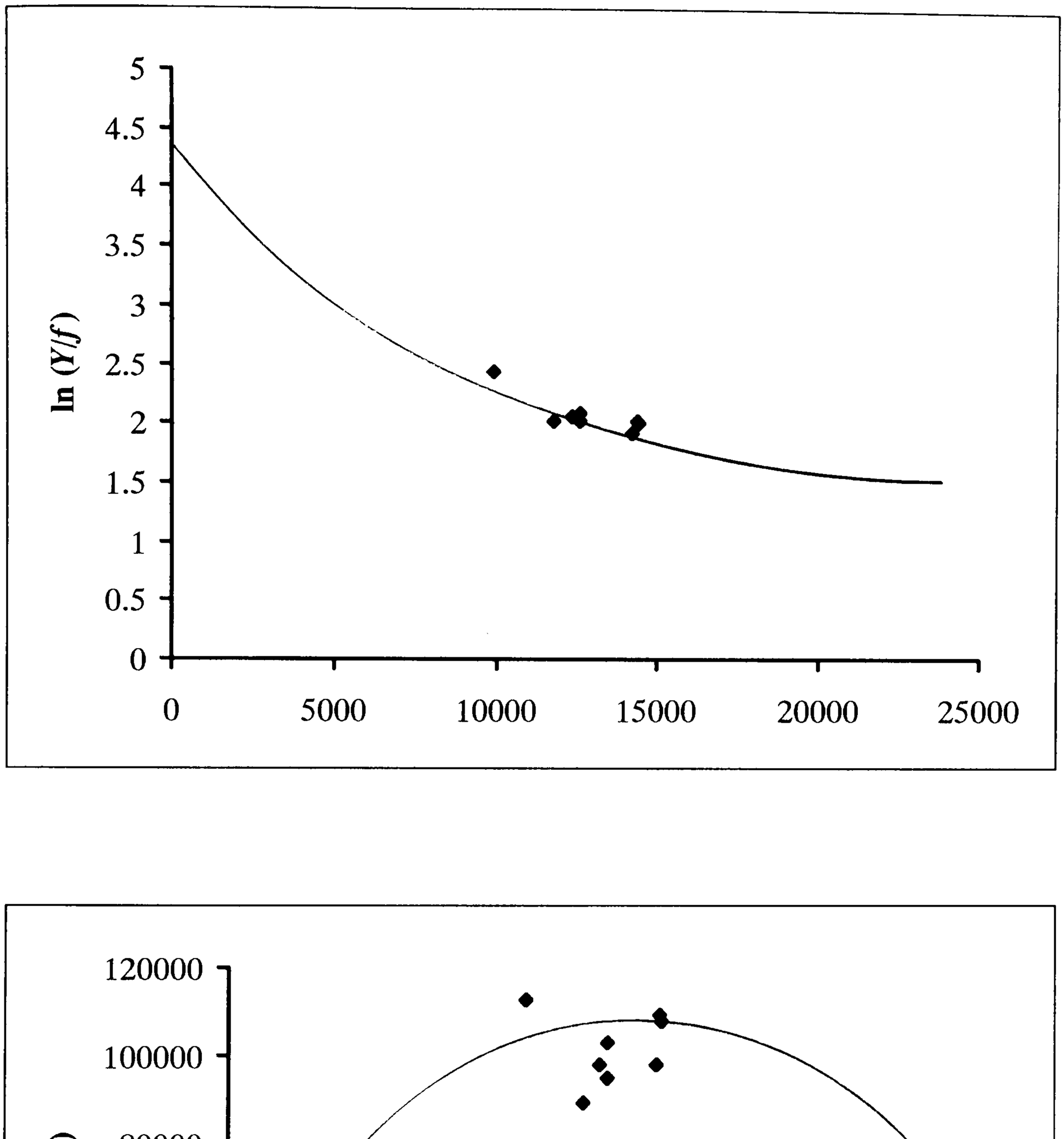


Figure 7.4 The Fox production model illustrated the yellowfin tuna purse seine yellowfin fishery of the WIO



c) Catch Effort Data Analysis (CEDA)

The third analysis is based on the use of the program CEDA. The yellowfin catch data were fitted to the three available production models, i.e. Schaefer, Fox and Pella-Tomlinson production models. However, only when using data from the period 1988-1995 was it possible to derive MSY. The Fox production model gave the best fit using the Least Squares error model.

The input parameters used in the analysis were:

i) Initial proportion

Generally, the yellowfin tuna is exploited at its juvenile stage by purse seiners, and at adult stage by longliners. In the WIO, longliners were fishing mainly for yellowfin in the region well before the expansion of the purse seiners. However, it is considered that the effort exerted by the longliners was directed to adult yellowfin. Thus, the pressure on juvenile yellowfin was perceived to be relatively low. Accordingly, the initial proportion value for yellowfin purse seine fishery is estimated to be 0.8.

ii) Time lag

The value of time lag L should lie between the default of zero and a maximum of the age at recruitment. It is known that purse seine fishery targets mainly juvenile yellowfin. Catches are composed of immature yellowfin as small as from age 0. Thus, for the yellowfin purse seine fishery, the value of time lag equal to 1 is suggested.

After entering and fitting the input parameters into the Fox production model, the results are as shown on Table 7.4. As in the analyses of the tuna available to purse seiners, several investigations have performed to examine the sensitivity of the fit and the estimated parameters.

d) Computer program BASICA

After entering the yellowfin catch and effort data as inputs, the trends of yield and the yield per unit of effort were plotted graphically. As with the other previous methods, only using the time series 1988-1995 was it possible to derive the MSY and f(MSY) reported in Table 7.4.

7.2.4 *Results*

The results of the four different methods used in calculating the MSY and f(MSY) of the yellowfin available to purse seine fishing in the WIO are shown in Table 7.4.

Table 7.4 Comparison results of the four different methods for yellowfin tuna

Models and programs	MSY (tonnes)	f(MSY) (fishing days)
Schaefer model	105238	11777
Fox model	101780	12731
CEDA	108427	-
BASICA	103449	11887

The estimated MSYs range from 101,780 tonnes to 108,427 tonnes and f(MSY) between 11,777 to 12,731 fishing days. As stock sizes varies with the strength of year classes moving through the fishery (King, 1995), both the upper and lower values of the estimated MSY could be taken into account as reference points for fisheries management. Nevertheless, in a conservative manner, it is preferable to consider the lower value of 101,780 tonnes relative to f(MSY) of 11,777 fishing days.

The actual exploitation rate of 107,420 tonnes has already exceeded the estimated MSY. Moreover the fishing effort exerted of 14,434 fishing days has gone far beyond the estimated f(MSY). This situation shows that the yellowfin tuna is under heavy fishing pressure and therefore further increases in fishing effort is not expected to substantially increase the catch of yellowfin.

With respect to the recorded high catch of 112,500 tonnes of yellowfin made in 1988, it can be concluded that:

i) the catch was well beyond the estimated MSY, therefore the subsequent increase in effort was not followed by an increase in catch;

ii) the optimal fishing effort corresponding to the MSY is far below the actual fishing effort applied to the fishery;

ii) the reduction of the fishing effort to the f(MSY) should result in building up the yellowfin stock to its sustainable level.

7.2.3 Other tuna species

a) Skipjack tuna

Skipjack is currently the most abundant tuna species in the WIO. After a dramatic increase due mainly to the rapid development of the purse seine fishery since 1984, the purse seine catch of skipjack has remained remarkably stable, levelling off to about 150,000 tonnes since 1992. The CPUE of skipjack has also increased steadily, remaining relatively constant since 1987. The skipjack tends to school in association with floating objects such as logs. This feature is important with respect to the management of the fishery. It has been shown (Hallier, 1993) that more than half the catch of the WIO purse seine fishery is made around logs. Several authors (Hallier, 1991; Hallier and Parajua, 1992) concluded that "log" school catches of the WIO are made up of 70 per cent skipjack; 25 per cent yellowfin; and 5 per cent bigeye, while free school catches are on average made up of 23 per cent skipjack; 75 per cent yellowfin; and two per cent bigeye. With the recent development of Fish Aggregating Devices (FADs) through different projects in the region (Cayré, 1990), purse seine fishing on "log" schools is expected to expand. As a possible consequence, the catch of skipjack is anticipated to increase, as well as juvenile yellowfin.

The Indian Ocean skipjack tuna is assumed to be a unitary stock (Anon, 1995). Considering the skipjack tunas' ability to reproduce at a small size, and taking into account its extended spawning area and large population, no limitation of effort on the species is currently needed. However, the impact of FADs on the stock should be monitored. In addition, following the recent declines in local catch rates in Maldives fisheries discussed at the Sixth Expert Consultation on Indian Ocean Tunas held in Colombo (Anon, 1995), the following recommendations have been made:

i) the recent decreases in the Maldivian pole-and-line fishery should be further investigated;

ii) as for yellowfin, the meaning and interpretation of the purse seine CPUE (on log, free-swimming or combined schools) and the consequences of the fishing efficiency increase are of utmost importance and should be actively studied;

iii) studies need to be undertaken to obtain accurate estimates of the skipjack tuna growth rate.

b) Bigeye tuna

Bigeye tuna is mainly targeted by longliners, and to a lesser extent by the artisanal fisheries of the coastal states. Although it is not the main target species, bigeye is caught incidentally by purse seiners. Various studies (Anon, 1995) suggest that the maximum sustainable yield for bigeye ranges from 33,000 tonnes to 77,000 tonnes. It is assumed also that the bigeye stock is unitary for the Indian Ocean and the actual exploitation rate of 65,000 tonnes (FAO, 1996) is already beyond the limit of its MSY. However, caution must be taken in interpreting catches of bigeye tuna due to the fact that it is sometimes lumped together with yellowfin tuna. A better species identification technique should be introduced. At the Sixth Session of the Expert Consultation on Indian Ocean Tunas held in Colombo (Anon, 1995), it was stated that no firm conclusions could be reached regarding the status of the bigeye stock. However, the following research recommendations have been made:

i) the statistical problem of obtaining a reliable estimation of the species composition of the catch by purse seiners (due to difficulties in identifying species) should be investigated;

ii) information concerning indices of abundance and the age structure of the catches should be compiled for carrying out cohort analyse.

c) Albacore tuna

Albacore is mainly targeted by longliners, but recently a seasonal purse seine fishery emerged in the WIO. Several authors (Chang, 1993; Chang and Hsu, 1993) give estimations of the MSY between 14,500 tonnes and 22,000 tonnes. Up to now, a single stock is assumed in the Indian Ocean (Lee and Liu, 1988). Before the ban of the driftnet fishing, the catch was well beyond the MSY. For example, the total catch was 31,400 tonnes in 1991. After the dramatic reduction, and then the total ban of the driftnet fishing from the end of 1992, the catches of albacore have reduced and stabilised within the range of the estimated MSYs. Further work is still needed to clarify the status of the

fishery, particularly with respect to the resurgence of the purse seine fleets. The following research recommendations have been made (Anon, 1995):

i) further work is needed to clarify the question of stock structure. In particular, that of possible heterogeneity within the Indian Ocean and possible exchanges between the Atlantic and the Indian Oceans remain to be elucidated;

ii) the analyses to obtain the indices of abundance need be redone to take into account significant year-area interactions;

iii) further analyses are needed in relation to the cohort analysis, including retrospective analyses and alternative model structures;

iv) the longline fishery catch, effort and size composition need to be carefully monitored over the next several years.

d) Southern bluefin tuna

The southern bluefin is the only tuna species under management regimes in the Indian Ocean. It is currently under management by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and therefore, the current management responsibilities are assumed primarily by CCSBT. For Australia, New Zealand and Japan the CCSBT is an important step towards meeting obligations under Article 64 of UNCLOS (Bergin and Haward, 1994).

The assessment of the status of the southern bluefin tuna is conducted by the Scientific Committee of the CCSBT. However, the report by this Scientific Committee in September 1995, and summarised by Anon (1995), highlighted the controversial nature of the current assessments and their different interpretations by the member states. The Australian scientist position were that the uncertainties in the interpretation of the most recent CPUE trends for young southern bluefin tuna limit the ability to accurately assess the status of the stock and, therefore, it has been recommended that a cautious approach to management must be followed. The position of the scientist from New Zealand were that, although there were encouraging signs about the recovery of the population, parental biomass still seems to be very low. They proposed the formulation of a robust mid-term management strategy. The Japanese scientist position were that there has been a significant rebuilding of the population in recent years, and that a rapid increase of parental stock is imminent. They also felt that the current quota constraints,

combined with increase CPUEs, limit the acquisition of necessary data to an inadequate sample of time-area strata.

Notwithstanding the fact that southern bluefin tuna occurs in the Indian Ocean, its management is left to the CCSBT, and thus, no recommendations were issued.

e) Other little tuna species

The most important of the other little tuna species in the WIO are longtail tuna (*Thunnus tonggol*, Bleeker, 1851), kawakawa (*Euthynnus affinis*, Cantor, 1849), frigate tuna (*Auxis thazard*, Lacepède, 1800) and bullet tuna (*Auxis rochei*, Risso, 1810). Almost, the entire catch of these species is made by the artisanal fleets of the coastal states bordering the Indian Ocean such as India, Indonesia, Iran, Maldives, Oman, Pakistan, Sri Lanka, Thailand and United Arab Emirates. Notwithstanding the great importance of these species to the coastal states, the basic catch statistics are limited and unreliable. Thus it is not possible to evaluate the status of these resources. Nevertheless, countries such as Iran and Oman noted the decline of their catches of kawakawa recently (Anon, 1995). There is a need to improve the catch statistics by species and the associated effort data for the other little tuna species. The following research recommendations were made by Anon (1995).

i) There continues to be a need for small tuna fishery statistics to be improved. The first priority is that all catches must be reported to IPTP by species, not by species group. The second priority remains the collection of associated effort data;

ii) Age validation, reproduction and migration studies are still required for kawakawa and longtail tuna.

7.3 Production trends

7.3.1 *Fishing effort*

In this analysis, the nominal fishing effort is expressed in fishing days. The many fluctuations and variations in fishing effort are not quite relevant to the main purpose of this study. As stated by Gulland (1983), often the average catch per seine is taken as a measure of the abundance of the stock; the actual catch taken in one haul will depend on a large number of factors (size of the seine, skill of the skipper, precise ground, season,

weather and so on). However, population dynamics are seldom concerned with the studying or predicting the catch of one haul, but are more concerned with the average catch over a period, say a year. Thus, although it is relatively imprecise, the use of fishing days as effort is justified (Figure 7.5).

Figure 7.5 WIO purse seine fishing effort

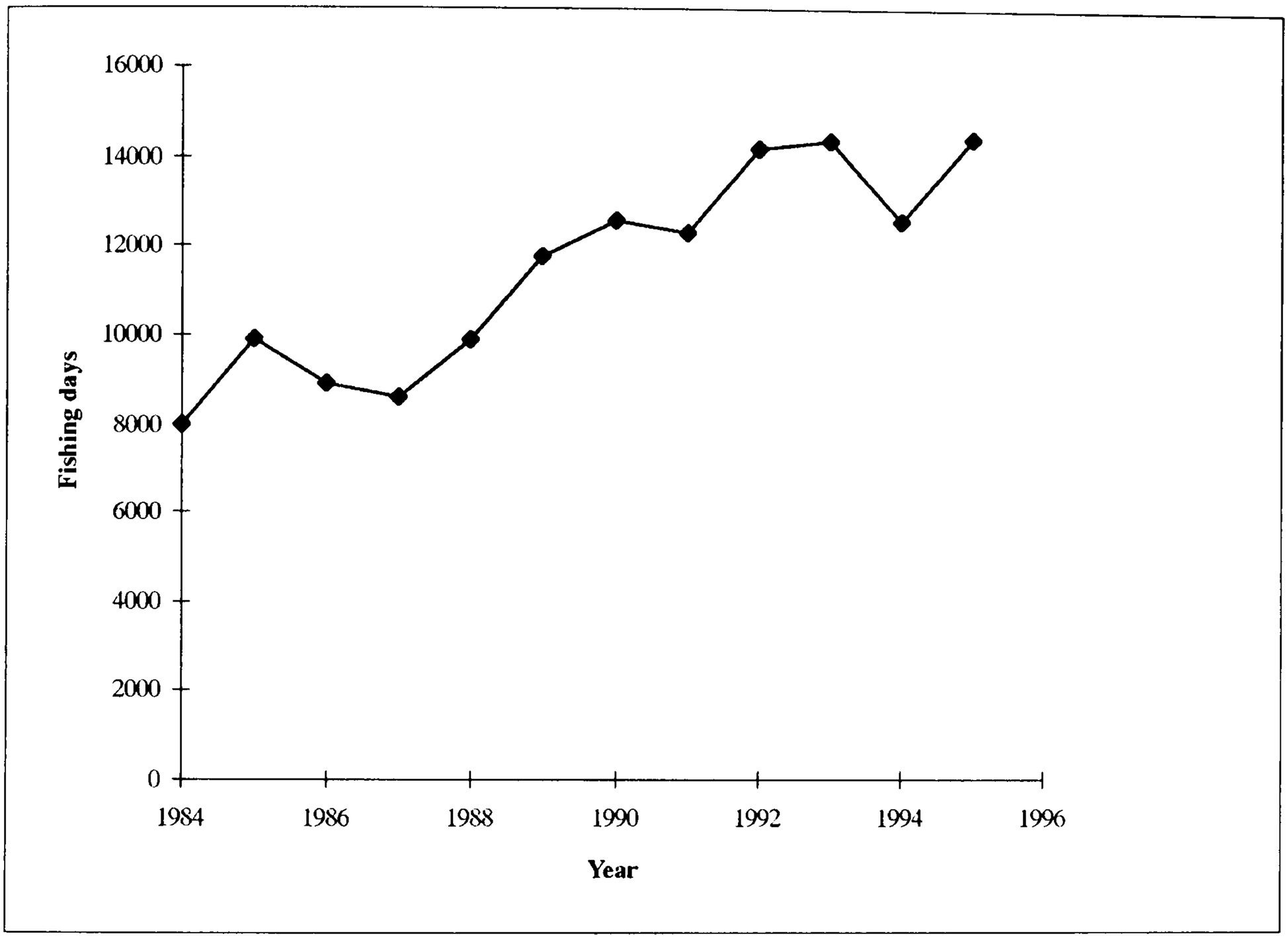
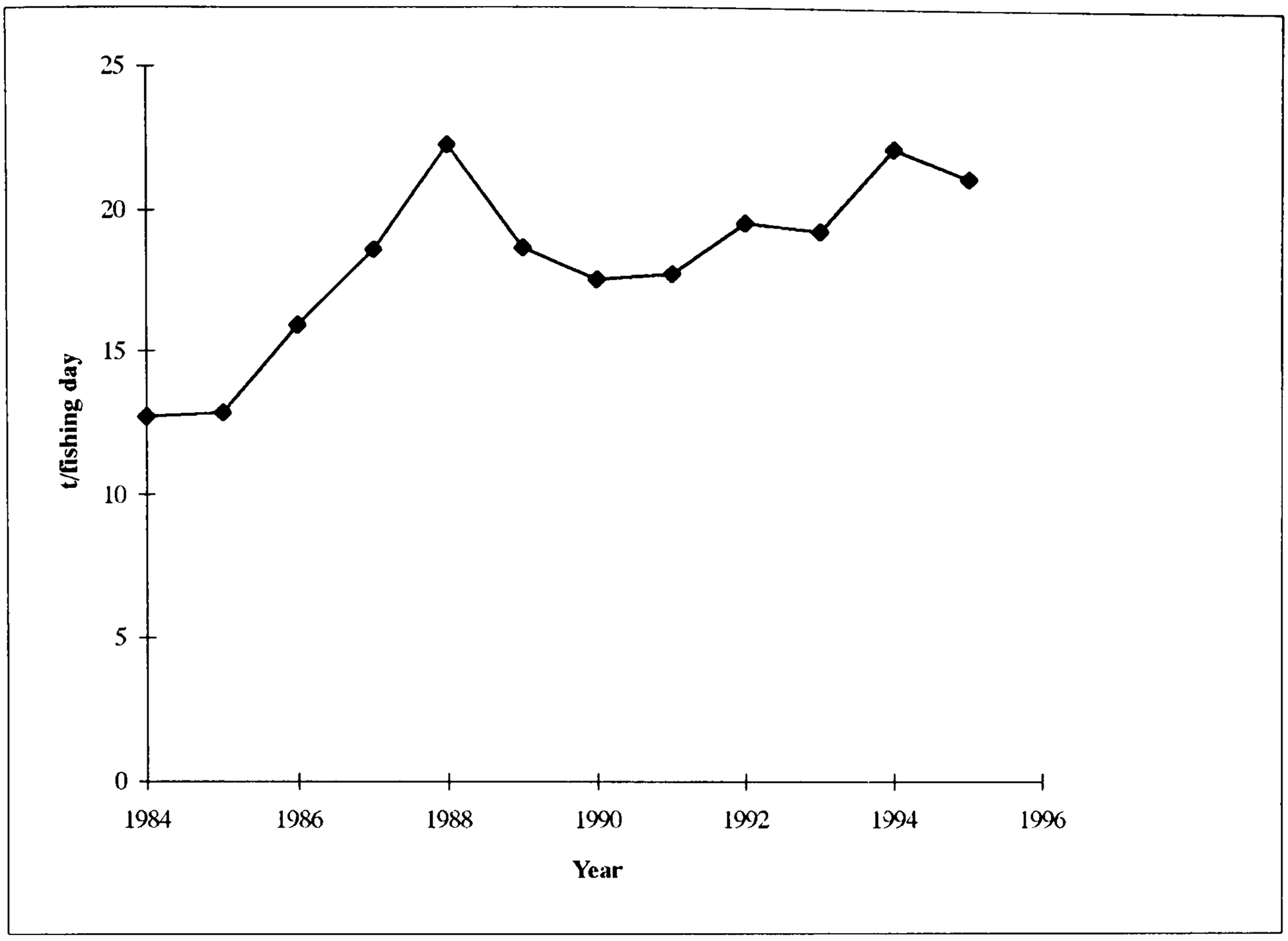


Figure 7.5 shows the steady increase of the WIO tuna purse seine fishing effort from the start of the fishery. Starting from 8,000 fishing days in 1984, the nominal fishing effort peaked at 14,434 fishing days in 1995.

7.3.2 *Catch per unit effort (CPUE)*

The average annual catch per unit effort of the purse seiners fishing in the WIO is shown in Figure 7.6. Broadly, CPUE can be used to provide estimates on stock size, and to measure rates of "surplus" production as related to the changing stock size (Hilborn and Walters, 1992).

Figure 7.6 WIO Catch per unit effort



The catch per unit effort, after reaching the peak of 22.3 tonnes/fishing day in 1988 has declined slightly and levelled off around 21 tonnes/fishing day. Based on the CPUE alone, it seems that the tuna resources available to purse seiners are not yet under threat. In any case, this is confirmed by the fact that an increase in effort yields increase in catch. However, this has to be interpreted cautiously in multispecies fisheries. Hilborn and Walters (1992) state that a common result of mixed-stock fisheries can be expected where the unproductive stocks are lost when the harvest rates are chosen to maximise total yield. One of the alternatives they suggest for this particular case is to manage the weakest stock. In this study, the weakest species is the yellowfin.

7.3.3 Species composition

In 1984, yellowfin tuna was the dominant species (56.3 %) caught by purse seiners as can be seen from the breakdown of the catch as shown on Table 7.5. It is also apparent that the species composition has changed over time; the most recent statistics pertaining to 1995 show that skipjack tuna is the dominant species (51.13 %) followed

by yellowfin tuna (35.14 %). The important pattern in the species composition is the decline in the proportion of yellowfin, coinciding with the increasing composition of skipjack and other species mainly bigeye and albacore tunas. The reduction of yellowfin in the catch composition reflects the build up of fishing effort and the heavy exploitation that now affects this species. The increase of the other tuna species in the catch composition could also reflect the change of the stock structure, as effort switched from yellowfin to other tuna species.

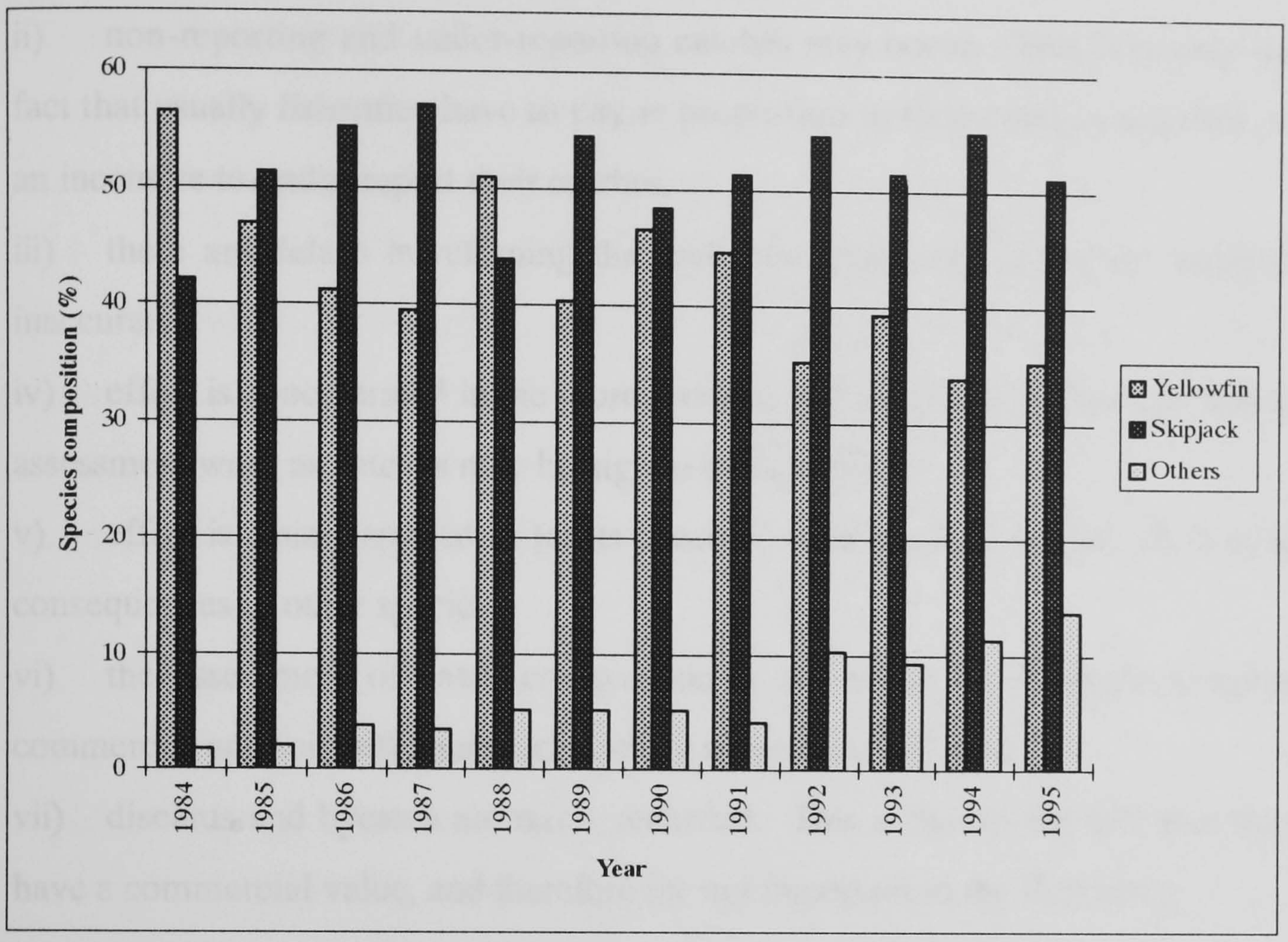
Table 7.5 Average annual species composition (%) of tuna catches attribuable to purse seiners active in the WIO

Year	Yellowfin	Skipjack	Others
1984	56.33	42	1.67
1985	46.78	51.25	1.97
1986	41.12	55.14	3.74
1987	39.47	57.14	3.39
1988	50.95	43.93	5.12
1989	40.31	54.59	5.1
1990	46.42	48.43	5.15
1991	44.55	51.33	4.12
1992	35.16	54.62	10.22
1993	39.34	51.38	9.28
1994	33.77	54.97	11.26
1995	35.14	51.13	13.73

Others: mostly bigeye and albacore.

Graphically, Table 7.5 is represented in Figure 7.7.

Figure 7.7 Species composition



It can be observed that yellowfin, the most economically valuable species is on the decline. This may be due to overfishing or a shift in the ecosystem. On the other hand, the other species have shown an increase, as the result of the decline in the yellowfin. This trend will have to be reversed through control of fishing activities, and efficient management of the fisheries resources.

7.4 Fundamental problems with the commercial data

Different sources of error exist in the collection and analyses of the data from the WIO tuna purse seine fishery. It is obvious that commercial fishing presents a useful source of data. As stated by Gulland (1977), fish population dynamics are mainly concerned with fish that are subject to large-scale commercial fishing. The commercial fishery itself is the source of much of the data that are used in the scientific study.

Although commercial fishing presents a useful source of data and information on a given stock, there are a number of limitations:

i) logbooks are mainly designed for commercial fishermen and thus, little information on biological aspects of the fishery can be extracted;

ii) non-reporting and under-reporting catches may occur. This is mainly due to the fact that usually fishermen have to pay in proportion to their catches and thus, they have an incentive to under-report their catches;

iii) there are delays in returning the logbooks which are sometimes incomplete and inaccurate;

iv) effort is concentrated in the more productive fishing areas. This can bias the stock assessment work as catches may be high in those areas;

v) effort is mainly applied to target species. As a result, it is difficult to evaluate the consequences to other species;

vi) the assessment of catch composition is not based on scientific sampling. The commercial and scientific nomenclature are sometimes different;

vii) discards and bycatch are rarely recorded. This is due to the fact that they do not have a commercial value, and therefore are not important to the fishermen.

Despite the above limitations, the WIO coastal states continue to use data from the commercial fishery for tuna stock assessment, not least because data from commercial fishing activities are relatively cheap to collect in comparison to data obtained from scientific sampling programmes. This situation will probably continue unless the coastal states can combine their efforts to design and implement a data collection system based on scientific sampling procedures. This could be done within the new organisation.

7.5 Possible options for tuna fisheries development

Given the problems that currently affect the stock of tuna and particularly the yellowfin in the WIO, it is appropriate to consider the options for their development. Whether as individual fishing nations or as members of a regional fisheries organisation, the WIO coastal states need to decide their priorities for tuna exploitation.

i) A likely outcome given the present attitudes of the coastal states towards DWFNs would be to allow fishing effort to continue to expand, accepting that yellowfin will further decline as a component of the catch and hoping that the overall short fall would be made up by an increase in the catch of other tunas, notably skipjack.

ii) Similarly even if fishing effort were pegged back at the current level, the yellowfin stock is likely to continue to decline unless effective resource conservation techniques could be implemented. This option would not only be difficult to agree but also to enforce.

iii) Actual reduction of fishing effort would not only be difficult and costly to implement and enforce but would be very likely at this stage not to receive support from many of the DWFNs and even the coastal states of the region. Thus, this option is not plausible in the near future.

7.6 Questionnaire data analysis

Following the return of the postal questionnaire, treatment and analysis began with the organisation and categorisation of data by concept of fisheries departments and fisheries organisations. As suggested by Yin (1989), data analysis is a multi-stage process, which consists of examining, categorising, tabulating and recombining evidence to address the study objectives and hypotheses. Thus, it was the first step in the process of analysis.

7.6.1 *Basic information of responding organisations and departments*

A total of 35 departments and organisations provided information on a wide range of issues regarding date of establishment, ministerial status, and the number of administrative, scientific and other categories of employees as shown in Table 7.6.

Table 7.6 Basic information data from responding organisations

(a) West Indian Ocean coastal states

Organisation	Date established	Ministry attached to	Employees		
			Administrative	Scientist	Other
1. Kenya Marine and Fisheries Research Institute (KMFRI)	1979	Not supplied	962	128	3
2. Direction des Ressources Halieutiques (DRH), Madagascar	1985	Fisheries	250	50	50
3. Albion Fisheries Research Centre (AFRC), Mauritius	1982	Fisheries and Marine Resources	7	50	60
4. Marine Research Department (MRD), the Maldives	1984	Fisheries and Agriculture	4	12	3
5. Seychelles Fishing Authority (SFA)	1984	Agriculture and Marine Resources	13	34	57
6. Institute of Marine Sciences (IMS), Tanzania	1979	Fisheries	50	18	7
7. Instituto de Desinvolvemento da Pesca de Pequena Escala (IDPPE), Mozambique	1989	Agriculture and Fisheries	19	8	25

(b) Pacific Ocean states

Organisation	Date established	Ministry attached to	Employees		
			Administrative	Scientist	Other
8. Division of Fish and Wildlife (DFW), Virgin Islands	Not supplied	Government	5	9	-
9. Fisheries Division (FD), Solomon Island	1978	Agriculture and Fisheries	4	5	25
10. Micronesia Maritime Authority (MMA)	1979	Semi-independent	4	3	5
11. Fisheries Department of Vanuatu (FDV)	1988	Agriculture, Forestry and Fisheries	10	5	25
12. Fisheries Department of Tuvalu (FDT)	1976	Natural Resources	3	2	26
13. Fisheries Division of Fiji (FDF)	1988	Agriculture and Fishery	9	15	83

(c): Other states and organisations

Organisation	Date established	Ministry attached to	Employees		
			Administrative	Scientist	Other
14. Inter-American Tropical Tuna Commission (I-ATTC)	1950	Independent	7	45	-
15 Commission for the Conservation of Southern Bluefin Tuna (CCSBT)	1994	Independent	3	-	-
16. International Pacific Halibut Commission (IPHC)	1930	Independent	6	20	-
17. International Whaling Commission (IWC)	1946	Independent	4	3	8
18. National Research Institute of Far Seas Fisheries (NRIFSF), Japan	1967	Agriculture, Forestry and Fisheries	25	50	23
19. Direction de l'Océanographie et des Pêches (DOP), Sénégal	Not supplied	Pêche et des Transports	5	220	1
20. INFOFISH, Malaysia	1981	Independent	5	5	20
21. North Atlantic Marine Mammal Commission, Norway	Not supplied	Independent	3	-	-
22. World-Wide Fund for Nature (WWF), UK	Not supplied	Independent	200 (total)	-	-
23. The Food and Agriculture Organisation (FAO)*, Rome	1946	Independent	4000 (total)	-	-

* In addition to completing the questionnaire, the FAO sent in numerous documentary data which were used extensively in discussions. The FAO's data covers 5 organisations. These are:

24. the Indian Ocean Tuna Commission (IOTC);
25. the Indian Ocean Fishery Commission (IOFC);
26. the General Fisheries Council for the Mediterranean (GFCM);
27. the Co-ordinating Working Party on Fishery Statistics (CWP); and,
28. the Western Central Atlantic Fishery Commission (WECAFC).

The organisations that supplied information for this study cover a wide range of international geographical area (Tables 7.6a-c). Their years of establishment vary, and all the organisations from the Indian Ocean and Pacific Ocean states are ministerial organs of their respective governments.

The majority of employees work in the administrative and scientific sectors. "Other" employees come under technicians, crew-men, service-men, clerical etc. This category of workers constitute an important and substantial proportion of the work-force. The international organisations have more employees in their scientific sectors, mainly in research and computer activities.

A number of international organisations supplied information through letters and reports, but did not respond to the questionnaires. These are:

29. the North Atlantic Salmon Conservation Organisation (NASCO);
30. the North Atlantic Marine Mammal Commission (NAMMCO);
31. the Overseas Development Administration (ODA);
32. the Pacific Islands Marine Resources Information System (PIMRIS);
33. the South Pacific Commission (SPC);
34. the International Council for the Exploration of the Sea (ICES); and,
35. the Australian Fisheries Management Authority (AFMA).

The majority of these organisations indicated that Board meeting approvals were necessary before organisational data can be supplied for research purposes. However, the little information they provided through documents have been incorporated in general discussions.

Useful information was supplied by the responding organisations on their budget estimates annually, and sources of revenue generation and funding. These are presented on Tables 7.7a-b.

Table 7.7a Information on annual budgets and funding sources

Organisational groups	Annual budget estimates (US$)		Funding sources
Indian Ocean states	Kenya	344,800	Donors and Government
	Mauritius	970,000	Government
	Seychelles	1,000,000	Government
	Tanzania	560,000	Government
	Maldives	not supplied	Government
	Mozambique	not supplied	Government
	Madagascar	not supplied	Government
Total average estimate		720,000	Mainly Government
Pacific Ocean states	Virgin island	800,000	Government
	Solomon island	420,000	Government
	Micronesia	500,000	Government
	Tuvalu	2,100,000	Government
	Fiji	not supplied	-
	Vanuatu	not supplied	-
Total average estimate		950,000	Mainly Government

Table 7 7b Information on annual budgets and funding sources (International organisations)

Organisations *	Annual budget estimate (US$)	Funding sources
1. I-ATTC	4,300,000	Member countries and vessel fees
2. CCSBT	560,000	Member countries
3. IPHC	1,600,000	United States and Canada governments
4. IWC	1,200,000	Contracting governments
5. INFOFISH	1,000,000	Member countries and revenue from sales and services
6. NAMMCO	360,000	Member countries
7. NRIFSF (Japan)	12,780,000	Government
8. DOPM (Sénégal)	1,200	
Total average estimate	2,725,000	Governments, member states and other sources

* Other organisations did not supply information.

Tables 7.7a-b provided useful information on budget estimates and funding sources of the Indian Ocean and Pacific Ocean organisations, as well as those of the international organisations. The main sources of funding were presented as the respective governments, and member countries. Notably, I-ATTC and INFOFISH generate revenue through other economic sources. The average total estimate of the budgets of each organisational groups are as shown in Tables 7.7 a-b.

7.6.2 *Data on organisational remit*

Two sets of data were obtained on the aims and objectives, as well as the terms of reference of the different organisations. In Table 7.8a, a number of the statements of the aims and objectives are presented; and in Table 7.8b, the views on terms of reference are analysed.

Table 7.8a Some statements of aims and objectives of the organisations

Statements of aims and objectives	Organisational group
1. To: (i) prepare the national fisheries management and development strategy and monitor its implementation; (ii) manage the fisheries resources and conduct scientific and development research	Seychelles (Indian Ocean)
2. To carry out research on the living marine resources within the Maldivian EEZ in order to promote their rational and sustainable utilisation	Maldives (Indian Ocean)
3. To enhance national economic benefits through exploitation of the marine resources, maximising benefits through licence fees, research, effective management, regulatory action on fishing efforts for sustainable development	Tuvalu (Pacific Ocean)
4. To develop and manage in co-operation with provincial authorities, the exploitation of all fisheries resources found within the EEZ in such a manner as to secure optimum social and economic benefits for the people of Solomon island	Solomon island (Pacific Ocean)
5. To contribute through regional consultation and co-operation to the conservation, rational management and study of marine mammals in the North Atlantic	NAMMCO (Norway)
6. To enable the fisheries of the contracting parties to develop in accordance with current and future market demand and to take full advantage of the potential offered by their fishery resources	INFOFISH (Malaysia)

Different organisations have different aims and objectives, which represent their organisational interests, environmental focus, and the common benefits they seek to derive from their activities in order to serve their target communities, society, country and member states.

Table 7.8b Organisational focus (Terms of reference)

Main area of focus of organisations	Percentage (%)
Management	40
Development	17
Planning	12
Negotiation	5
Co-ordination	3
Other (research, conservation, etc.)	23
Total	100

The main focus of activity for the majority of the organisations is the management of fisheries resources (40 per cent) and in the area of conservation and research (23 per cent). Planning is an equally important reference point (12 per cent). The international organisations as well as the regional coastal institutions are concerned with the development of the environment and the people they serve (17 per cent). Co-ordination and negotiation activities are relatively less significant (three per cent and five per cent respectively).

7.6.3 *Main activities of the organisations*

The main activities of the organisations in order of importance are presented on Table 7.9.

Table 7.9 Top ten organisational activities in descending order of importance

Activities	Percentage (%)
1. Information collection	28
2. Research and data processing	19
3. Information dissemination	14
4. Sector studies	10
5. Advisory management	8
6. Monitor, control and surveillance	6
7. Negotiation and fisheries agreement	5
8. Day to day activities	4
9. Policy formulation	3
10. Staff training	3
Total	100

The main activities of the organisations are in the areas of information collection (28 per cent); research and data processing (19 per cent) and information dissemination (14 per cent). Policy formulation (three per cent) and staff training (three per cent) are the areas of least activities. It is therefore clear that these organisations engage mainly in activities that lead to the provision of information on fish stocks, fishing activities, and resource environment.

7.6.4 *The views of the organisations on a range of regional issues*

Table 7.10 shows the opinion of the organisations on a number of issues regarding the management of fisheries in the West Indian Ocean states.

Table 7.10 Views on regional issues

Statement	Scale (%) rating		
	Agree	Uncertain	Disagree
1. Highly migratory species should be managed by bilateral agreement	17	8	75
2. Highly migratory species should be managed by regional organisation	86	-	14
3. Highly migratory species should be managed by international organisation	35	46	19
4. Membership of a regional organisation should include only coastal states	68	9	23
5. Regional organisation should be vested with management decisions	85	5	10

There is a general disagreement response (75 per cent) among the organisations that such highly migratory species as tuna should be managed by bilateral agreement; management by regional organisation (86 per cent) is favoured compared to international (35 per cent). The high level of uncertainty in their opinion (46 per cent) on the involvement of any international organisation in the management of tuna raises important issues as to the right direction to go in proposing an organisation structure for fisheries resource management in the WIO region.

Another important element of this data analysis is the views expressed by the organisations that membership of any regional organisation that would be given the role of tuna management must be exclusively for the coastal states (68 per cent); and management decisions should be vested solely on such organisation (85 per cent).

7.6.5 *Views on relationships between organisations*

A number of views were expressed by the responding organisations on the nature of their relationships with other institutions such as fisheries organisations, non-governmental organisations (NGOs), international fisheries organisations and so on. The general opinion is that relationships between these organisations and other organisations are relatively good. However, there are certain isolated cases where the relationships with NGOs were considered uncertain. This particular feature was stressed more forcefully by some of the coastal states. The nature of NGOs as pressure groups may be responsible for this conflict situation.

At present, relationships between the different regional fisheries organisations can best be described as casual, informal and sometimes suspicious. The organisations are political organs of their respective countries, and are therefore there to serve specific interests. It can be seen that relationships between the organisations can only be on the basis of national sovereignty. There is need for greater co-operation between these organisations.

7.6.6 Views on management problems

The responding organisations gave their views on the nature of the problems they encounter in the management of fisheries as shown in Table 7.11.

Table 7.11 Main sources of management problems

Statement	Scale (%) rating		
	Main cause	Uncertain	Not a main cause
1. Multiobjectives in fisheries	41	-	59
2. Different views between scientists and politicians	78	-	22
3. Reluctance to delegate rights	9	-	91
4. Too many rules and regulations	12	-	88
5. Too many boats chasing too few fish	75	8	17
6. Lack of support from member states	50	-	50
7. Different objectives between member states	65	-	35

The views expressed by the organisations in Table 7.11 show that the main sources of management problems are: different views between scientists and politicians (78 per cent), and the fact that too many boats are chasing too few fish (75 per cent). Reluctance to delegate rights (nine per cent), and too many rules and regulations (12 per cent) are not considered significant sources of management problems. It is therefore necessary to address the main sources of management conflicts among member state organisations in the regional fisheries organisation to be proposed in Chapter 8.

7.6.7 *Comments on strengths, weaknesses and future prospects*

Concerning their perceptions of the strengths and weaknesses of the organisations, the majority of the respondents expressed that an independent institution, good scientific staff, and legislative support constitute a strength; whilst dependency on other ministries, lack of scientific staff, and strong political involvement represent a weakness. In addition, other weaknesses identified by the respondents include: lack of, or limited, financial support, and lack of well trained staff.

Some suggestions were made by the responding organisations on the direction to follow in future in the development of fisheries in the region. The most stressed suggestion is the need to increase funding for organisational activities especially staff training.

Some of the organisations have made comments which suggest that lack of proper co-ordination of the already existing institutions dealing with such highly migratory species as tuna constitute an obstacle to the development of regional fisheries, and therefore need to be addressed. This study has addressed this important issue in Chapter 8.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 The contingency-political model for the regional organisation for the management of tuna in the WIO

The purpose of this study is to propose an organisation that would co-ordinate the activities of the present fisheries institutions existing in the WIO, so as to produce a suitable framework for the efficient management of tuna resources in the region. From the data analysis, a clear indication emerged among the responding organisations of the need for such an organisation. For the organisation to serve any useful purpose, it must not duplicate the roles of the many commissions and institutions operating in the region. This study is therefore proposing the establishment of the "Regional Organisation for the Management of Tuna in the West Indian Ocean" (ROMTWIO). Details of this organisation are discussed in Section 8.2 of this chapter. First, a theoretical framework for the existence of this organisation will have to be evolved.

Earlier in this thesis, the contingency model was proposed as the most suitable theoretical framework for any organisation that would: carry out the role of effectively bringing together the tuna fisheries activities of the nine regional coastal states of the WIO; and provide an efficient management structure for the co-ordination and harmonisation of the objectives, plans, policies and rules of the different regional tuna institutions; and also serve as a common medium for relating to other international fisheries bodies and generating maximum financial benefits for the various governments of the WIO states.

The political nature of the fisheries organisations, departments or institutions that already exist in the different states, and also the complex relationship between these organisations and the international bodies engaged in fishery activities in the region, raise vital political issues that cannot be ignored in the structural framework of any regional organisation that would be established to deal with tuna resources in the region. Consequently, this study proposes a contingency-political model for the ROMTWIO.

The ROMTWIO can be visualised as an organisation consisting of different subsystems, and each subsystem contributing to building up a pattern of interrelationships with other subsystems. The subsystems will represent management, technical, legal, monitoring, control and surveillance, scientific, international relations, financial and administrative units of the organisation.

There is also a political dimension to this organisation. Any organisation such as the proposed ROMTWIO, dealing with nine different sovereign states, each with its own separate policies, interests, autonomy, plans, goals, and political authority, in addition to other international interest groups such as the EU and other DWFNs, would have to anticipate conflicts and power struggles, and therefore must have a suitable subsystem to deal with such problems.

In effect, co-determination, as a form of organisational rule where parties, governments or states combine in joint management of mutual interests (in this case tuna resources), each party drawing on a specific power base, for the purpose of attaining common benefits, can be a suitable political direction for the ROMTWIO. Under this system, the member states co-determine the future of this organisation by sharing power and decision-making, electing board members, and operating the ROMTWIO under the principle of self-management (Morgan, 1986).

Conflicts are bound to arise when the interests of the participating WIO states collide, or even when the policies of the ROMTWIO are considered unacceptable by the foreign organisations or institutions engaged in tuna fishing activities in the region. The ROMTWIO, in order to be seen as serving any useful purpose, must serve as a medium through which conflicts of interests are resolved.

The political interests of the member states must be taken into account in the structural arrangement of the ROMTWIO, and this must include relationships with the fisheries departments or directorates of the WIO coastal states, as well as involving the states in policy formulation at ministerial level. There has to be an understanding among member states on whom the control and authority of the ROMTWIO lies. A clear channel of conflict resolution within member states and other foreign organisations, must be integrated into the structural arrangement of the organisation. Control of the

decision-making process, and co-ordination of financial matters will have to be spelt out.

All the political elements of this organisation will be integrated into the various subsystems of the organisation to provide a holistic contingency-political framework, suitable for the peculiar tuna management needs of the WIO region. It must be recognised that for the proposed ROMTWIO to serve any useful purpose, it must not only provide a framework for the efficient management of the WIO states joint tuna resource, but it must also recognise and respect the political autonomy of the participating member states, and respond to the interests of other foreign organisations that have interests in tuna fisheries of the region.

8.2 The structure of the ROMTWIO

The proposed "Regional Organisation for the Management of Tuna in the West Indian Ocean" (ROMTWIO) will consist of several units as shown in Figure 8.1 with the Management Board as its core operational unit. The units all interact through this central management board. The structure provides for links with the regional directors of fisheries, the international fisheries organisations, and the supreme Council of Fisheries Ministers of the member states.

8.2.1 *The Management Board*

The management board will be headed by a Secretary-General to be appointed by the Council of Fisheries Ministers from any member state for a period of four years on a rotatory basis. The Secretary-General is the administrative head of the organisation. It might be useful to suggest that appointments to the post of Secretary-General from the member states should be done in alphabetical order. This would remove fears and suspicious of possible domination or political motives in the selection process.

Every member state will appoint a member to the Management Board of the organisation. The Board has the supreme power and authority over all matters relating to the organisation, and its decisions are subject to ratification by the Council of Fisheries Ministers of the WIO states meeting annually. All decisions taken are binding on member states. Only the Council can over-rule Board decisions.

The Management Board shall be responsible for the formulation of policies on the recommendation of, and inputs from the Committee of Directors of Fisheries of all the member states. This arrangement will ensure that the objectives, plans, goals, policies and decisions of the Management Board reflect the individual and collective interests of the member states. It is at this Committee that conflicts and political interests will be resolved and harmonised.

All the units or subsystems of the organisation will submit regularly their various reports to the Management Board, from which goals and objectives will be derived. In broader terms, the goals of the ROMTWIO at the initial stage will be:

i) to provide a framework for the management of tuna resources among the member states of the WIO;

ii) to generate maximum benefits and financial revenue for the collective good of the member states;

iii) to have in place a mechanism for resolving conflicts among member states and other international organisations in tuna fisheries activities.

8.2.2 *Legal unit*

At the moment, the United Nations Convention on the Law of the Sea (UNCLOS, 1982) Articles 63 and 64 which spelt out the rules and regulations to be observed in the fishing activities within the exclusive economic zones (EEZs) of the coastal states of the WIO, especially with regard to such highly migratory species as tuna, are being openly flouted and completely disregarded by the coastal states themselves and the other international organisations engaged in tuna fishing in the region. This is a possible source of conflict in the region. In addition, coastal states of the region have been losing a large amount of revenue as the result of this trend. It is therefore the responsibility of the legal unit of this organisation to monitor the legal implications of the fishing activities of all member states and those of the other international organisations, to ensure that everyone is complying with the rules and regulations. Defaulters should be identified and

reported to appropriate authorities such as the MCS unit, police and justice office for legal actions to be taken. If this role is successfully carried out, proper assessment of tuna fish stocks can be carried out, and fishing activities will be better controlled for greater revenue yield to the member states of the region.

8.2.3 *Monitoring, control and surveillance unit*

There is need for a subsystem in the organisation to perform the monitoring, control and surveillance (MCS) of the tuna fishing activities in the WIO. This role will be performed by the MCS unit. Its functions will include:

i) issuing of licences to all tuna fishing fleet in the WIO to ensure that quota regulations or other management measures are strictly adhered to;

ii) eradicating all illegal fishing activities in the WIO; this may include power to arrest all suspected defaulting fishing vessels;

iii) ensuring that only appropriate recommended fishing techniques for tuna are used in the region to avoid overfishing;

iv) reporting all activities about fishing that violate environmental protection regulations.

8.2.4 *Scientific and research unit*

This subsystem will be responsible for data collection on all aspects of tuna resources with the aim to generate useful information on conservation and development of the regional tuna fisheries of the member states. It will co-ordinate all research activities of tuna fisheries of the regional and international organisations, and make such research data available to all member states for effective management of tuna in the region.

The research activities of the unit will extend from catching , through processing, to marketing of tuna fish, and providing information on the best techniques and model for the development of tuna fisheries in the WIO coastal region.

8.2.5 *Financial unit*

The ROMTWIO will only operate efficiently if it is properly funded, to this end, member states will have to make an annual contributions. The governments of the various states meeting at the Council of Fisheries Ministers, on the recommendation of the Committee of Regional Directors of Fisheries, will determine annually how much each state will contribute to the funding of the organisation based on the immediate financial needs of ROMTWIO, and the revenue each member state derives from tuna fisheries activities.

In addition, the organisation will be funded from revenue generated from other economic sources such as licensing fees. Each member state will maintain its autonomy in financial matters regarding its income from tuna fishery activities, but must provide such information to the financial unit for statistical purposes. It is necessary to state that the financial activities of the organisation must be disseminated to the member states in the annual reports. In addition, grants from international bodies such as the EU can be another source of funding.

8.2.6 *Administrative unit*

The administrative subsystem will be responsible for the recruitment and training of suitable and qualified staff of all categories, for clerical, technical, and managerial posts. In addition, it will deal with staff motivation and creation of incentives to maintain efficient social and psychological aspects of the organisational performance.

8.2.7 *International relations unit*

The role of the distant water fishing nations (DWFNs) such as the EU, Japan, Taiwan and other international bodies is very significant in the effective management of the tuna resources in the WIO. The international relations unit of the organisation has an

important duty to ensure that good relationships between the organisation and these international bodies are maintained. This can be done through constant consultations and advisory sessions with these organisations.

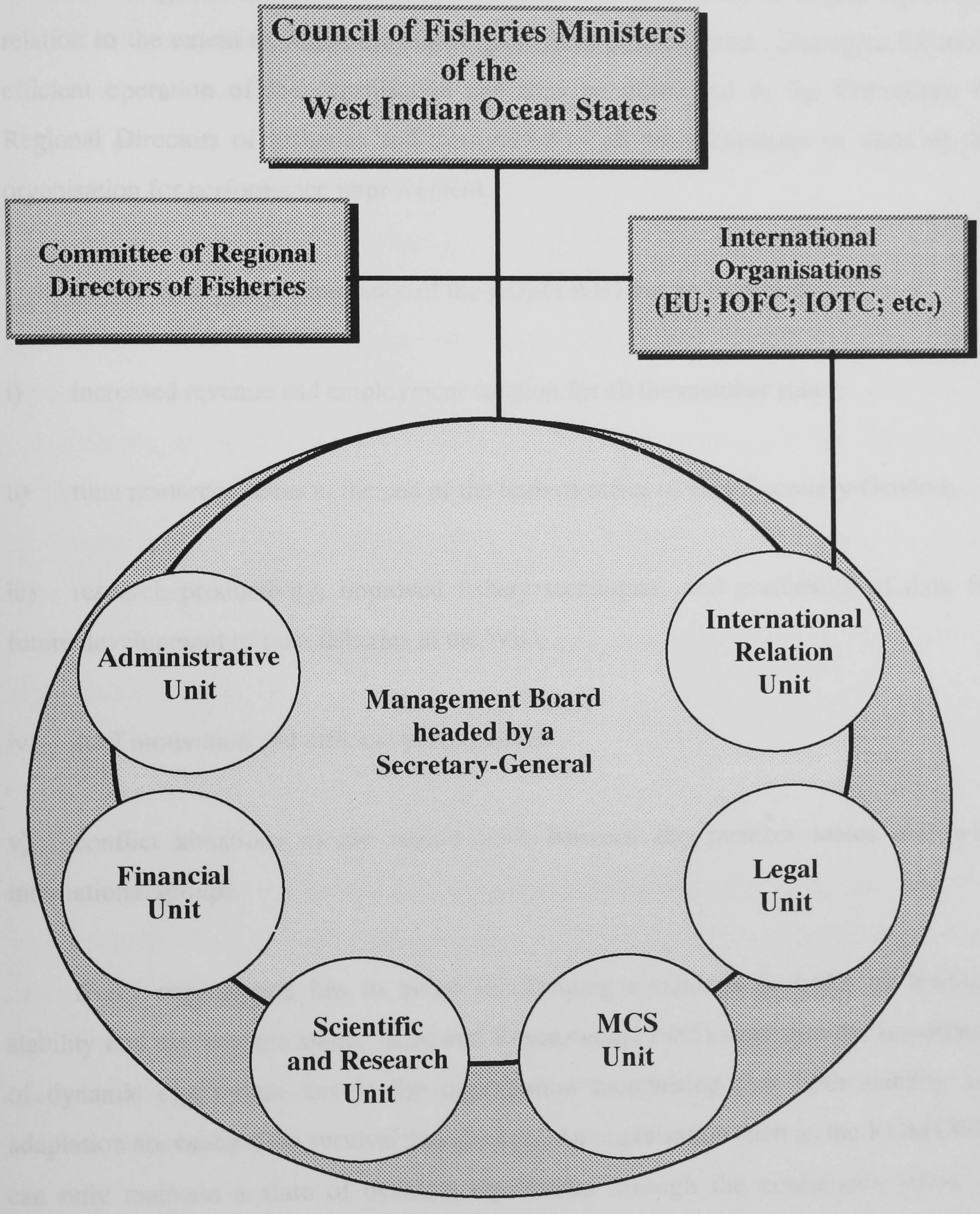
It will also serve as the medium through which technical assistance can be obtained for the organisation and the member states for the development of tuna fisheries in the region. Furthermore, the international relations subsystem should play a role in protecting the WIO fisheries from overexploitation by the various foreign fleets and non-compliance with the fishing regulations.

8.3 The Committee of regional Fisheries Directors, and the Council of Fisheries Ministers

The ROMTWIO cannot be separated from the political structures of the member states without generating some problems. Since it will depend on the political authorities of the states for its financial existence, the Council of Fisheries Ministers must be a major component of its decision-making process. It has already been mentioned that this Council will have the final say on its policy matters.

It is important that the goals, objectives, and planning process of the organisation reflect the interests of the member states. This will be the role of the regional Directors of Fisheries. The Secretary-General is the head of both the Council of Fisheries Ministers, and the Committee of Regional Directors of Fisheries. This mechanism will ensure that both the political and management aspects of the organisation are effectively co-ordinated and harmonised, thereby removing all sources of conflicts, and reconciling different interests.

Figure 8.1 Organisational structure for ROMTWIO



8.4 Assessing the performance of the ROMTWIO

The performance of the organisation shall be assessed annually at the Ministerial Council through the analysis of its achievements as contained in its annual reports, in relation to the extent to which the stated goals have been realised. Strategies for more efficient operation of the organisation can then be developed at the Committee of Regional Directors of Fisheries and transmitted to all the subsystems or units of the organisation for performance improvement.

In real terms, the performance of the ROMTWIO can be based on:

i) increased revenue and employment creation for all the member states;

ii) tuna resources status at the end of the term of office of each Secretary-General;

iii) research productivity, improved fishery techniques, and availability of data for future development of tuna fisheries in the WIO;

iv) staff motivation and efficient performance;

v) conflict situations in the region both between the member states and with international groups.

Every organisation has to adapt to changing conditions in order to maintain stability and not become static. Kast and Rosenzweig (1985) state that the importance of dynamic equilibrium lies in the organisation recognising that both stability and adaptation are essential to survival and growth. An organisation such as the ROMTWIO can only maintain a state of dynamic equilibrium through the continuous inflow of materials, energy and information. It therefore means that the ROMTWIO must focus a great deal of attention on how to receive sufficient input of resources in order to maintain its operational efficiency, and also export the transformed resources to the environment in sufficient quantity to continue the cycle (Kast and Rosenzweig, 1985).

There are two important issues to be considered in seeking ways of ensuring dynamic equilibrium for the ROMTWIO. First, the fact that politics of the WIO region and the economic interests of the different member states of the WIO could generate conflicts and instability that could affect the operational efficiency of the ROMTWIO. The political element cannot be predicted, but the structural arrangement of the ROMTWIO made provisions for maintaining political stability through negotiations and consultations at the Council of Fisheries Ministers, and also at the Committee of Fisheries Directors.

Second, the ROMTWIO has to guarantee a steady inflow of resources in order to maintain operational efficiency. The member states will provide the greater bulk of the running cost. Other possible sources of funding major structural, technical and research aspects of the ROMTWIO could be to apply for grants for specific projects such as for the purchase of the initial regional fleet, the structural building of the organisation, research grants for the development of fishing techniques, stock assessment, fish processing and generating statistical data and information. In this regard, this study recognises the role of the EU, FAO, and other DWFNs can play in helping the ROMTWIO maintain operational efficiency and dynamic equilibrium through bilateral and multilateral aids.

The ROMTWIO will have to recognise the need to have in place contingency plans for fighting external threats from the environment. Such threats may come in the form of severe market competition on world tuna production, pricing, processing and marketing. The ROMTWIO will have to seek powerful and friendly foreign allies in Europe and Japan in order to protect the regional fisheries resources and market. Through the international relations unit, closer co-operation with the different international organisations engaged in tuna fisheries in the region will have to be maintained for the efficient management, survival and growth of the ROMTWIO. Control over fishing activities for the purpose of maintaining stable tuna market world-wide must be considered.

It is proper to expect that disagreements over the fisheries policies of the different member states can be a possible source of conflict. The procedure for decision-making must therefore reflect the interests of at least 75 per cent of the member states. It would

be better if a general consensus can be reached in all important policy matters to avoid instability. The best way to guarantee stability, survival and growth in the decision-making process is to ensure through pre-Summit and pre-Committee lobbying by the Secretary-General, that the views and interests of all the member states have been reflected in the agenda for such meetings. Differences must be discussed and reconciled before meetings. A two-third majority system of voting must be an appropriate way of reaching decisions at all levels of the ROMTWIO deliberations, including at the Ministerial Council, at the Committee of Fisheries Directors and at the Board meeting.

The survival, stability and growth of the ROMTWIO and tuna fisheries in the region will depend largely on the effectiveness of the monitoring, control and surveillance unit of the organisation. A decision must be reached at the Council of Ministers of Fisheries to provide a multinational police force according to the scope of the MCS task to be discharged, under the command of the Secretary-General but headed by a high-ranking police office, to effectively monitor the fishing activities in the region. This will help in controlling overfishing and eradicating illegal fishing. These measures would help to maintain the stability and growth of the ROMTWIO and the tuna fisheries in the region.

There is need for a regional fleet to operate in the WIO. In practice, the fleet might be, initially, a joint-venture fishing fleet between the EU or other DWFNs and the member states of the ROMTWIO. As soon as the region can attain self-sufficiency in fleet management, the ROMTWIO should implement this regional fleet policy, but maintain technical and service related links with other international bodies.

Finally, the ROMTWIO will need to maintain constant inflow of information and ideas for efficient management of tuna resources in the region. It can achieve this through the scientific and research unit engaging in international exchange of current fisheries research documents and information at conferences, seminars and workshops. The organisation should have its own research institute as in Europe and Japan so that it can conduct studies regularly on issues that can promote the stability and growth of tuna fisheries in the region, in line with international trends.

8.5 Summary of findings

A number of findings have been made in this study, some through documentary statistical data, and others resulted from questionnaire data analysis. A list of these findings is given below.

i) The "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks" (United Nations, 1995) outlines the need for a regional organisation for the efficient management of tuna resources. The information from the analysis of the questionnaire data has reinforced the need for a regional organisation to accomplish this goal in the WIO. It is therefore necessary that all the coastal states of the WIO should sign up to the "Agreement" in order to facilitate the activities of the ROMTWIO.

ii) The biological analysis of data shows that yellowfin species is presently exploited beyond its maximum sustainable yield. However, overall tuna stocks generally seem to be reasonably in good health at the moment. Therefore, the efficient management of yellowfin species should be an area of priority for the ROMTWIO.

iii) At present, the fishing effort of the purse seine exceeds the level of requirement to exploit the yellowfin in the region. The normal fishing effort should be restored as quickly as possible in order to maintain stability of yellowfin stock.

iv) There is need to set up a regional fleet for tuna fishing which can be easily monitored and controlled for efficient management of tuna resources.

v) Fisheries agreements between the coastal states and other DWFNs should be reviewed to conform with the objectives and purpose of the ROMTWIO.

vi) Joint-ventures should be seen as intermediate measures, and on the long run subject to the overall authority and redefinitions of the ROMTWIO.

vii) The present situation in terms of open access to the WIO tuna fisheries without regulations is a source of concern to the states of the region. This should be brought under control by the ROMTWIO.

viii) The common property status of the tuna resources of the region creates an atmosphere of competition which tends to obstruct the proper management of tuna fisheries of the coastal states. This situation must be dealt with by the new organisation.

ix) The various fisheries organisations already in existence in the region have not focused attention on how to co-ordinate fisheries activities for the general benefit of the regional states. The ROMTWIO is intended to fill this vacuum, and deserves the support of all the coastal states.

x) The ROMTWIO has been conceived as an organisation for the WIO coastal states, but because of the highly migratory nature of tuna species, room should be made for other coastal states around the region who share common tuna resources to join in later years.

xi) At present, the management of fisheries, especially tuna fisheries is an entirely political issue. The ROMTWIO has to be aware of the political aspects of its role in order to achieve the management goals.

xii) The activities of the foreign fisheries organisations in the region must be recognised by ROMTWIO as an essential component in the development of an efficient management structure for tuna resources in the region, and also as a valuable source of economic and technological benefits, within the framework of agreed regulations and safeguards.

xiii) At present, data on the fishing activities in respect of tuna purse seine are reasonably available. This explains why this study has focused on tuna purse seine fishing techniques for information. Research should explore ways of generating reliable statistics on longlining and artisanal fishing techniques in the region with regard to tuna fisheries.

xiv) Highly migratory species such as tuna must be managed co-operatively , hence the need for the Regional Organisation for the Management of Tuna in the West Indian Ocean.

8.6 For further research

There is need for a more comprehensive research into all the fishing techniques including purse seining, longlining and artisanal fishing, in order to obtain complete statistics on tuna resources situation in the region for more efficient management. The impact of the activities of each fishing technique on each other should be investigated in order to have a better picture of how best to manage tuna resources in the WIO.

A proper understanding of the separate fishing management strategies of each coastal states will be helpful in determining a common policy for the entire region. This needs to be examined more carefully for the better operation of the ROMTWIO.

Fisheries research institutions have been conducting detailed studies of effective tuna resource management all over the world. Research institutions in the South Pacific region, Europe and Africa, and the knowledge they have generated on tuna resource management can be another area for further research by the ROMTWIO, to see what aspects of the information can be integrated into the development of regional tuna fisheries management in the WIO.

The ROMTWIO will need to be assessed after a few years of its establishment in order to see whether the contingency-political model on which it is based is appropriate or not.

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Appendix A

Highly migratory species as designated by Annex I of UNCLOS III (United Nations, 1982).

1.	Albacore tuna	*Thunnus alalunga.*
2.	Bluefin tuna	*Thunnus thynnus.*
3.	Bigeye tuna	*Thunnus obesus.*
4.	Skipjack tuna	*Katsuwonus pelamis.*
5.	Yellowfin tuna	*Thunnus albacares.*
6.	Blackfin tuna	*Thunnus atlanticus.*
7.	Little tuna	*Euthynnus alletteratus; Euthynnus affinis.*
8.	Southern bluefin tuna	*Thunnus maccoyii.*
9.	Frigate mackerel	*Auxis thazard; Auxis rochei.*
10.	Pomfrets	*Bramidae.*
11.	Marlins	*Tetrapturus angustirostris; T. belone; T. pfluegeri; T. albidus; T. audax; T. georgei; Makaira mazara; M. indica; M. nigricans.*
12.	Sailfishes	*Istriophorus platypterus; I. albicans.*
13.	Swordfish	*Xiphias gladius.*
14.	Sauries	*Scomberesox saurus; Cololabis saira; C. adocetus; Scomberesox saurus scombroides.*
15.	Dolphin	*Coryphaena hippurus; C. equiselis.*
16.	Oceanic sharks	*Hexanchus griseus; Cetorhinus maximus; Alopiidae; Rhincodon typus; Carchahinidae; Sphyrnidae; Isuridae.*
17.	Cetaceans	*Physeteridae; Belaenopteridae; Balaenidae Eschrichtiidae; Monodontidae; Ziphiidae; Delphinidae.*

Appendix B

PROTOCOL

defining, for the period 21 May 1995 to 20 May 1998, the fishing opportunities and the financial contribution provided for by the Agreement between the European Economic Community and the Government of the Republic of Madagascar on fishing off Madagascar

Article 1

Pursuant to Article 2 of the Agreement, licences authorising simultaneous fishing in Madagascar's fishing zone shall be granted to 42 freezer tuna seiners and 16 surface longliners for a period of three years beginning on 21 May 1995.

In addition, at the request of the Community, authorisation may be granted for other categories of fishing vessel under conditions to be laid down in the joint Committee referred to in Article 9 of the Agreement.

Article 2

The amount of the contribution referred to in Article 7 of the Agreement shall be ECU 1,350,000 for the duration of the Protocol, payable in three equal annual instalments. This amount is to cover an annual catch of 9,000 tonnes of tuna in Malagasy waters; if the tuna caught by the Community vessels in Madagascar's fishing zone exceeds this weight, the amount referred to above shall be proportionately increased.

Article 3

1. The Community shall also, during the period referred to in Article 1, contribute ECU 375,000 to finance a Malagasy scientific programme to improve knowledge of the highly migratory species existing in the Indian Ocean around Madagascar.

At the request of the Government of Madagascar, this contribution may take the form of assistance with the cost of international meetings to improve knowledge of those species and the management of fishery resources.

2. The competent Malagasy authorities shall send the Commission a summary report on the use of those funds.

3. The Community contribution to the scientific programme shall be paid into the account indicated by the Malagasy authorities.

Article 4

1. The two parties hereby agree that increasing the skills and knowledge of those concerned with sea fishing is essential to the success of their co-operation. The Community shall therefore facilitate the entry of Malagasy nationals to establishments in its Member States and, for this purpose, shall make available to them study or practical training awards lasting a maximum of five years in the various scientific, technical and economic fields and in related activities linked to the development of the fisheries and aquaculture sectors, as judged necessary by the Government of Madagascar. The total cost of these grants may not exceed ECU 450,000. The grants may also be used in any other State linked to the Community by a Co-operation Agreement.

2. The amount referred to in paragraph 1 shall be payable as and when used.

Article 5

Should the Community not make the payments referred to in Articles 2 and 3 of this Protocol, the Fisheries Agreement may be suspended.

Article 6

The Annex to the Agreement between the European Economic Community and the Government of the Republic of Madagascar on fishing off Madagascar is hereby repealed and replaced by the Annex to this Protocol.

Article 7

This Protocol shall enter into force on the date of its signature.

It shall apply from 21 May 1995.

ANNEX

Conditions for the pursuit of fishing activities by Community vessels in Malagasy waters.

1. Licence application and issuing formalities

The application procedure for, and issue of the licences enabling Community vessels to fish in the waters of Madagascar shall be as follows:

(a) the Commission of the European Communities, through its representative of the Commission in Madagascar, shall present to the authorities of Madagascar an application, made by the shipowner, for each vessel that wishes to fish under this Agreement, at least 20 days before the date of commencement of the period of validity requested. The application shall be made on the forms provided for that purpose by Madagascar, a specimen of which is annexed hereto. Each licence application shall be accompanied by proof of payment of the fee for the period of the licence's validity.

(b) licences shall be issued for a specific vessel and shall not be transferable. However, at the request of the Commission of the European Communities, a vessel's licence shall, in the case of *force majeure*, be replaced by a new licence for another vessel with characteristics similar to those of the first vessel. The owner of the first vessel shall return the cancelled licence to the Malagasy Ministry of Fisheries via the Delegation of the Commission of the European Communities in Madagascar.

The new licence shall indicate:

-the date of issue,

-the fact that it invalidates and replaces the licence of the previous vessel.

No fee as laid down in Article 5 of the Agreement shall be due for any unexpired period of validity.

(c) licences shall be transmitted by the Malagasy authorities to the Delegation of the Commission of the European Communities in Madagascar,

(d) the licence must be held on board at all times. However, on the receipt of the notification of the advance payment sent by the Commission of the European Communities to the Malagasy authorities, the vessel will be included on a list of vessels with authorisation to fish, which is sent to the control authority of Madagascar. Pending

receipt of the original of the licence, a copy of the licence that has been drawn up may be issued by telefax to be held on board the vessel.

(e) tuna shipowners shall appoint a representation in Madagascar.

(f) before the entry into force of the Agreement the Malagasy authorities shall communicate the arrangements for payment of the licence fees, in particular the details of the bank account to be used.

2 Validity of licences and payment of fees

(a) Licences shall be valid for one year. They shall be renewable.

(b) The licence fee shall be set at ECU 20 per tonne of tune caught in Malagasy waters. Licences shall be issued following advance payment to Madagascar of a lump sum of ECU 1,500 a year for each tuna seiner and ECU 500 a year for each surface longliner.

(c) The final statement of the fees due for the fishing period shall be drawn up by the Commission of the European Communities at the end of each calendar year on the basis of the catch statements made by each shipowner and confirmed by the scientific institutes responsible for verifying catch data such as the French *Office de la Recherche Scientifique et Technique d'Outre-mer* (ORSTOM), the *Instituto Espanol de Oceanografia* (IEO) and the *Unite Statistique Thoniere d'Antsiranana* (USTA).

The statement shall be forwarded simultaneously to the sea fishing services of Madagascar and to the shipowners. Any additional payment due shall be made by the shipowners to the Malagasy services not later than 30 days after notification of the final statement.

However, if the amount of the final statement is lower than the above mentioned advance, the resulting balance shall not be reimbursable to the shipowner.

3 Statement of catch

(a) For all Community vessels authorised to fish in the Malagasy waters under the Agreement a statement of their catch must be provided to the Malagasy fishing services, with a copy to the Commission Delegation of the European Communities in Madagascar, in accordance with the procedures set out below:

-for tuna seiners and surface longliners a fishing log shall be kept, in accordance with Appendix 2, for each fishing period spent in the Malagasy fishing zone. The form

must be sent, within 45 days of the end of the fishing voyage spent in the Malagasy waters, to the competent authorities.

-forms must be completed legibly and be signed by the master of the vessel.

(b) should this provision not to be adhered to, the Malagasy authorities reserve the right to suspend the licence of the offending vessel until the formality has been complied with.

In this case, the Delegation of the Commission of the European Communities in Madagascar shall be informed.

4 Radio communication

The captain shall notify, at least 24 hours in advance, to the radio station of Antsiranana, his intention to enter his vessel into the Malagasy fishing zone.

The name, call sign and frequency shall be specified in the licence.

5 Observers

At the request of the Malagasy authorities, tuna vessels shall take on board an observer who shall be accorded the conditions enjoyed by officers of the vessel. The time spent by an observer in board shall not be longer than the time required to fulfil his duties.

Conditions of his embarkation shall be defined in common accord between the shipowner or his representative and the Malagasy authorities.

The shipowner shall pay the Malagasy Government, through his representation, the sum of ECU 10 per day spent by an observer in board.

Should a vessel with an observer on board leave the Malagasy fishing zone, all measures must be taken to ensure the observer's return to Madagascar as soon as possible at the expense of the shipowner.

6 Signing-on seamen

For all tuna seiners fleet, at least two Malagasy seamen shall be signed on permanently during the fishing time.

Should the seamen not be signed on, the shipowner shall be obliged to pay a lump sum equivalent to the wages of seaman not signed on.

This sum will be used for the training of seamen/fishermen in Madagascar and is to be paid into an account specified by the Malagasy authorities.

The wages of these seamen shall be fixed by mutual agreement between the shipowner's representation and the seamen themselves.

7 Fishing zones

Fishing zones for the Communities vessels shall be the waters under the Malagasy jurisdiction and situated beyond 2 nautical miles measured from the baseline.

In case the Malagasy authorities shall decide to install FADs (fish aggregating devices), they shall inform the European Commission and the shipowners in indicating the geographical co-ordinates of the FADs.

From the thirtieth day after the notification, it shall be prohibited to approach near less than 1.5 nautical miles from these FADs. Every demolition of the FADs shall be communicated without delay to the parts concerned.

8 Utilisation of harbour facilities

The Malagasy authorities shall determine with the shipowners the conditions of using the harbour facilities.

9 Inspection and monitoring

Any community vessel fishing in Malagasy waters shall allow on board any official of Madagascar for inspection and monitoring the fishing activities

10 Transhipment

In case of transhipment, tuna vessels shall give the fish they shall not preserve to the society or organisation designed by the Malagasy fishing services.

11 Services

Community vessels fishing in the Malagasy waters shall give privilege to the Malagasy services (reparation, handling etc.)

Appendix C

Strictly confidential

Questionnaire: Fisheries Department

Please return this questionnaire with your answers and comments to :

Mr. EDALY, University of Hull
International Fisheries Institute
HULL, HU6 7RX UK.

1. Basic information:

Name of the Department:

Date when established:

Under which Ministry:

Number of employees:
a. administrative:
b. scientific:
c. other:

Annual operating budget (estimate):

Origins of funding:

2. Organisational remit:

Aims and objectives:

Terms of reference (please tick box as appropriate)

a. planning ☐
b. development ☐
c. management ☐
d. co-ordination ☐
e. negotiation ☐
f. others (please specify):

3. Main activities:

List the following activities in order of priority. Place a number in each box: 0 (if not relevant), 1 (first priority), 2 (second priority), and so on.

- day to day activities ☐
- information collection ☐
- undertaking baseline studies ☐
- establishing information collection system ☐
- data processing ☐
- information dissemination ☐
- publishing ☐
- sector studies ☐
- research (areas) ☐
- identification of development options ☐
- negotiation of fisheries agreements ☐
- resource survey work ☐
- monitoring, control and surveillance ☐
- staff training ☐
- presentation of national workshops ☐
- policy formulation ☐
- fishing rights and access agreements ☐
- others (please specify):

4. Your views on regional organisation:

Please indicate if you agree or disagree with the following statements (tick appropriate box).

	agree	uncertain	disagree
• Highly migratory species should be managed by bilateral agreement	☐	☐	☐
• Highly migratory species should be managed by regional organisation	☐	☐	☐
• Highly migratory species should be managed by international organisation	☐	☐	☐
• Membership of a regional organisation should include only coastal states	☐	☐	☐
• Regional organisation should be vested with management decisions	☐	☐	☐

- Additional comments:

5. Your views on your Department:

Please indicate how can you define the relationship between your Department and (please tick appropriate box)

	very good	good	uncertain
• ministry of fisheries	☐	☐	☐
• other marine related departments	☐	☐	☐
• existing regional fisheries organisations	☐	☐	☐
• existing international fisheries organisations	☐	☐	☐
• Fisheries related NGOs	☐	☐	☐
• other Departments (please specify)			

Please indicate how you perceive the strengths/weaknesses of your Department (tick appropriate box)

	strength	weakness
• independent department	☐	☐
• dependant of agricultural ministry	☐	☐
• good scientific staff	☐	☐
• lack of scientific staff	☐	☐
• legislative support	☐	☐
• strong political involvement	☐	☐
• other strengths:		
• other weaknesses:		

6. Your views on the management problems:

Do you see the following as basic causes of the problems in fisheries management? (please tick appropriate box)

	basic cause	not a basic cause	uncertain
• multiobjectives in fisheries	☐	☐	☐
• different views between scientists and politicians	☐	☐	☐
• too many rules and regulations	☐	☐	☐
• too many boats chasing too few fish	☐	☐	☐
• others:			

7. Future prospects:

What should be done to enhance the capability of your Department? (please tick box)

- increased funding ☐
- staff training ☐
- create an independent ministry ☐
- internal reorganisation ☐
- greater legislative power ☐
- others (please explain): ☐

8. Are there any other comments you wish to make? (please continue on a separate sheet if you wish).

Thank you for your co-operation. **Please return the completed questionnaire**

Appendix D

Strictly confidential

Questionnaire: Fisheries management organisation

Please return this questionnaire with your answers and comments to:

Mr. EDALY, University of Hull
International Fisheries Institute
HULL, HU6 7RX UK

1. Basic information:

Name of the organisation:

Date of establishment:

Number of employees:
a. administrative:
b. scientific:
c. other:

Annual operating budget (estimate):

Origins of funding:

2. Organisational remit:

Aims and objectives:

Terms of reference (please tick box as appropriate):

a. planning ☐
b. development ☐
c. management ☐
d. co-ordination ☐
e. negotiation ☐
f. others (please specify): ☐

3. Main activities:

List the following activities in order of priority. Place a number in each box: 0 (if not relevant), 1 (first priority), 2 (second priority) and so on:

- day to day activities
- project management
- information collection
- undertaking baseline studies
- data processing
- information dissemination
- publishing
- sector studies
- research (areas)
- identification of development options
- negotiation of fisheries agreements
- resource survey work
- monitoring, control and surveillance
- staff training
- presentation of regional workshops
- policy formulation
- fishing rights and access agreement
- others (please specify):

4. Your views on regional organisation:

Please indicate if you agree or disagree with the following statements (tick appropriate box).

	agree	uncertain	disagree
• Highly migratory species should be managed by an organisation which is regionally based	☐	☐	☐
• Highly migratory species should be managed only by an international organisation	☐	☐	☐
• Membership of a regional organisation should include only coastal states	☐	☐	☐
• Regional organisation should be vested with management decisions	☐	☐	☐

- Additional comments:

5. Your views on your organisation:

Please indicate how can you define the relationship between your organisation and (tick appropriate box):

	very good	good	uncertain
• the member countries	☐	☐	☐
• other regional organisations	☐	☐	☐
• other international organisations	☐	☐	☐
• other NGOs fisheries related			

Please indicate how you perceive the strengths/weaknesses of your organisation (tick appropriate box):

	strength	weakness
• effective participation from countries represented	☐	☐
• legislative support	☐	☐
• scientific support	☐	☐
• political support	☐	☐
• others (please explain):		

6. Your views on the management problems

Do you see the following as basic causes of the problems in fisheries management? (please tick box).

	basic cause	not a basic cause	uncertain
• Different objectives between member states	☐	☐	☐
• Different views between scientists and politicians	☐	☐	☐
• Reluctance of coastal states to delegate their rights	☐	☐	☐

- Lack of support from the member states ☐ ☐ ☐
- Other basic causes?

7. **Future prospects**:

What should be done to enhance the capability of your organisation? (please tick box)

- Increased funding ☐
- Wider membership ☐
- Linkages to other institutions ☐
- Better qualified staff ☐
- Greater legislative power ☐
- Others (please specify):

8. Are there any other comments you wish to make? (please continue on a separate sheet if you wish).

Thank you for your co-operation. **Please return the completed questionnaire.**.

Appendix E

List of Abbreviations

ACP	Afrique, Caribbean and Pacific
AFMA	Australian Fisheries Management Authority
AT/COI	Association Thonière/Commission de l'Océan Indien
CAN	Centre d'Appui National
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CEDA	Catch Effort Data Analysis
CPUE	Catch per Unit effort
CWP	Co-ordinating Working Party on Fishery Statistics
DRH	Direction des Ressources Halieutiques
DWFN	Distant Water Fishing Nation
ECU	European Currency Unit
EEC	European Economic Commission
EEZ	Exclusive Economic Zone
EU	Europen Union
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organisation of the United Nations
FISA	Fisheries Society of Africa
FFA	South Pacific Forum Fisheries Agency
GDP	Gross Domestic Product
GFCM	General Fisheries Council for the Mediterranean
GNP	Gross National Product
HIFI	Hull International Fisheries Institute
I-ATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tuna
ICES	International Council for the Exploration of the Sea
IOFC	Indian Ocean fishery Commission
IOMAC	Indian Ocean Marine Affairs Co-operation
IOTC	Indian Ocean Tuna Commission
IPTP	Indo-Pacific Tuna Development and Management Programme

ITQ	Individual Transferable Quota
MCS	Monitoring, Control and Surveillance
MSY	Maximum Sustainable Yield
NAMMCO	North Atlantic Marine Mammal Commission
NASCO	North Atlantic Salmon Conservation Organisation
ODA	Overseas Development Administration
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre-mer
ROMTWIO	Regional Organisation for the Management of Tuna in the West Indian Ocean
SFA	Seychelles Fishing Authority
SPC	South Pacific Commission
SWIOP	South West Indian Ocean Project
TAC	Total Allowable Catch
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Conference on the Law of the Sea
UNDP	United Nations for Development Programme
USTA	Unité Statistiques Thonières d'Antsiranana
WECAFC	Western Central Atlantic Fishery Commission
WIO	West Indian Ocean
WIOMSA	West Indian Ocean Marine Science Association
WIOTO	West Indian Ocean Tuna Organisation

Appendix F

Summary of information on Regulatory Fishery Bodies in the Indian Ocean

Body	Date established and Auspices	Headquarters	Eligibility for membership	Area of competence	Resources covered	Functions
IOFC	1967 FAO	FAO, Rome: Italy	All FAO Member Nations and Associate Members of FAO	Indian Ocean and adjacent seas, but excluding the Atlantic area	All species	To promote programmes of fishing development and conservation; to encourage research and development. activities; to examine management problems
SWIOP	1981 - 1991 FAO	FAO, Rome: Italy	Signatory states: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, Tanzania	South West of Indian Ocean: FAO Fishing Area 51	All species	To assist the member states to achieve self-sufficiency in the development and management of their marine resources
IPTP	1982 FAO	Colombo: Sri Lanka	FAO Member Nations	Indian Ocean: FAO Fishing Areas 51 and 57	Tuna species	To assist governments in the area in the preparation of long-term management of fisheries for tuna and tuna-like species
AT/COI	1987 - 1996 Coastal states	Antananarivo: Madagascar	Signatory states: Comoros, Madagascar, Seychelles, Mauritius, Reunion	Area of the "*Commission de l'Océan Indien*": EEZs of the signatory states	Tuna species	To develop a regional fishing method for tuna, local capabilities in the collection and analysis of statistical data on tuna fisheries, set up a regional data base on biological research

WIOTO	1994 Coastal states initiated by Seychelles	Mahé: Seychelles	Signatory states: Comoros, Madagascar, Mauritius, Seychelles, Sri-Lanka, Kenya, Tanzania, Mozambique, India	West Indian Ocean: FAO Fishing Area 51	Tuna species	To manage DWFNs tuna fishery. To assist member states in negotiation of access agreements and in the legislative aspects relative to the control of foreign fishing
IOTC	1996 FAO	Mahé: Seychelles	Coastal states within the area and DWFNs fishing in the area. FAO non member states but members of Untied Nations (if approved by two thirds majority of IOTC members)	Indian Ocean: FAO Fishing Areas 51 and 57	Tuna species	To ensure through management the conservation and optimum utilisation of tuna stocks
ROMTWIO	To create (Probably in 1998)	To define (Probably in the African mainland)	Probably the founding states: Comoros, Madagascar, Mauritius, Seychelles, Maldives, Mozambique, Tanzania, Kenya, Somalia	West Indian Ocean: FAO Fishing Area 51	Tuna species	To exchange scientific, economic and social information on tuna species within the region; to set up a management plan for the exploitation of tuna resources in the region

Appendix G

Comparative table of Malagasy fishing agreements with the EEC.

	Accord valid from 21 May 1986 to 20 May 1989	Accord valid from 21 May 1989 to 20 May 1992	Accord valid from 21 May 1992 to 20 May 1995	Accord valid from 21 May 1995 to 20 May 1998
Number of licences	40 seiners/year	45 seiners/year	42 seiners/year and 8 longliners/year	42 seiners/year and 16 longliners/year
Fishing zone	beyond 2 nautical miles from the coastline	beyond 2 nautical miles from the coastline	beyond 2 nautical miles from the coastline	beyond 2 nautical miles from the coastline
Loans paid by the shipowners	555 ECU/vessel/year	1,000 ECU/vessel/year	1,000 ECU/vessel/year and 500 ECU/vessel/year for longliner	1,500 ECU/vessel/year and 500 ECU/vessel/year for longliner
Financial compensation	510,000 ECU/year for a catch less or equal to 10,200 tonnes/year	600,000 ECU/year for a catch less or equal to 12,000 tonnes/year	600,000 ECU/year for a catch less or equal to 9,000 tonnes/year	450,000 ECU/year for a catch less or equal to 9,000 tonnes/year
Additional price for the surplus catch	50 ECU/tonne	50 ECU/tonne	50 ECU/tonne	50 ECU/tonne
Scientific programme	350,000 ECU	600,000 ECU	600,000 ECU	375,000 ECU
Formation	390,000 ECU	500,000 ECU	450,000ECU	450,000 ECU