Control of Foreign Fisheries

Workshop Report

White Sands Hotel, Dar Es Salaam
14th – 15th November 2005

MRAG

DFID Department For International Development

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Contents

Abbreviations

CFF	Control of Foreign Fisheries
DFID	UK Department for International Development
EEZ	Exclusive Economic Zone
EU	European Union
IOTC	Indian Ocean Tuna Commission
IUU fishing	Illegal, unreported and unregulated fishing
JIS	Joint Inspection Service
MCS	Monitoring, Control and Surveillance
MR	Marginal Rent
MRAG	Marine Resources Assessment Group
RFMO	Regional Fisheries Management Organisation
SADC	Southern African Development Community
VMS	Vessel Monitoring System
WIO	Western Indian Ocean

1. Introduction

This report provides an overview of a regional workshop on the Control of Foreign Fisheries (CFF), held at the White Sands Hotel, Dar Es Salaam, Tanzania between Monday 14th November and Tuesday 15th November 2005.

The main aim of the workshop was to increase regional awareness of economic models to maximise the benefits through the CFF. In addition, the workshop was developed to increase national capacity to highlight a range of CFF strategies. The workshop undertook the following activities:

(i) Provide an overview of the model
(ii) Share and discuss national and regional perspectives on MCS
(iii) Practical sessions using CFF spreadsheet model game to develop hypothetical MCS strategies
(iv) Field visit to MCS Operations centre, Mbegani

A copy of the workshop agenda is provided in Appendix A and a contact list of participants in Appendix B.

Although the main focus of the workshop was based around practical exercises from the CFF model, participants from several coastal states presented a short summary of their fisheries sector, including the role and status of foreign fishing activities. In addition to these national perspectives, an overview of the SADC MCS Programme was given, highlighting the main MCS issues within Angola, Mozambique, Namibia, South Africa and Tanzania. These are described in more detail in section 2. Copies of the available presentations are given in Appendices C to E.

An introduction to the CFF model was given by means of two short practical sessions (see Appendices F to I). The theoretical basis and assumptions behind the model were described by a series of slides (see Appendices J and K). Further details have been provided in section 3 below.

A field visit was made on Tuesday 15th November to the Tanzanian MCS Operations Centre at Mbegani. This provided an opportunity for participants to observe first-hand the scale and success of the surveillance operations and to ask questions to those on duty. A short photo gallery of this trip is presented in Appendix L.

2. Overview of foreign fishing activities relevant to East Africa

This section of the report attempts to summarise the main CFF issues (surveillance and licence revenue) derived from a series of short presentations made by participants at the workshop, with additional information added where appropriate.

2.1. National Perspectives

Kenya (Presented by Kennedy Shikami & Martha Mukira)

Kenya has offered licences to purse seiners since the 1996 fishing season. Since then, vessels have been licensed for varying lengths of time, at various fee rates. The key period for purse seiners in the Kenyan Zone is the middle of the year, from July to September. This is the time when these vessels are most likely to be seeking access to the Zone.

The first short term licences (3 months from 1 June to 31 August) were issued in 2000. In 2001 a mixture of 1, 2, 6 and 8 month licences were issued. The cost of licences has varied according to their duration. In 2002 and 2003 all licences were 8 months long with various start dates. At present, 32 purse seiners have been licensed in 2005 for $20,000 each, under annual agreements that will expire at the end of March 2006. The average number of vessels licensed at any one time over the period 1996 to 2003 was 27.

Up to the end of 2003, the majority of licenses issued to purse seine vessels were flagged in Spain (44%), while the next largest fleet was France (23%). The involvement of Spain in Kenya's purse seine tuna fishery has been relatively consistent, while that of the French fleet has been somewhat more variable. Three other flag states have consistently had vessels licensed for fishing in the Kenyan EEZ: Netherlands, Belize and Seychelles.

Little or no information is currently available for the longline fleet. The majority of licenses are sold to Taiwanese flagged vessels, at a cost of $12,000 per year.

Annual catches reported within the Kenyan EEZ are highly variable, with a peak of over 6,000 tonnes occurring during 1996 (IOTC data 1984-2001). The long-term average annual catch, however, is considerably less than this at approximately 200 tonnes. These figures are likely to under-estimate the true catch value, since there is no mechanism in place for recording foreign fishing catches, or providing observers on board vessels.

Within the Kenyan EEZ, surveillance patrols are currently limited to those undertaken by the Kenyan Navy. No further details are available, although it has been acknowledged that surveillance operations could be increased.

Tanzania (Presented by Robert Sululu)

Tanzania currently issues foreign fishing licences from two sources; the mainland and Zanzibar. Until very recently, the Tanzanian mainland issued between 5 and 10 annual purse seine licenses and a similar number of longline licenses a year, equivalent to $173,000 in total licence fee revenue. The majority of the purse seine fleet were Spanish flagged vessels (90%) whereas Japan dominated the longline fleet. In contrast, Zanzibar licensed only 5 vessels (category unknown) in 2002, equivalent to approximately $10,000 in total licence fee revenue.

Following the implementation of the EU-funded SADC MCS Programme and a number of successful surveillance patrols within the Tanzanian EEZ during 2004, the number of licenses issued rose sharply during the second quarter of 2004. These ranged from 10 purse seine vessel licenses in April 2004 to nearly 40 in June of the same year. It is interesting to note that although the number of licensed Spanish flagged purse seine vessels increased, the rise also coincided with the sudden appearance of French flagged vessels. More recently, within the latter half of 2005, the number and diversity of longline flagged vessels has also shown a similar increase. In total, the number of licenses issued by the mainland has increased from 20 vessels in 2002 to 84 in 2004, which is equivalent to

$1.74 million in total licence fee revenue. Similarly, Zanzibar has experienced a similar trend, with a total of 78 licensed vessels in 2003 equivalent to approximately $160,000.

Mozambique (Presented by Noa Senete and Manuel Castiano)

A short presentation was given on the surveillance activities within the Mozambique EEZ. A copy of the presentation can be found in Appendix C.

Mozambique has a comparatively large EEZ area to patrol, which his approximately 400,000 km^2 in size. The first fisheries inspectors were appointed in the 1980s, which now total 60 personnel. They are responsible for a range of tasks, including port inspections at various offloading points, fishing centres and beaches. Fisheries inspectors are also on board foreign fishing vessels up to a month in duration. The Mozambique Navy and Maritime Police are also responsible for surveillance operations.

In 2004 and 2005, 11 maritime surveillance missions were undertaken as a result of several bilateral (Mozambique/South Africa) and trilateral (Mozambique/South Africa/Namibia) agreements. The South African Fisheries Patrol vessel “Eagle Star” was used as the primary surveillance platform with aerial support. The result of the 11 missions led to the arrest of two foreign fishing vessels engaged in illegal fishing (illegal gear) and more than 40 vessels inspected.

It was reported that several vessels attempted to use deception to prevent their real identity from being revealed. For example, this included putting an incorrect call sign/vessel owner in large letters on the side of the vessel.

In addition to the recent surveillance operations, VMS is now being used on 72 vessels to monitor their position in time and space. Currently a number of limitations exist in the maritime surveillance, such as training of personnel to ensure all the latest regulations are adhered to.

Seychelles (Presented by Michel Marguerite)

A short presentation was given on the revenue generation from industrial tuna fishing activity in the Seychelles. A copy of the presentation can be found in Appendix D.

Seychelles is a small island developing state which consists of approximately 115 islands within a large EEZ covering 1.4 million km^2. The fisheries sector is responsible for 47% of the foreign exchange inflow and represents nearly 20% of the GDP (all fisheries sub-sectors combined). The fisheries sector has thee sub-sector; the artisanal, semi-industrial and industrial.

Within the industrial sub-sector, the purse seine and longline fleet are entirely foreign owned, mainly by the Spanish and French. The first licence to fish was issued in 1979 to longliners, whereas purse seining started in 1984. The first fisheries agreement was signed in 1985 with the Spanish. In 2004, between 46 and 51 purse seine vessels were licensed to fish under the Seychelles-EU fishing agreement and other private fishing agreements. The total catch for this period was 365,800 mt, which was a small decline from the previous season. In contrast, over 330 licenses were issued to longliners, mainly from Korea, Japan and Thailand.

The volume of tuna landed or transhipped within the Seychelles in 2004 was 300,937 mt, equivalent to 80% of all catches transhipped or landed in the Western Indian Ocean. In the same year, 12 Seychelles registered purse seiners caught a total of 82,600 mt of tuna.

The revenue generated from the tuna industrial fishery consists mainly of vessels expenditure in port, private company spending and licence fees, including financial compensation from the EU. For the last 10 years, the Seychelles has earned approximately $80 million in licence fees.

The main factors that influence the total revenue from the industrial fisheries sub-sector include the number of vessels licensed, the volume of catch and transhipment, the number of port calls and the length of stay, the cost of goods and services (especially fuel costs), exchange rate movements, labour productivity, safety and security in port area and tariff rates.

There remain, however, a number of challenges that must be met to continue the benefits derived from the sub-sector. These include maintaining a good quality of service and excellent infrastructure and facilities. The Seychelles must also ensure competitive prices to mitigate competition from other ports, and avoid any cost of labour unrest. To maintain a long-term sustainable fishery, the role of the IOTC is important in establishing management advice that will maintain the status of the stocks.

Finally, it is noted that the success of the Seychelles tuna fishery is due to a number of main advantages. These include its geographical position and size of the EEZ. The Seychelles is situated in the middle of the migratory path of the tuna stock and will therefore have regular access to the resource. It also has a good infrastructure and communications services, safe and secure port, good national governance, a productive and efficient labour force and good dialogue between fishers and Government.

Somalia

No information was available at the meeting although IUU fishing is considered to be both prolific and widespread throughout the Somalia zone.

2.2. Regional Perspective (Presented by James Wilson and Ian Shea)

A regional perspective on the control of foreign fishers was presented by James Wilson on behalf of the SADC MSC Programme. A copy of the presentation can be viewed in Appendix E.

The EU-funded SADC MCS Programme covers five coastal states around southern Africa (Angola, Mozambique, Namibia, South Africa and Tanzania) with a combined coastline extending of over 10,000 km and EEZs covering nearly 3 million km^2. Several key issues were raised concerning the scale and uncertainty of the MCS problem to develop cost-effective strategies for the region. These include a large sea area which is both expensive and technically difficult to police; the dynamic nature of the EEZ pelagic resources, including uncertainty in the value of the resource, and; uncertainty as to the overall scale of the problem, such as how many vessels want to fish and how many are fishing illegally. Historically, the abundance and distribution of large pelagic resources in the western Indian Ocean have been highly variable.

A second major issue regards the potentially high benefits derived from infractions within the offshore fisheries sector. These range from targeting incorrect species, fishing in prohibited areas (e.g. inshore waters) and sporadic bumper yields, which can lead, amongst others, to under-reporting.

The nature of foreign fishers was also an important consideration to the scale and uncertainty of regional MCS issues. Within the region, foreign fishers are highly mobile, dynamic, diffuse and transitory bodies that can be difficult to detect, have limited or no local representation or assets. Furthermore there exist difficulties between language and communication in general and fishers are insensitive to social sanctions and local government pressure. Poor flag state control has also been shown to exacerbate the problem of IUU fishing.

The ability of the coastal state to take control and effectively regulate foreign fishing activities is currently impeded by a number of important issues. First, a lack of technical means has been identified with insufficient surveillance platforms available and a lack of operational support and budget to maintain them. Other national shortcomings include inadequate trained staff; limited passage of information between coastal states; inadequate dissuasive mechanisms such as legal, penalties and probability of detection; and exceptionally high licence fees that encourage IUU fishing, particularly in transitory fisheries.

The average proportion of national MCS expenditure to landed catch value within the SADC region (excl. Tanzania) was approximately 1%. Although this might be considered relatively low, the level of financial penalties can help to deter illegal fishing activities. A range of fixed penalties have been estimated for each country as a proportion of their licence fee and average annual gross revenue. Clearly, both licence fees and financial penalties varied considerably between states, where Mozambique and Angola appeared to have the lowest maximum ($3,571) and highest maximum ($15 million) fines respectively. In the case of Mozambique it appears that the maximum level of fine is also lower than the annual licence fee ($20,000). Only in the case of Angola does the maximum fine exceed the average annual gross revenue per vessel.

One means of generating revenue for surveillance activities can be through increasing licence fees. This surveillance-licence-revenue cycle can be seen clearly in the following illustration.

<u>Tanzanian (mainland) Licence Revenue</u>

2002 $173,000

2004 $1.74 million (post surveillance expenditure)

<u>Number of Vessels</u>

2002 20

2004 84 (post surveillance expenditure)

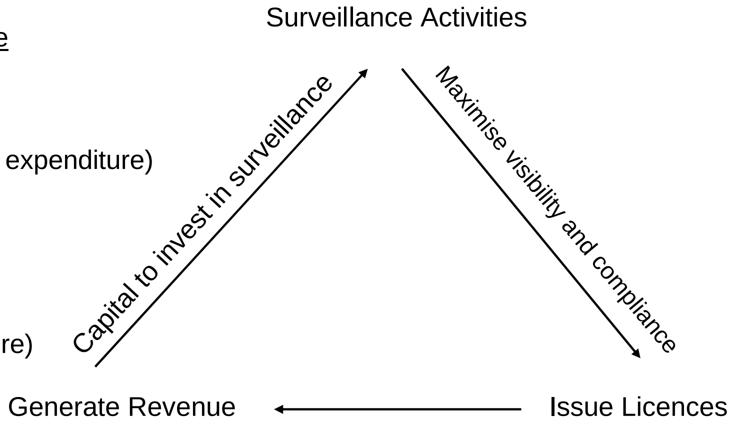

Figure 2.1 The surveillance cycle (re-drawn from illustration presented by Cmdr Ian Shea)

It was shown that using typical annual costs equivalent to a net margin of 5% and expected revenues from a tuna purse seine vessel of $6 million, it would spend approximately 22% of its time spent paying for an annual licence worth $20,000. Under these circumstances, it appears that there is little or no room to increased licence fees.

Looking at the level of regional technical MCS assets revealed that few states have dedicated platforms available for surveillance activities. South Africa was the only state that currently has a fully commissioned satellite VMS system in place.

A number of regional strategies were presented that might be employed to increase the effectiveness of MCS activities. These include increases in technical development (e.g. VMS, vessel design, and information systems), bilateral and multilateral cooperation, revision of legal frameworks (e.g. penalties and sanctions), rationalisation and harmonisation of fees, and participation in regional associations such as RFMOs.

A range if technical options exist that can reduce national MCS costs, including sharing resources between one or more coastal state. However, a number of complex issues such as availability, administration, status, and sovereignty (i.e. inspectors cannot make arrest in other jurisdiction without changes to legal framework) will need to be resolved. The latter issue of sovereignty has recently been addressed within EU as part of the new MCS Joint Inspection Service (JIS), based in Vigo, Spain. The main objective of this EU initiative is to utilise the MCS means within all European Member States as efficiently and effectively as possible, thus reducing the overall cost to the EU.

Regional cooperation will also benefit MCS strategies through information exchanges (e.g. fleet characteristics, licence information, and a vessel register) in addition to benefits derived from sharing VMS data (where has the vessel fished prior to obtaining a licence – does it have a high level of compliance?). Improved legal harmonisation and increased dialogue between coastal states will also improve opportunities to exchange information and undertake more cost-effective joint surveillance and inspection duties.

Revisions may be required to national legal frameworks as foreign fishing activities continue to evolve within the region, new technologies are employed, and a harmonisation of sanctions and penalties are developed. Management of highly migratory and straddling fish stocks is a regional problem, and as such require regional associations (e.g. through membership of IOTC) to provide management advice on the current status of the stocks and safe limits of fishing effort.

Regional MCS strategies have already been started by several coastal states that have established bilateral patrol agreements. These include those between South Africa and Mozambique, and Namibia and Angola.

Regional and or bilateral actions increase the opportunity for a wide range of services, including asset lending/pooling, information exchange protocols, legal harmonisation and regional training, for example.

3. Optimal Control of Foreign Fishing

3.1. Background

Two DFID-funded projects have previously looked at the control of foreign fisheries. The first, R.4775 (MRAG 1993), developed a methodology for evaluating the net benefits from licensing of foreign fishing vessels operating in national jurisdictions in order to inform policy and legislation on issues such as licensing (and fees) and surveillance. The second, R.5049CB (MRAG 1995), tested the methodology and results to assess the extent to which they can be applied in practice by governments of developing countries in forming policies for controlling foreign fishing.

The scenario examined in the research undertaken during the Control of Foreign Fisheries research project (R.4775, MRAG 1993) was one in which a coastal state has declared a 200 nm EEZ containing a single exploitable fish stock. Provided they perceive a benefit in doing so, foreign fishing vessels will want to exploit this fish stock, and they approach the coastal state with a view to gaining access to the EEZ. They are prepared to pay a fee for that access. The coastal state wishes to maximize the net revenue it can accrue from granting access to the foreign vessels. At least initially, it is assumed that there is no alternative domestic fleet, nor any stock conservation problem associated with granting access to the foreign fishermen.

For the state, the principal potential source of revenue arises from licence fees charged to the foreign fishermen for access to the EEZ. Clearly, from this restricted point of view the larger the individual licence fee, the greater the revenue accruing to the state. However, if the licence fee is set too high, it will no longer be considered worthwhile by the foreign fishermen to try to gain access to the EEZ. Even if licence fees are set at levels such that gaining access to the EEZ is still attractive to the foreign fishermen, some vessels may opt not to pay the licence fee and rather to fish illegally inside the EEZ. To counteract this, the state must enforce the EEZ by detecting and penalising illegal fishing. However the surveillance and enforcement activity itself bears a cost, which may or may not be offset by the fines paid by illegally fishing vessels that have been detected.

Throughout this section, the benefits to either the coastal state or the foreign fishermen will be assessed in terms of net revenues. For the coastal state, the net revenues will consist of the total income from licence fees, less the cost of surveillance, plus the revenue from fines paid by foreign fishing vessels operating illegally that have been detected by the state's surveillance activities. For the foreign fishermen, the net revenue accruing from fishing within the zone is made up of the net increase in catch value attained by fishing within the EEZ as opposed to fishing elsewhere, minus the licence fee (if paid) or minus any fines if detected fishing illegally.

The first obvious conclusion from this very simple formulation is that the foreign fishermen will not seek to buy licences, nor will they have any incentive to fish illegally inside the coastal state's EEZ, unless the value of the catches that can be taken within the EEZ exceed those that could be taken elsewhere. It further follows that the incentive to fish within the zone will increase as the (perceived) value of fishing within the EEZ increases. The most obvious case in which there will be a net benefit in fishing within the EEZ is one in which the catch rates for the target species are higher within the EEZ than outside it.

Analyses carried out by MRAG (1993) showed that the choice the foreign fishermen would make regarding whether to seek a licence, fish illegally or fish elsewhere would be predicated on the values of three variables:

MR which is the marginal revenue available from fishing inside the EEZ as opposed to outside the EEZ;

L which is the licence fee charged by the coastal state for access to the EEZ; and

E(F) which is the expected fine the fishermen would face if they were caught fishing illegally within the EEZ.

In the simplest case, a risk neutral foreign fishermen will either

(i) purchase a licence and fish legally inside the EEZ if $L \leq MR$ and $L < E(F)$;

(ii) not purchase a licence and fish illegally within the EEZ if $E(F) \leq MR$ and $E(F) < L$;

(iii) not purchase a licence and fish legally outside the EEZ if $L > MR$ or $E(F) > MR$.

In the special case when $L=E(F)$ and both are less than or equal to *MR*, then the fishermen will be indifferent between fishing illegally and legally.

In MRAG (1993), all variables were effectively treated as being deterministic. For the current project, it is important to recognise that actually both *MR* and *E(F)* represent statistical expectations of random variables. Only the licence fee is fixed and certain. In some cases, mainly those where the EEZ contains the preferred habitat of the target species, it is reasonable to expect that it will always be preferable to have access to the EEZ to catch the target species, provided the licence fees are not set too high. In other circumstances this might not be the case. A typical example is one in which the EEZ lies near the migration route of a highly migratory species. In some years, the species may migrate through the EEZ, in which case it will be attractive to be able to fish within the EEZ, but in other years this may not occur. In MRAG (1993), it was assumed that the fishermen would base their decisions on their expected marginal revenues, which would take account of both the good years and the bad years.

The role of the statistical expectation is even clearer when considering the expected fine *E(F)*. This is made up of the product of two other variables:

q, the probability that an illegally fishing vessel is detected, and

F, the fine imposed by the coastal state.

While it is perfectly rational to base decisions on the expectation of the fine, it is important to recognise that there may be a considerable difference between the fishermen's perception of the probability of their being detected and the actual probability based on the real surveillance activities of the state. Furthermore, the fishermen's perception may change over time, depending on the coastal state's record in detecting illegal fishing. This distinction becomes important in later case studies.

In MRAG (1993), a simple theoretical model was assumed to relate the per vessel expenditure on surveillance (*S*) and the resulting probability of detection. This was

$$q = Q\,(1 - \exp(-KS)), \text{ where } Q \leq 1.$$

This model reflects the diminishing returns in terms of increased probability of per-vessel detection that arises as the expenditure on surveillance increases. It also allows for the possibility that it might never be possible to detect vessels with certainty, regardless of the expenditure. The model is illustrated in Figure 3.1.

As indicated above, the coastal state wishes to maximize its net revenues from foreign fishing activities. To achieve this, it has three control variables it can set:

L, the level of licence fee;

F, the fine to be imposed on illegal fishing; and

S, the a

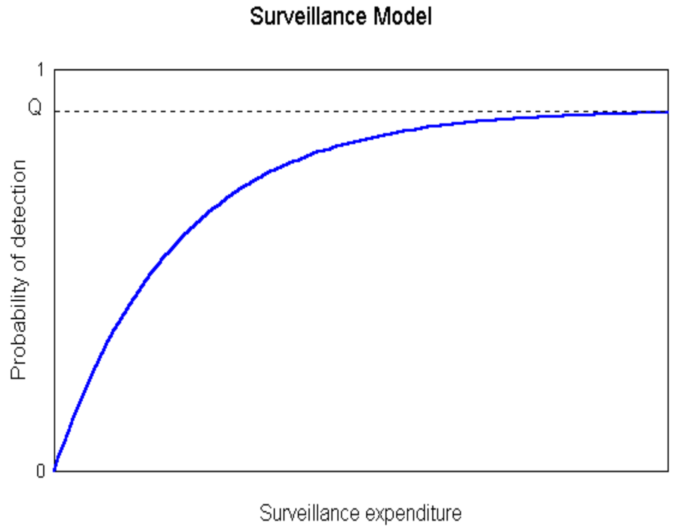

Figure 3.1 Surveillance model

If there is a single fleet of *N* foreign fishermen wishing to gain access to the EEZ, then the total net revenue accruing to the state is given by

Net revenue to state = $N L + \quad N q F - N S$.

The most basic decision rule for the state regarding the issuing of licences, in cases where the foreign fishing fleet does want to gain access to fish in the zone either legally or illegally, is

If L < E(F) then refuse to issue licences even if fishermen want them.

If L > E(F) then seek to issue licences.

If L = E(F) then do either.

It may seem somewhat perverse that the coastal state may consider not issuing licences even when the foreign fishermen want them. This option arises because it is indeed possible with some combinations of parameters that the state could gain more revenue by detecting and fining illegal fishermen than by licensing legal ones. In practice, the state may be far more comfortable with having every fishermen fishing legally, and it may even be prepared to forego some revenue to ensure this. Under such circumstances, the first inequality could be replaced by

If L < S, then issue no licences.

If S < L < E(F), then consider issuing licences.

These new conditions differentiate between two regions. In the first, the per vessel surveillance cost is greater than the licence fee, so issuing licences is unprofitable. It is almost inconceivable that the state could be in this position, unless fishermen are just not prepared to pay more for licences. In this case, the state would choose do nothing, i.e. not to issue licences and not to mount any surveillance operations. However, if the state had obligations to manage or conserve stocks it would have to accept that the fishery would run at a loss.
The second inequality describes a region where the state can afford to be more flexible. Issuing licences in this region would indeed be profitable for the state. However, the expected fine is greater than the licence fee so the state could actually make more by fining a vessel than by licensing it. This region could therefore be one within which licence fees are negotiated.

The objective of the analysis carried out in MRAG (1993) was to determine values of the three state control parameters (licence fee, fine, expenditure on surveillance) that maximize the state revenue. The next sections summarise the results of that analysis, while including a few modifications that were made to the model during the adaptive phase of the project.

3.2. Single fleet of foreign fishing vessels, risk neutral fishermen

The first principle that arises from analysis of this scenario is a powerful one, and it seems to have very wide generality.

While the licence fee enters the calculation of net revenue to the state in a very straightforward way, there is a clear interaction between the level of fine set and the amount spent on surveillance. If we consider the issue of optimal surveillance and penalty on its own, it can be shown (MRAG 1993) that if one wishes to maximize the net benefit from surveillance activities, the level of the fine for illegal fishing should be set at its maximum possible value.

A formal proof of this is given in MRAG (1993), but heuristically it is clear why this is true. The decision rules for the state and the fishermen depend on the parameter $E(F)$, which is the product of the fine F and the probability of detection, q, which itself is an increasing function of surveillance expenditure. Any given value of $E(F)$ can be attained by different pairs of values of q and F, such that $q\,F = E(F)$, but clearly the cost to the state is least when the surveillance expenditure is lowest, which can only occur when F is at its maximum.

In practice, the maximum fine is likely to be related to the value of the fishing vessel and its fishing gear, plus the value of the catch in its hold on arrest. In most cases, fishing vessels and gear have such a high value that the maximum fine is far larger than the marginal rate, i.e. $Q\ F_{max} > MR$. The following discussion will assume that this so, while the alternative case will be described later.

If the optimal value of the fine control variable is set as

$$F^* = F_{max}$$

MRAG (1993) then showed that the net revenue to the state is maximized in the limit by setting

$$L^* = MR, \text{ and } E(F)^* = MR.$$

That is, both the licence fee and the expected fine are set equal to the marginal revenue the fishermen would attain from fishing within the zone. In fact, at these parameter values the fishermen will actually be indifferent amongst their alternative decisions (buy licence, fish illegally or fish outside), so the true optimal policy would be to set L^* and $E(F)^*$ just fractionally below MR.

It is intuitively clear that this result holds in theory, but in practice if this policy were followed it would be extremely unlikely that any fishermen would seek to buy a licence. This is because the values of both MR and of $E(F)$ that would be attained in any one year can be highly uncertain, while the licence fee, L, is fixed. A rather more likely situation is one in which there is an effective maximum proportion of the marginal revenue the fishermen would be prepared to pay for a licence, say

$$L \leq a\ MR, \text{ where } a \leq 1,$$

in which case the optimal policy is

$$L^* = E(F)^* = a\ MR \qquad \text{if } Q\ F_{max} - 1/K \geq a\ MR$$
$$L^* = E(F)^* = Q\ F_{max} - 1/K \qquad \text{otherwise.}$$

The point $L = Q\ F_{max} - 1/K$ is the point at which the licence fee minus the surveillance cost per vessel is the greatest, i.e. where the state revenue is at a maximum. The optimum licence fee will thus be $a\ MR$ or $Q\ F_{max} - 1/K$, whichever is the smallest. The second option will arise only if K is quite small, which corresponds to a situation where surveillance is very ineffective. For example, this could be the case if fishermen manage to find out in advance when and where surveillance flights are to take place. If K becomes so small that $K \leq 1 / Q\ F_{max}$, then there is no profitable level of licencing at all.

The two situations described above are illustrated graphically in Figures 3.2 (a) and (b). The figures depict the state and fishermen's decisions for various combinations of licence fee and surveillance expenditure; the fine is assumed constant at its maximum value. S' is the level of surveillance required for the expected fine to be equal to MR. This is considered an upper bound for S since the fishermen will not risk more than the profit which they could make from fishing inside the zone.

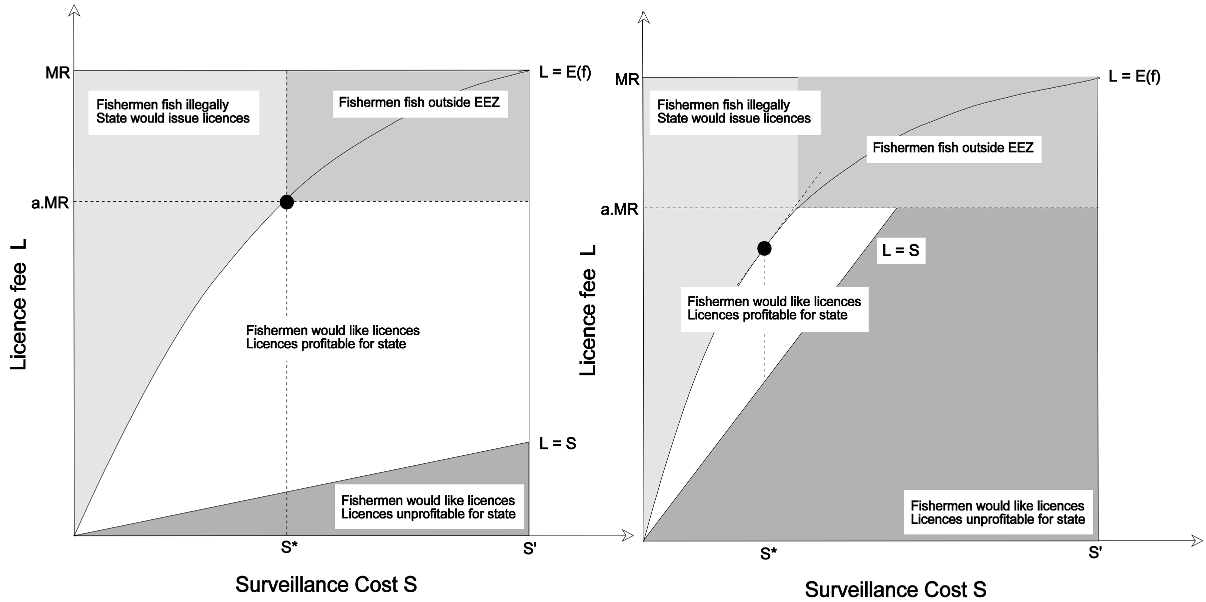

Figure 3.2 Decision rules and optima for state and fishermen

Note that the scale of the surveillance axes in the two figures is different. The L=S line always has a gradient of 1, but because K is smaller in Figure 3.2(b) it takes much more surveillance expenditure for the L=E(f) line to reach MR. If the figures were drawn to the same scale, Figure 3.2(b) would have to be far wider than it is.

Graphs such as these are useful to a fishery manager in that they portray the decision space in a manner that is easy to interpret. The white area in the figures represents a region of potential negotiation. Here, the fishermen are prepared to buy licences, although they would like the fees to be as low as possible, so they will try to negotiate to a point near the bottom of the region. The state is prepared to issue licences even though it could make more from fines, but the most profitable points are at the top of the region. The graphs assist the state by clarifying the extent of this region, e.g. for a given level of surveillance, one can read off the range of licence fees within which both parties requirements could be accommodated. This could be useful during subsequent negotiations.

The optimal point for the state in each of the two figures is marked with a black dot. In figure (a) the optimum licence fee is set at the maximum that fishermen are prepared to pay. The surveillance expenditure is then the minimum necessary to deter illegal fishing, given that fee. In case (b), where surveillance is inefficient, this licence fee would require a level of surveillance that is so expensive that the state's profits would be lower than could be otherwise obtained. Here, the optimum licence fee is lower than in (a), while the corresponding cost of surveillance is higher. Also, you can see that the height of the region of negotiation is considerably smaller. This means that the state's scope for negotiation on licence fees has been reduced.

If the actual optimal points were used, then in case (a) the fishermen would theoretically have no clear preference between fishing legally, illegally or outside the EEZ. In case (b) they would wish to fish within the EEZ, but would be indifferent between fishing legally or illegally. It is tempting to assume that when fishermen are, in principle, indifferent between fishing legally or illegally, they would actually opt to fish legally. There may well be some incentive to act lawfully when there is no benefit in acting unlawfully, but as already noted the licence fee is a certain cost to the fishermen, but it is by no means certain that the expected marginal revenue or the expected risk of detection when fishing illegally would actually be realised in any one year. Under these circumstances, it is quite likely that the fishermen may show risk prone behaviour. This is the subject of the next section.

3.3. Single fleet of foreign fishing vessels, risk prone fishermen

In the first case studied, it was assumed that there would be some threshold level $L = a\ MR$, with $a<1$, which would constitute the maximum licence fee fishermen would be prepared to pay to fish in the zone. Due to the uncertainty about whether they may or may not be detected when fishing illegally, or because their perceptions of the risk of capture might be optimistic, assume now that they are prepared to fish illegally when the expected fine $E(F) \leq b\ L$, where $b \geq 1$. This means that they are prepared to risk a fine greater than the current licence fee. For risk averse fishermen, $b \leq 1$, since they will not risk even as much as the licence fee. Risk averse fishermen are not considered in this analysis.

The above definition for risk aversion and risk proneness differs from that of MRAG(1993). The earlier work was primarily concerned with identifying optima rather than regions of potential negotiation. It was felt that the current model gives a better representation of risk proneness and aversion in such regions.

For ease of notation we define $c = 1/b$. The parameters a and c bring an asymmetry into the decision-making process and the modified set of decision rules for the fishermen is now:

If $L \leq a\ MR$ and $L < c\ E(F)$ then fish inside the EEZ with a licence

If $L > c\ E(F)$ and $c\ E(F) < a\ MR$ then fish illegally inside the EEZ

If $L > a\ MR$ and $c\ E(F) > a\ MR$ then fish legally outside the zone

The decision rules for the state remain as before.

The optimal point differs for the two cases $c > a$ and $c < a$:

Optimal licence fee:	$L^* = a\ MR$	if $c > a$
	$L^* = c\ MR$	if $c < a$
Optimal fine level:	$F^* = F_{max}$	
Optimal surveillance cost:	$S^* = -1/K\ ln(1- a\ MR / c\ QF_{max})$	if $c > a$
	$S^* = -1/K\ ln(1- MR / QF_{max})$	if $c < a$
Optimal detection probability:	$q^* = a\ MR / c\ F_{max}$	if $c > a$
	$q^* = MR / F_{max}$	if $c < a$

The combined rules for the fishermen and the state are depicted graphically in Figures 3.3 (a) and (b) for the cases $c > a$ and $c < a$ respectively. Remember that c is an indicator of risk proneness; the smaller c is, the more risk prone the fishermen.

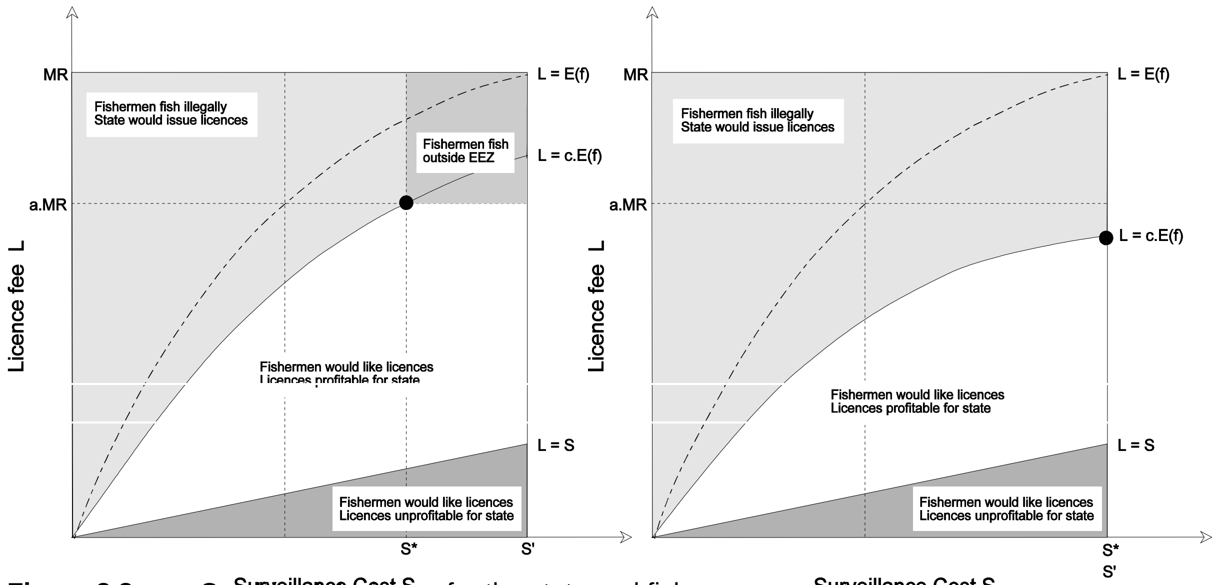

Figure 3.3 Combined decisions for the state and fishermen.

Notice that the original region of negotiation has become smaller. In the risk neutral case the upper boundary of the region used to lie along the line *L=E(f)*, but here it becomes lower as *c* decreases. The more risk prone the fishermen are, the smaller the area of negotiation will be. Points which were in the interior of the risk neutral region now become optimal in the risk prone case, and the state has to settle for points close to the new upper boundary.

Figure 3.3(a) is similar to Figure 3.2(a) in that the optimum licence fee is the maximum that fishermen are prepared to pay. The surveillance expenditure needed to enforce the optimum fee is higher than in the risk neutral case, and the more risk prone the fishermen are, the greater the level of surveillance required. With increasing risk proneness, the stage is eventually reached where the level of surveillance is so high that the expected fine is greater that the potential profit from fishing inside the zone. Any further increase in surveillance merely forces the fishermen outside the EEZ. This point is therefore the optimum, and it corresponds to a lower licence fee than the maximum fishermen would otherwise have been prepared to pay for licences.

4. CFF practical exercises

One of the main aims of the workshop was to provide an overview of the CFF model and to undertake a series of practical sessions using a spreadsheet model game to develop hypothetical MCS strategies. A copy of the CFF software has been included on CD-Rom attached to the back of this document. Course material was developed and written for workshop participants within two practical sessions.

Practical session 1

This session was developed to build on the theory already presented on the decision rules and optimal control parameters for the Control of Foreign Fishing model (see section 3 above). A series of numerical examples were provided (see Appendix F) using a Microsoft Excel spreadsheet model (Figure 4.1; Practical_1.xls). The selected examples looked specifically at changing catch rates inside the EEZ (total net benefit to the fishers), the maximum fine imposed, the surveillance efficiency, and licence fees.

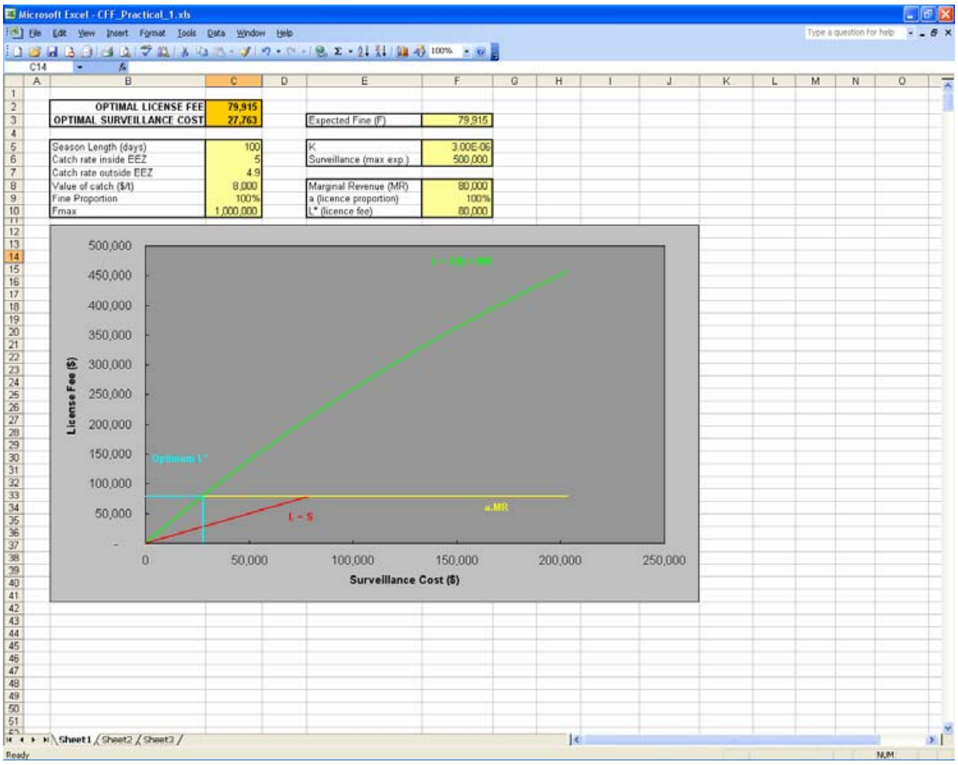

Figure 4.1 Illustration of basic CFF spreadsheet model, showing graphical representation of changing different parameters values.

These simple calculations consider the case of a single fishing vessel. The results, presented in Appendix G, were then discussed before moving on to the second practical session. The results of this exercise are discussed in section 5 below.

Practical session 2

This second practical session was developed to build on the theory and experience of practical 1: Numerical examples of CFF model. Participants were divided into two or more teams each representing a hypothetical coastal state with an interest in licensing foreign fishing. The model was used to analyse the potential outcome from a number of alternative foreign fishing scenarios (see Appendices H and I for further details) using the Excel spreadsheet model game (Practical_2.xls). Unlike practical 1, these exercises consider a single fleet with multiple vessels. The following figures illustrate different screen-shots taken from the CFF spreadsheet model game.

Figure 4.2 Screen shot of start-up screen of CFF spreadsheet model game.

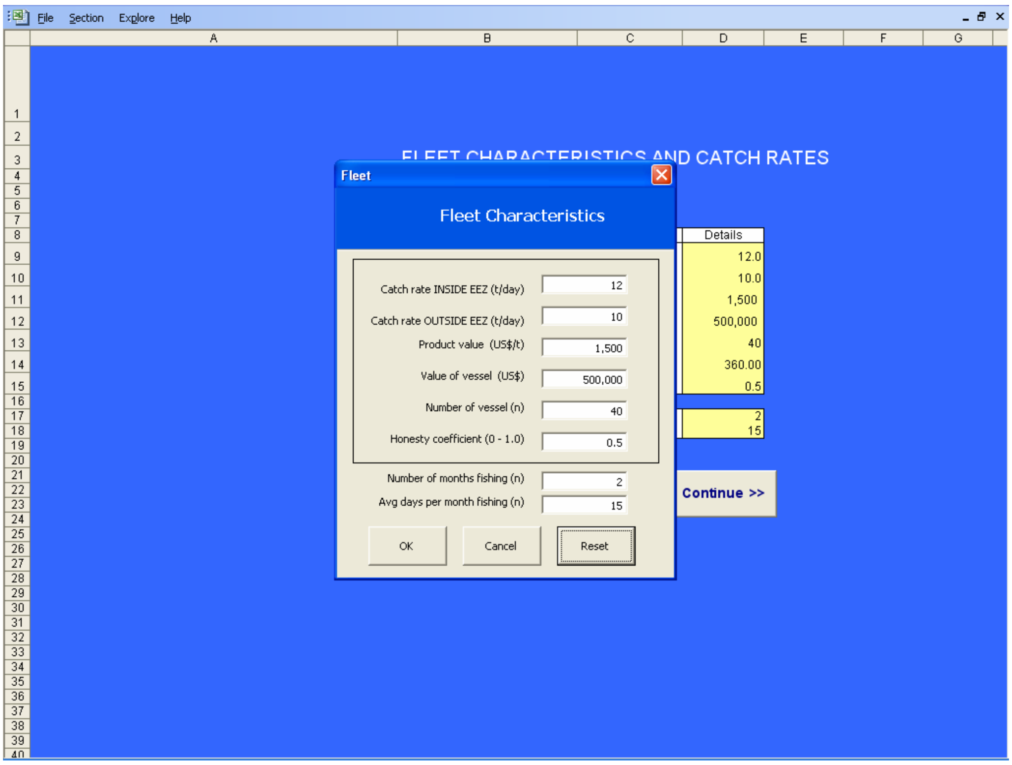

Figure 4.3 Screen shot of CFF spreadsheet model game with details of fleet characteristics.

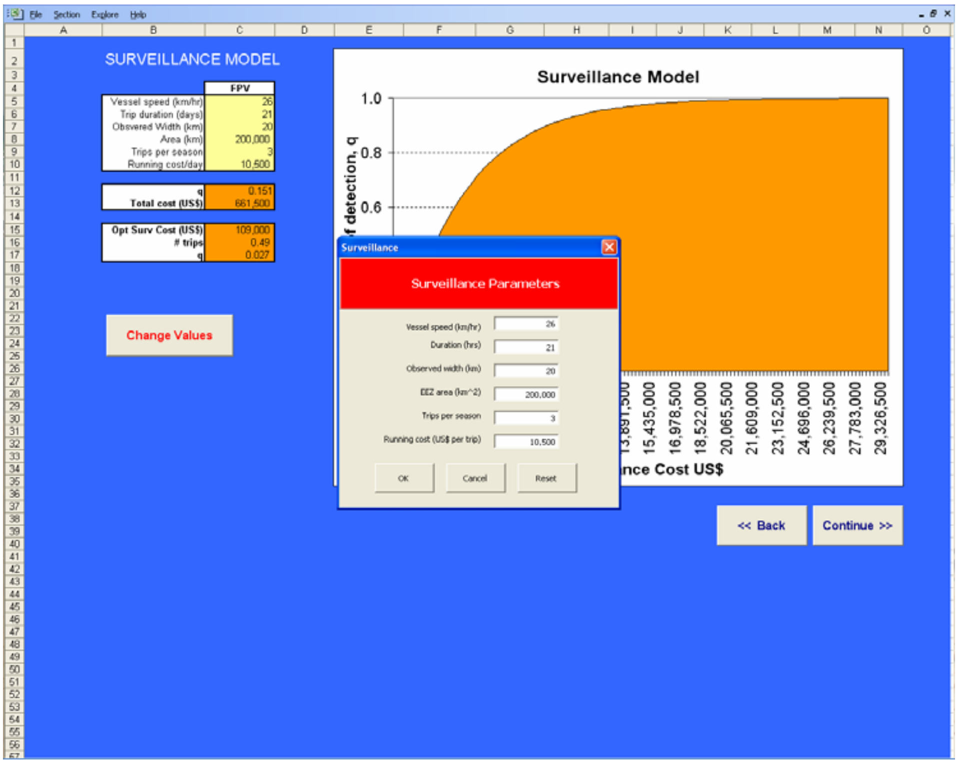

Figure 4.4 Screen shot of CFF spreadsheet model game with details of surveillance characteristics.

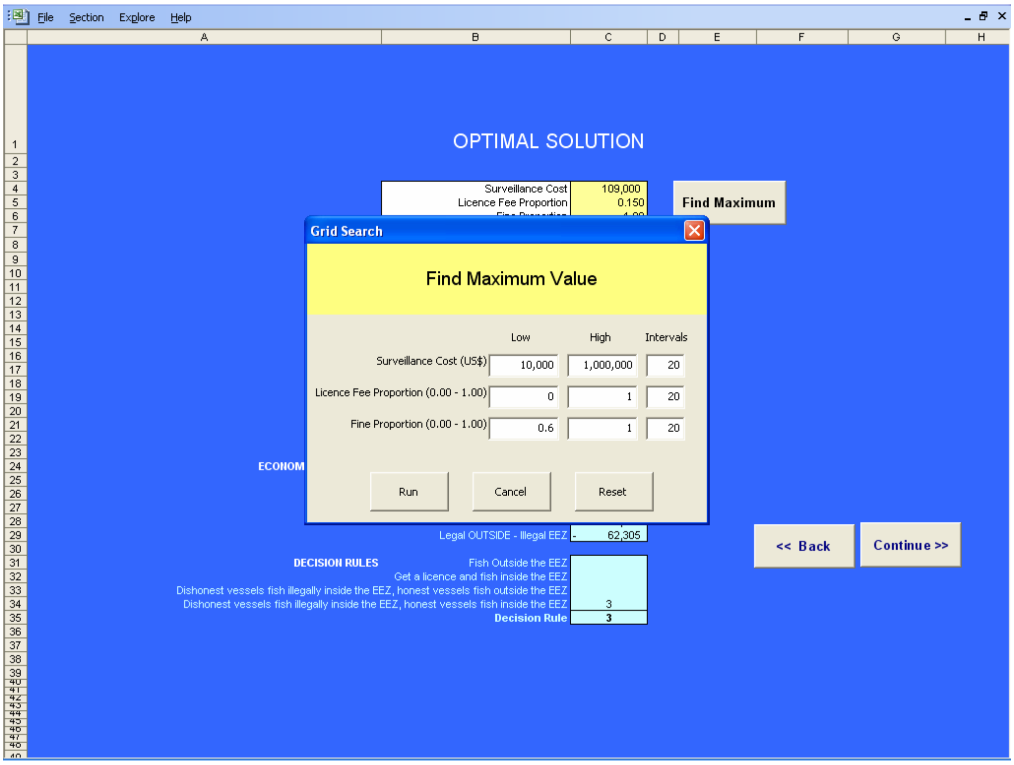

Figure 4.5 Screen shot of CFF spreadsheet model game with details of optimisation routine.

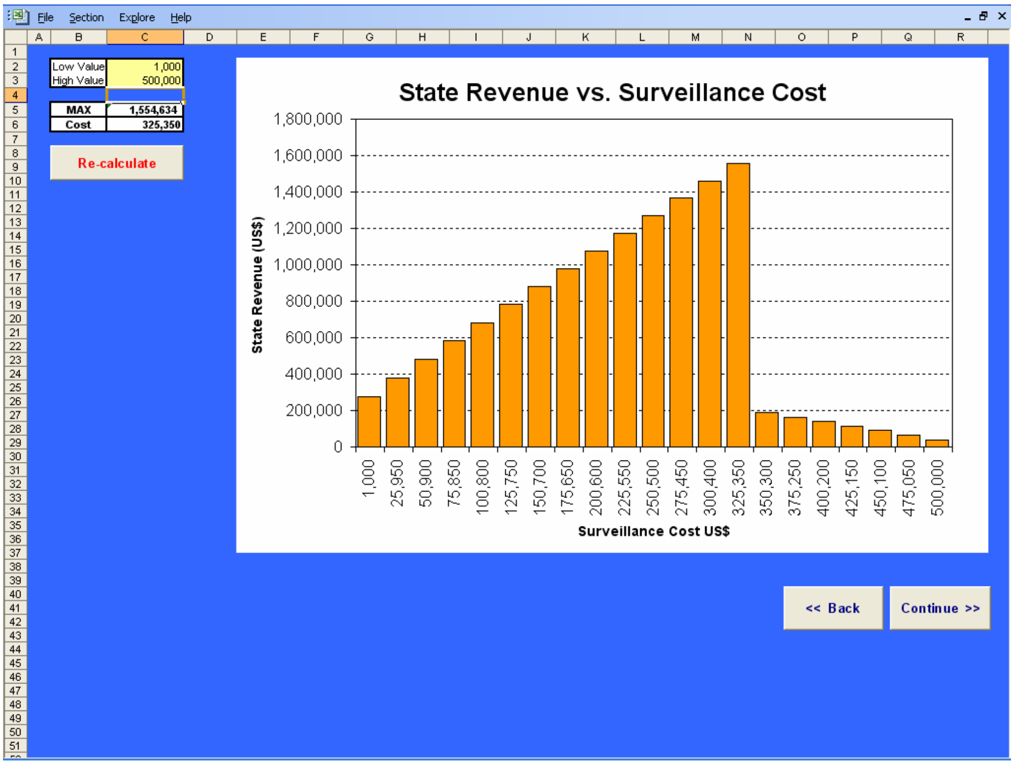

Figure 4.6 Screen shot of CFF spreadsheet model game showing sensitivity of changing Surveillance costs with Total State Revenue.

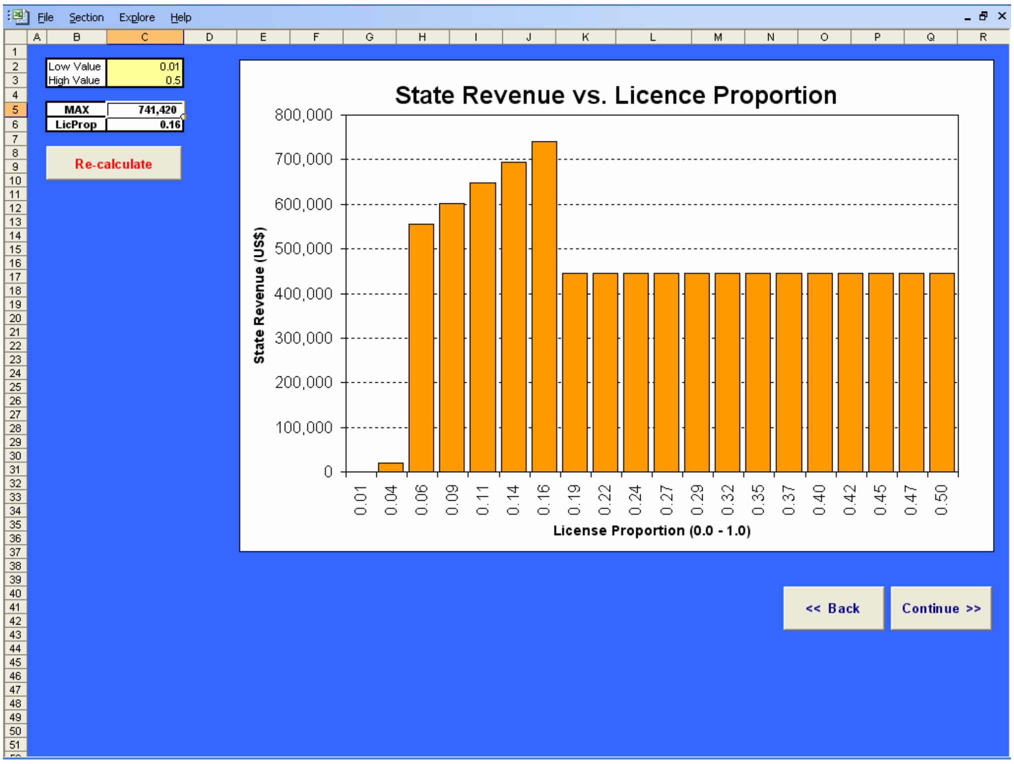

Figure 4.7 Screen shot of CFF spreadsheet model game showing sensitivity of changing Licence Fee Proportion with Total State Revenue.

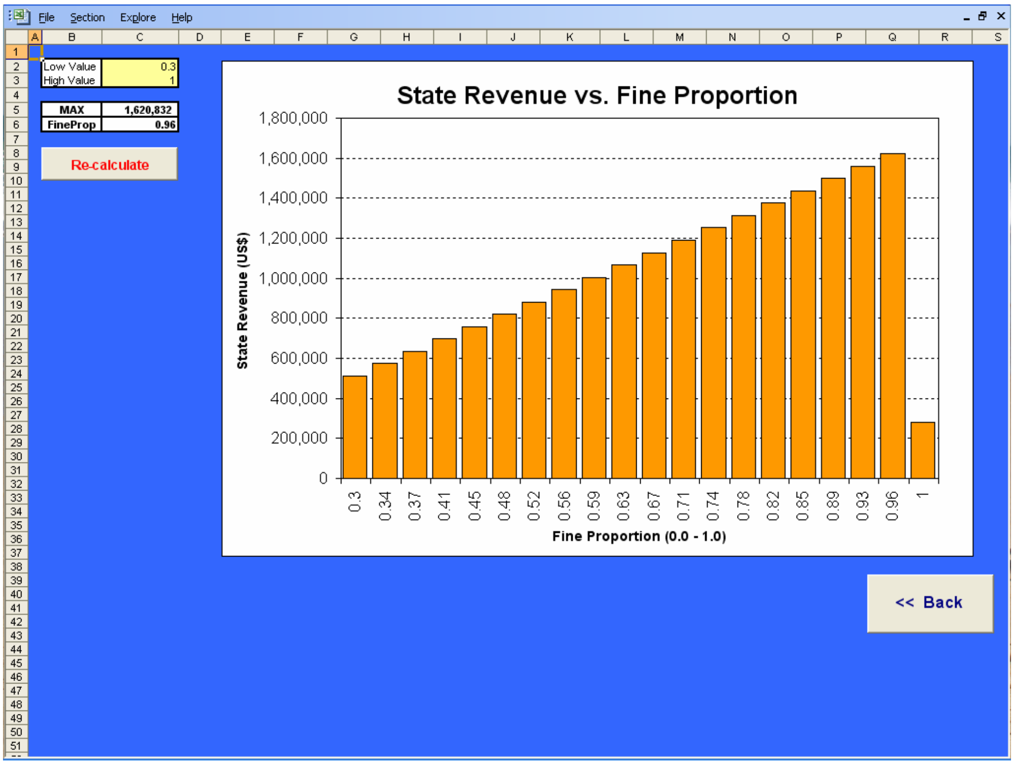

Figure 4.8 Screen shot of CFF spreadsheet model game showing sensitivity of changing Fine Proportion with Total State Revenue.

5. Discussion of practical exercises & lessons learned

The results of both CFF practical exercises (section 4 above) are helpful to raise a number of general issues to consider when looking at the control of foreign fisheries. These range for example, from changes in catch rates inside the EEZ to changes in the surveillance efficiency. These are discussed in more detail below and include some discussion on the current limitations and assumptions of the model. In addition to these, a number of general lessons learned have been extracted from previous case studies to support the findings of the practical exercises (section 5.6).

5.1 Changes to catch rates inside EEZ

The results of the model indicate that as the advantage of fishing inside the zone increases, both the optimal amount a fisher would be prepared to pay for a licence fee and the number of fishers wanting access increases. Furthermore, with the value of the total catch inside the zone varying according to the catch rate, the proportion of the optimal licence fee to the annual total catch value increases. Estimated licence fees greater than 10% of catch value are extremely rare in tuna fisheries. However, was noted that, in principal, the licence fee should be set as a proportion of the marginal revenue accruing to the fisher rather than as a proportion of the total catch value. In other words, the licence fee should be based on the net economic benefit from fishing inside, rather than outside the EEZ.

Within the model, increasing the catch rate inside the EEZ attracted an increase in the level of illegal fishing. However, it was noted that increasing the catch value also increased the maximum fine imposed (i.e. sum of vessel cost and vessel catch value). This increase in the level of fine results in higher fine revenue which leads to a higher State Revenue to spend on surveillance, and hence increase the probability of detection. As a direct result, the level of illegal fishing has been controlled.

It should be noted that under certain circumstances when the difference between catch rates inside and outside the zone are very small, the optimal total licence fee revenue can be less than the total optimal surveillance cost. If no additional revenue was generated that year from successful prosecutions, the Coastal State would have made an overall loss. Specific changes to the maximum fine are discussed below.

5.2 Changes to the maximum fine

In the model, changes to the maximum fine imposed have a direct impact on the amount of surveillance required to deter illegal fishing. If the maximum fine, equivalent of the sum of the cost of a new vessel, replacement of gear and catch value, is reduced then the probability of detection and hence surveillance cost needed to enforce existing regulations, increases.

If the total surveillance expenditure were to greatly exceed the total licence fee revenue to the state, this situation would be intolerable without additional economic benefits derived from the sector. However, the state cannot just reduce expenditure on surveillance, because if it did so, the fishers would find it more attractive to fish illegally in the EEZ and refuse to buy a licence. This exercise supports the thinking that the level of fine should be set as high as possible.

5.3 Changes to the surveillance efficiency

In the model, increasing the cost-efficiency of surveillance (i.e. parameter value, K) substantially reduces the cost as a proportion of the total licence fee revenue. However, caution should be given where the optimal surveillance cost approaches the total licence fee revenue at low values of maximum fine.

The possible response by the coastal state of retaining the licence fee at its current level but only spending what can be afforded on surveillance was dismissed above, because it will only lead to illegal fishing and no licence revenue. Another alternative might be to reduce the licence fee itself. This was considered next.
In the workshop, an example of increasing the cost-efficiency of surveillance was by reducing the vessel daily running costs. This had the immediate affect of substantially reducing the optimal surveillance cost as a proportion of the maximum state revenue. One approach to increase the cost-efficiency of surveillance might be to look at regional cooperation of surveillance platforms and data

exchange of key information, such that overall costs can be reduced and the benefits are clearly demonstrated here.

5.4 Changes to the licence fee

The last exercise during the workshop looked at the possible outcomes of reducing a vessel licence fee when the maximum the state is prepared to spend on surveillance remains fixed.

In the model, the effect of reducing an individual vessel licence fee (single vessel model only) was similar to reducing the maximum fine imposed such that the probability of detection and hence surveillance cost needed to enforce existing regulations, increases.

If the maximum fine, equivalent of the sum of the cost of a new vessel, replacement of gear and catch value, is reduced then the probability of detection and hence surveillance cost needed to enforce existing regulations, increases.

The analysis showed that there is an overall improvement in the results by reducing the licence fee rather than maximum fine, but not very much. This exercise shows that there is a trade off between reduced licence fees with reduced surveillance expenditure, but this becomes impossible when the maximum fine is set too low.

5.5 Model assumptions

It has to be emphasised that these numerical examples are not based on “real” fishery parameter values, so little should be read into the individual values. However, it is clear that this strong interaction between surveillance costs, maximum fine levels and licence fees will carry over to real fisheries. In particular, if the maximum fine is set too low, it may prove almost impossible to effectively deter illegal fishing.

During the workshop it was stressed that the model has a number of important assumptions. These will briefly be discussed here.

The model assumes that foreign fishing vessels only want to buy a licence when catch rates inside the EEZ are higher than those outside the zone. In most situations this assumption will probably hold true, but there are examples where foreign vessels have purchased licences, even when catch rates are lower inside the zone. The Seychelles is such an example. Clearly there are other benefits than fishing inside the zone. Within Seychelles, it appears that vessels want to have the opportunity to fish whilst entering and leaving the EEZ whilst transhipping in the port of Victoria. Since the EEZ is comparatively large and incorporates the migratory route of tuna, it might prove beneficial to fish whilst transiting the zone.

The total revenue from foreign fishing to the state is calculated based on the sum of the total licence fee revenue and total fine revenue obtained from catching illegal fishers. Clearly, other sources of revenue can also be extracted from foreign fleets entering the zone, such as transhipment fees and other goods and services within the port, for example. In addition, obtaining the total fine revenue also assumes a series of important steps, made implicit within the model. These include:

- The illegal vessel must be detected
- It must be closed upon by the surveillance platform
- Evidence of illegal fishing must be collected
- The vessel must be detained
- A successful prosecution must be made under the relevant legislation
- Finally the fine or penalty must be collected

The model also uses a function that relates the surveillance cost to a probability of detection. It has been noted that substantial start-up cost might be incurred before any surveillance operations are undertaken, thus setting a minimum cost with zero detection. However, it might not always be economically viable to purchase and maintain a surveillance platform. Instead, vessel charters can be used to eliminate high start up costs. Multiple surveillance platforms (FPV and aerial) can also be used to increase the cost efficiency of operations.

5.6 Synthesis of lessons learned from case studies

A review of previous CFF case studies has been undertaken to identify a range of common lessons learned when using the CFF model. The principal conclusion from three previous case studies (Seychelles, BIOT and South Georgia) is that it is possible to use the methodology developed within the Control of Foreign Fishing research project to develop practical advice on the management of foreign fishing. The methodology has now been extended to include two additional coastal states within East Africa (Kenya and Tanzania).

To apply the methodology, it is necessary to carry out two types of analysis. The first relates to the calculation of catch and effort both inside and outside the coastal state's EEZ in order to determine the potential benefits to foreign fishers of fishing within the EEZ. The second requires the estimation of the probabilities of detection and successful prosecution of unlicensed foreign fishing vessels arising from different surveillance operations. For both analyses, it is important to tailor the analysis to the particular fisheries and surveillance characteristics of the region or country. This was relatively straightforward for both BIOT and South Georgia case studies, since only a single fishery, fishing fleet and state were involved. Within the Seychelles, the situation became more complicated with a number of fleets taking different species at different times of the year, thus requiring a more complex analysis of the catch and effort data. The previous case studies have led to a number of general lessons learned so far:

- **Each case study emphasized the importance of imposing large fines for illegal fishing activities.** In each case study, the funds available to the coastal state to pay for surveillance activities were very limited. If there were significant potential benefits for foreign fishing within the state's EEZ, then it is reasonable for the coastal state to set relatively high licence fees. This is only possible, however, provided the expected fine faced by the fishers for fishing illegally considerably exceeds the license fee. If the amount of surveillance that can be afforded is strictly limited, this can only be assured by imposing very high fines.

- **Where the deterrence of illegal fishing is the primary management issue, affordable surveillance becomes much more important.** The key to achieving this was also to set very high fines. However, it is important not to treat the revenue from fines as a positive benefit. The reason to restrict the number of licenses is to limit the catch and to help conserve the long term sustainability of the stock. By basing revenue expectations on the opportunity to impose fines without addressing the central problem of illegal vessels catching too many fish, the stock comes under increased pressure and risk from overfishing. The management aim should therefore be to strongly deter any unlicensed fishing. Only if this is successful, thereby effectively eliminating revenues from fines, will there be a long term sustainable fishery from which licence revenue can be generated sustainably.

- **The perceived and actual risks of detection can be very different.** A case study showed that even though the actual level of surveillance was constant over a 3 year period, it was only following a near record fine imposed on one vessel caught fishing illegally that license applications increased markedly in the third year. Clearly this arose because the perceived risk of being detected and fined rose to a level at which the expected fine exceeded the cost of obtaining a licence, even though the actual risk had not changed at all.

- **Following a high profile surveillance operation, it is important that the perceived increase in risk is maintained.** This can be achieved, for example, by increasing the number of patrols throughout the year as to elevate the probability of detection. A degree of targeting can be used to increase the chance of detection during surveillance patrols by making use of reports from other sources that illegal fishing activities are occurring.

- **Licence fees should be calculated as a proportion of the marginal benefit arising from fishing inside the EEZ, rather than as a proportion of the catch taken inside the zone.** This is because the value to the fishers of obtaining a license arises from the difference between the catches that can be taken inside and those taken outside, rather than just the amount of catch taken from the zone. Results from the case studies showed that strong inter-annual variability could occur from the expected benefits of fishing inside the zone. In calculating appropriate levels of license fee, average estimated benefits were mainly used, but this meant that in some years the cost of a license was greater than the expected benefits. If this were to occur several years in a row, foreign fishers may become reluctant to renew their licences. Under these circumstances, it might be necessary to develop innovative solutions to the problem.

- **Additional benefits can be generated from alternative sources of revenue.** The results of the model currently assume only two sources of revenue; from the sale of licence fees and fines generated from successfully prosecuting illegal vessels. There are however, a number of other benefits that can be generated from foreign fishing activities such as transhipment fees and port facilities offering goods and services, for example.

- **Estimates need to be made of the probabilities of detection and successful arrest** of unlicensed fishing vessels arising from different levels of surveillance activities

- **Licence fees of 10% of the catch value are rare in tuna fisheries.**

- **Increasing the cost-efficiency of surveillance can substantially reduce the cost of surveillance as a proportion of the licence fee**. However, when the maximum fine is reduced, the cost of a licence can approach the cost of surveillance.

- **Reducing the maximum fine if the cost of surveillance is kept constant, means the probability of detection (efficiency) must increase to ensure the same level of surveillance.**

- **Although high values of Maximum State Revenue can be obtained from Fine Revenue alone, this could lead to unpredictable and unsustainable levels of revenue and put the status of the resource as risk of over-exploitation.**

6. References

MRAG (1993). *Control of Foreign Fisheries*. The construction of a model to optimise benefits to coastal state developing countries from the control of foreign fishing. Final Technical Report. Fisheries Management Science Programme, UK Department for International Development, London. 89pp.

MRAG (1995). *Control of Foreign Fisheries. Adaptive Research*. Final Technical Report. Fisheries Management Science Programme, UK Department for International Development, London. 125pp.

Appendix A: Outline of Agenda

Monday 14th November

08:30	Registration
09:00	Welcome address
09:15	Introduction & Background to CFF
09:30	National Perspectives
	- Seychelles
	- Mozambique
10:00	Outline of CFF model
10:45	**Coffee Break (set up laptops etc)**
11:15	Practical Session 1: Numerical examples of CFF
12:45	Discussion
13:00	**Buffet lunch**
14:00	Regional perspectives
	- SADC MCS Programme
14:30	Practical Session 2: CFF model demonstration
15:30	**Coffee Break**
16:00	Practical Session 2 (cont'd)
16:45	Discussion
17:00	End of day 1

Tuesday 15th November

08:30	Meet at reception, Hotel White Sands
09:00	Depart for field visit: MCS Operations Centre, Mbegani
10:00	Guided tour of Operations Centre
12:30	**Lunch (Bagamoyo)**
14:00	Depart for Hotel White Sands
15:00	Lessons learned from CFF exercises
15:30	**Coffee Break**
16:00	Discussion & Workshop Summary: National & Regional CFF Priorities
17:00	End of Workshop

Appendix B: List of Participants

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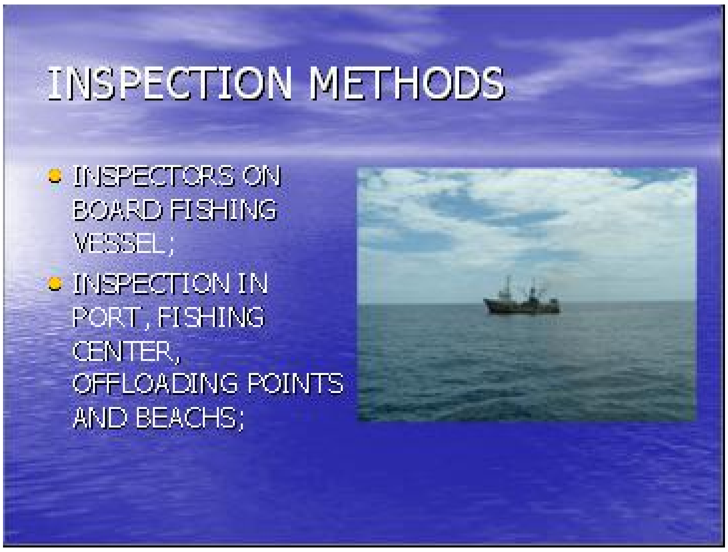
Appendix C: National perspectives: Mozambique (by Noa Senete and Manuel Castiano)


THE 80'S :
THE FIRST GROUP OF FISHERIES INSPECTORS WAS CREATED

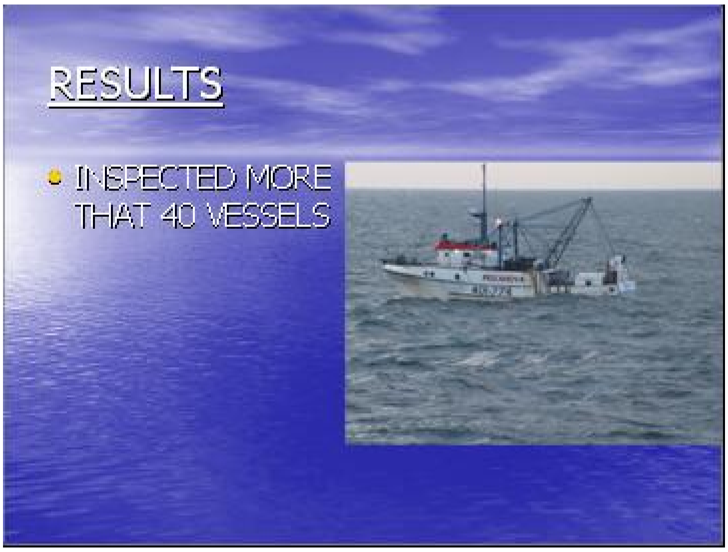

INSPECTION METHODS
INSPECTORS ON BOARD FISHING VESSEL;
INSPECTION IN PORT, FISHING CENTER, OFFLOADING POINTS AND BEACHS;

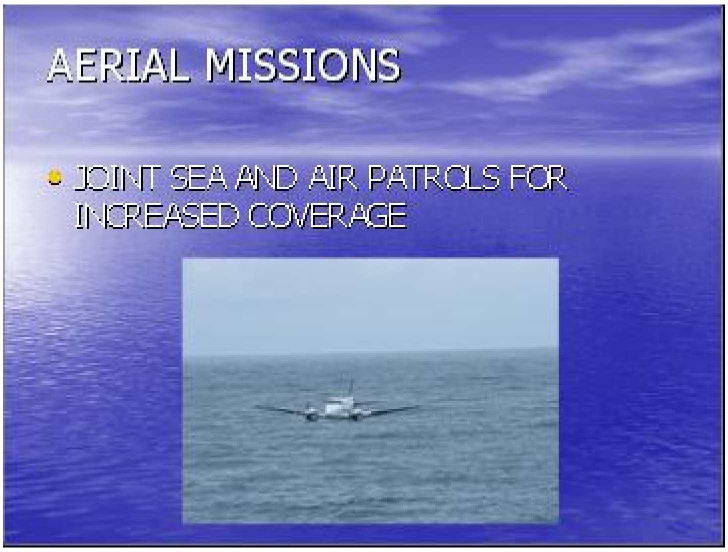

CURRENT SITUATION
FISHERIES ADMINISTRATION DIRECTORATE RESPONSABLE FOR FISHERIES SURVEILLANCE (60 INSPECTORS)
OTHER ENTITIES:
MOZAMBIQUE NAVY;
MARITIME POLICE.


INSPECTIONS
IN 2004/2005 – MADE 11 MISSIONS INCLUDING (BILATERAL AND TRILATERAL) MARITIME AND AERIAL


MEANS USED
SOUTH AFRICAN PATROL VESSEL "EAGLE STAR"


RESULTES
ARRESTED TWO FOREIGN VESSELS ENGAGED IN ILLEGAL FISHING;

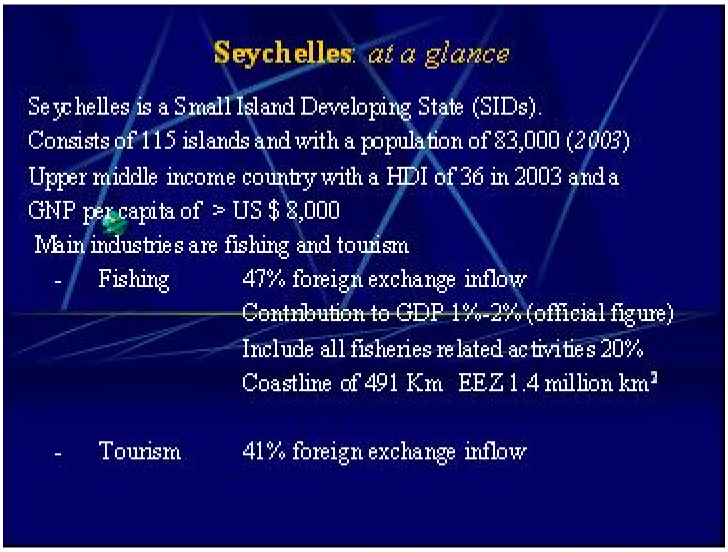

RESULTS
INSPECTED MORE THAT 40 VESSELS

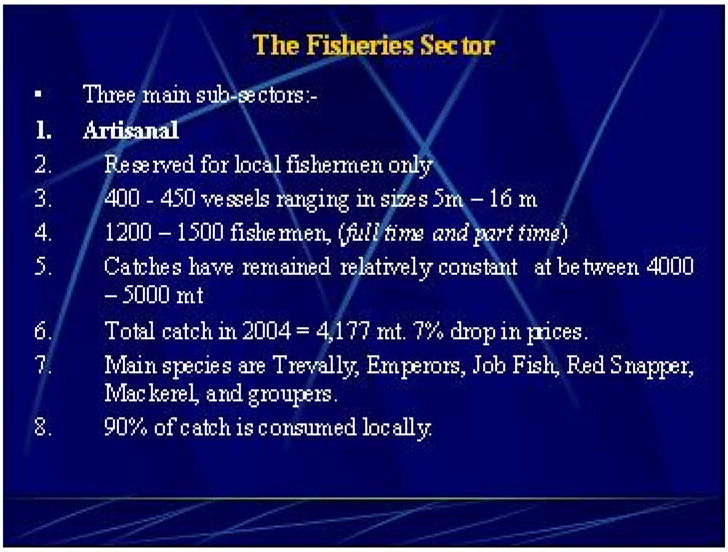

AERIAL MISSIONS
JOINT SEA AND AIR PATROLS FOR INCREASED COVERAGE


OTHERS TOOLS
IMPLEMENTATION OF VMS;
INSTALED 72 BLUE BOX

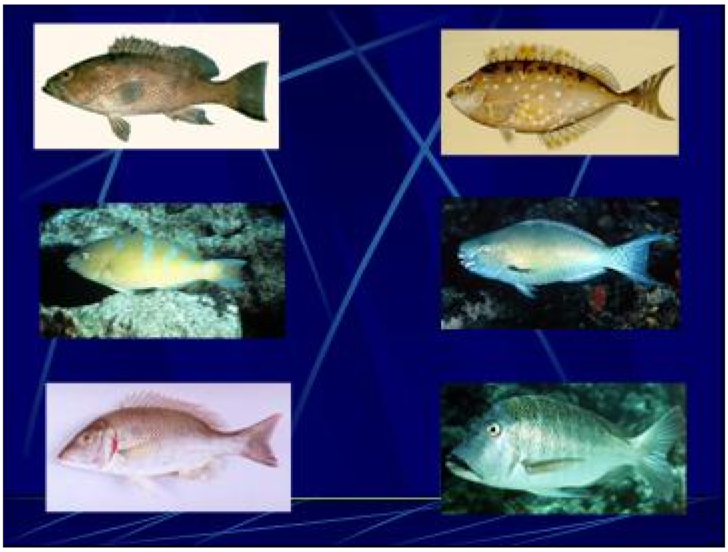

MUITO OBRIGADO

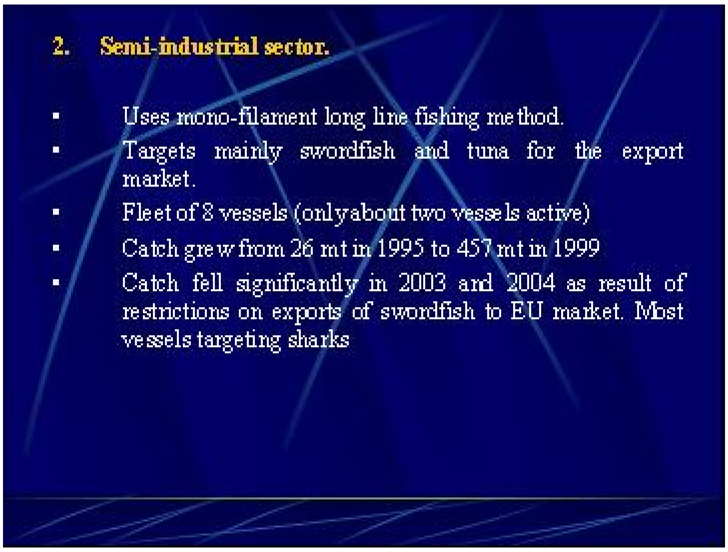
Appendix D: National perspectives: Seychelles (by Michel Marguerite)

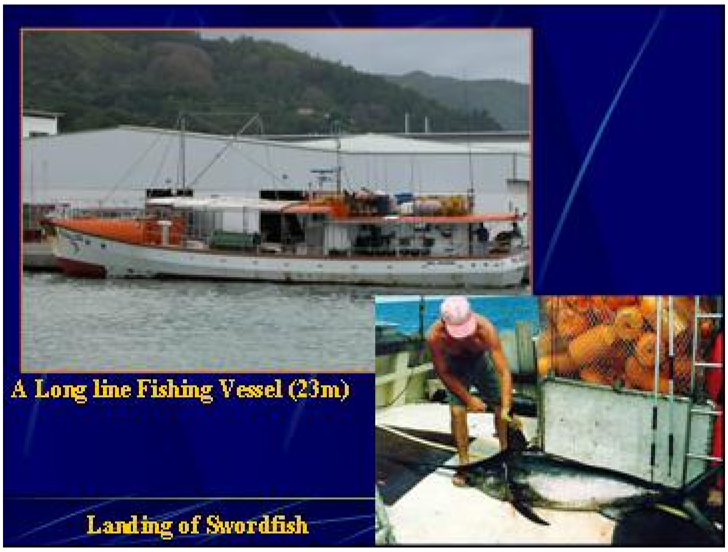


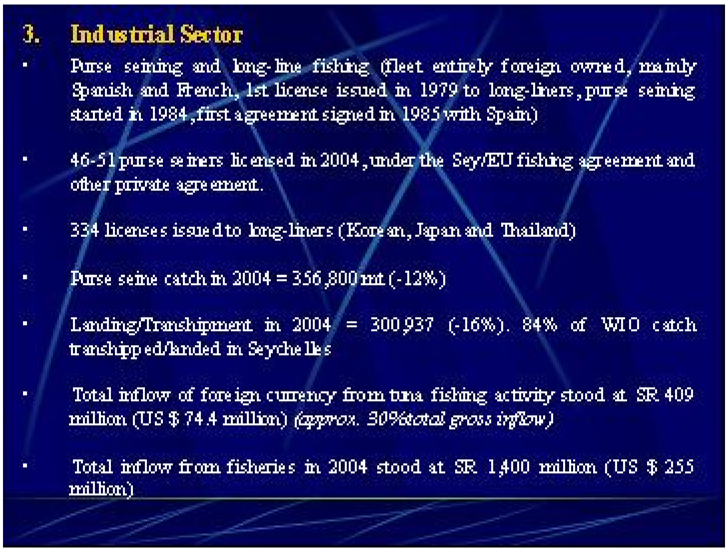

The Fisheries Sector
▪ Three main sub-sectors:-
1. Artisanal
2. Reserved for local fishermen only
3. 400 - 450 vessels ranging in sizes 5m – 16 m
4. 1200 – 1500 fishermen, (full time and part time)
5. Catches have remained relatively constant at between 4000 – 5000 mt
6. Total catch in 2004 = 4,177 mt. 7% drop in prices.
7. Main species are Trevally, Emperors, Job Fish, Red Snapper, Mackerel, and groupers.
8. 90% of catch is consumed locally.


Pic 2. A Super Sea Dog
Pic 4. A Whaler
Pic 5. A Lavenir
Pic 6. Schooners




2. Semi-industrial sector.
▪ Uses mono-filament long line fishing method.
▪ Targets mainly swordfish and tuna for the export market.
▪ Fleet of 8 vessels (only about two vessels active)
▪ Catch grew from 26 mt in 1995 to 457 mt in 1999
▪ Catch fell significantly in 2003 and 2004 as result of restrictions on exports of swordfish to EU market. Most vessels targeting sharks


A Long line Fishing Vessel (23m)
Landing of Swordfish

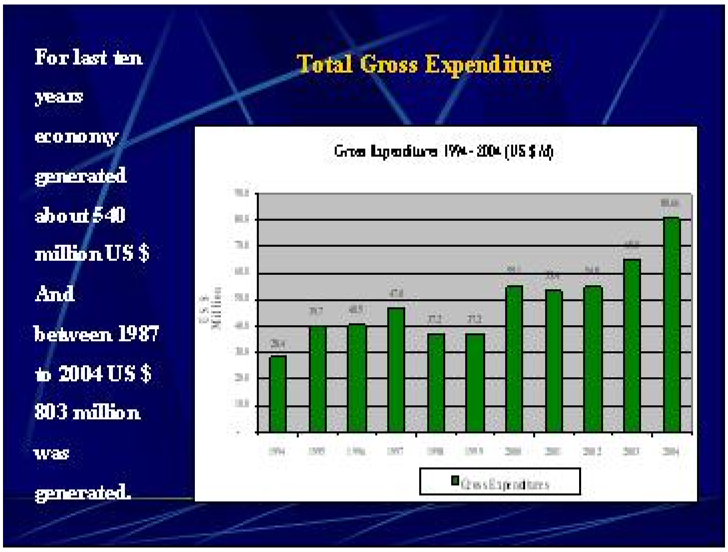

3. Industrial Sector
• Purse seining and long-line fishing (fleet entirely foreign owned, mainly Spanish and French, 1st license issued in 1979 to long-liners, purse seining started in 1984, first agreement signed in 1985 with Spain)
• 46-51 purse seiners licensed in 2004, under the Sey/EU fishing agreement and other private agreement.
• 334 licenses issued to long-liners (Korean, Japan and Thailand)
• Purse seine catch in 2004 = 356,800 mt (-12%)
• Landing/Transhipment in 2004 = 300,937 (-16%). 84% of WIO catch transhipped/landed in Seychelles
• Total inflow of foreign currency from tuna fishing activity stood at SR 409 million (US $ 74.4 million) *(approx. 30% total gross inflow)*
• Total inflow from fisheries in 2004 stood at SR 1,400 million (US $ 255 million)

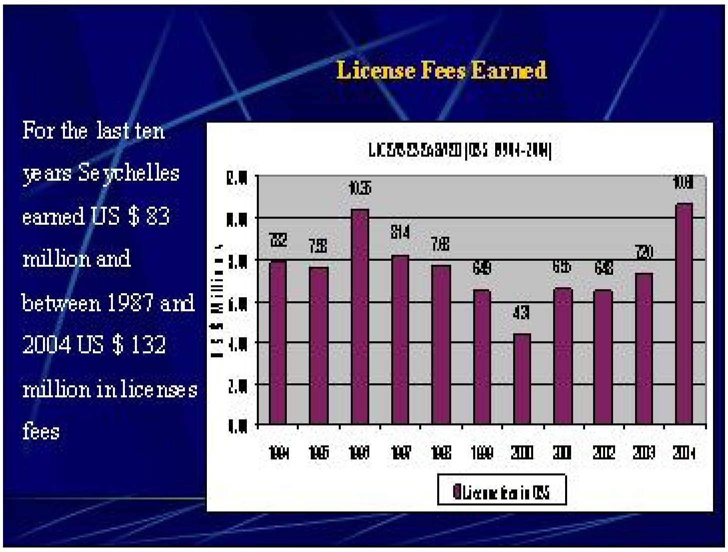
- Revenue from Industrial Tuna Fishing Activity (SRM)

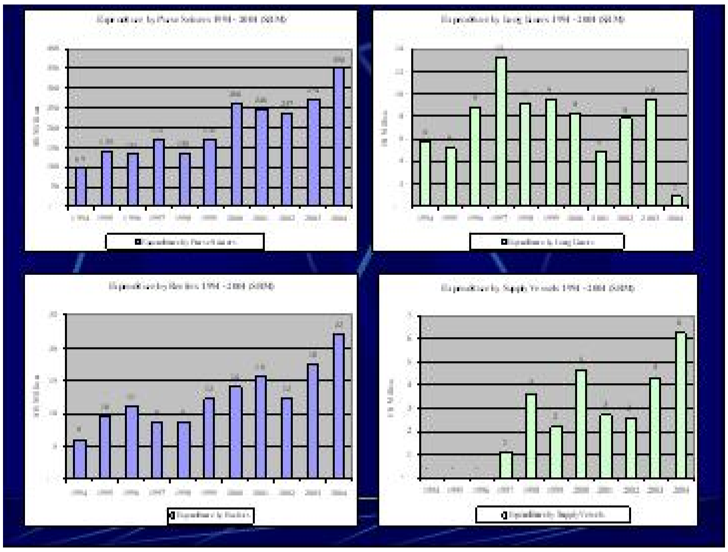
	2003	2004	% Change
Vessel's Expenditure	305.345	344.455	12.81
Company's Spending	6.681	6.145	- 8.02
License Fees	38.866	58.400	50.25
Total	350.892	409.000	16.56

- Net inflow US $ 32.8 million
- In 2004 Seychelles registered 12 purse seiners and 32 long liners.
- Seychelles registered purse seiners caught a total of 82,600 mt of tuna in 2004.

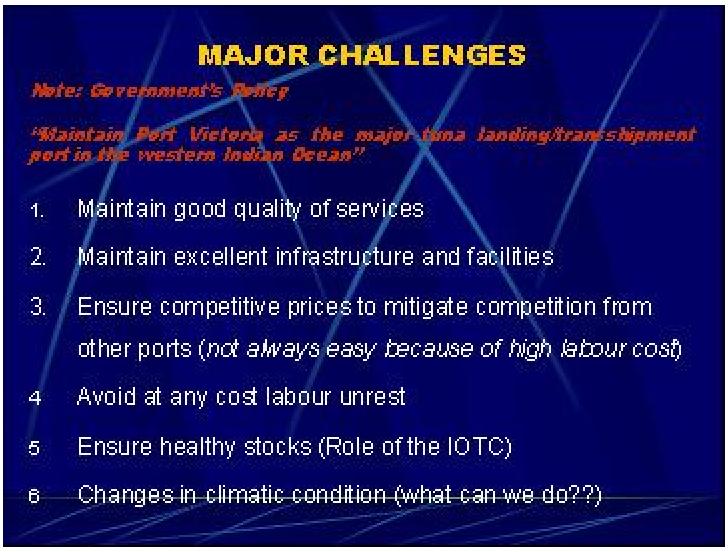

Revenue From Industrial Tuna Fishing Activity
1. Consist mainly of;
- Vessels expenditure in Port
- Companies Spending
- License fees, include financial compensation from the EU.
1.1 Vessels Expenditure
- (port dues, crew salary, shipchandling, engineering, travel, agency fee, stevedoring, custom dues, miscellaneous, bunkering)
1.2 Companies Spending
- (rent, salary, communication charges, utilities,)
1.3 License Fees
- (financial compensation, ship-owners contribution, fees for excess catch


For last ten years economy generated about 540 million US $ And between 1987 to 2004 US $ 803 million was generated.
Total Gross Expenditure


License Fees Earned
For the last ten years Seychelles earned US $ 83 million and between 1987 and 2004 US $ 132 million in licenses fees




MAIN FACTORS INFLUENCING REVENUE
1. Number of Vessels Licensed
2. Volume of Catch and Transshipment
3. Number of Calls and average stay in port
4. Cost of goods and services, (specially fuel prices)
5. Exchange Rates movements
6. Labour Productivity
7. Safety and Security in port area
8. Tariff Rates

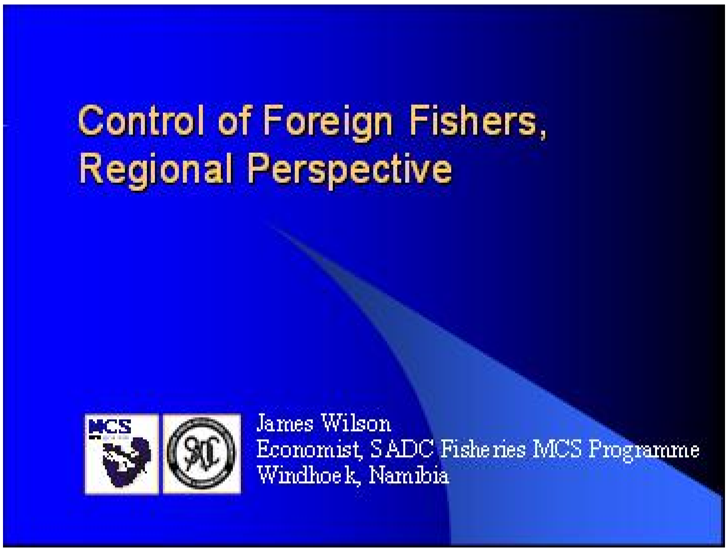

MAJOR CHALLENGES
Note: Government's Policy
"Maintain Port Victoria as the major tuna landing/transshipment port in the western Indian Ocean"
1. Maintain good quality of services
2. Maintain excellent infrastructure and facilities
3. Ensure competitive prices to mitigate competition from other ports (not always easy because of high labour cost)
4 Avoid at any cost labour unrest
5 Ensure healthy stocks (Role of the IOTC)
6 Changes in climatic condition (what can we do??)

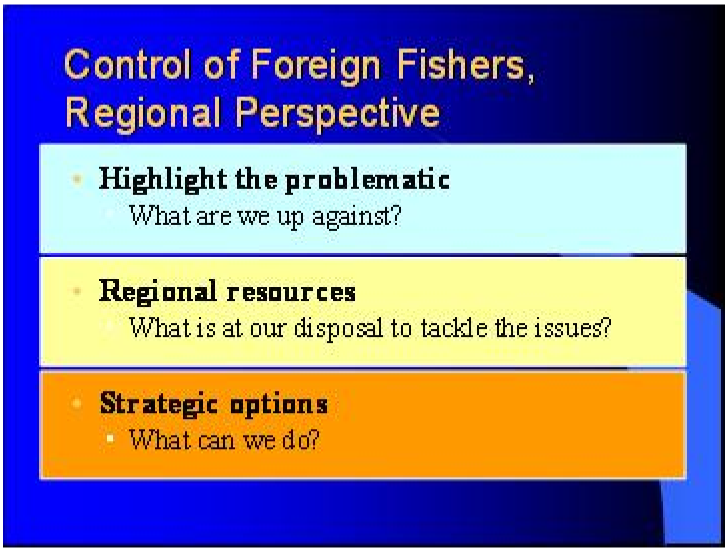

MAIN ADVANTAGES
Geographical Position.
Port Victoria lies in the middle of the migratory path of the tuna stock.
Good infrastructure and communication services
Safe and Secure Port.
(no wars or political violence)
Government
Productive and efficient labour
Dialogue
Government listens to foreign companies concern and tries to accommodate to their needs.

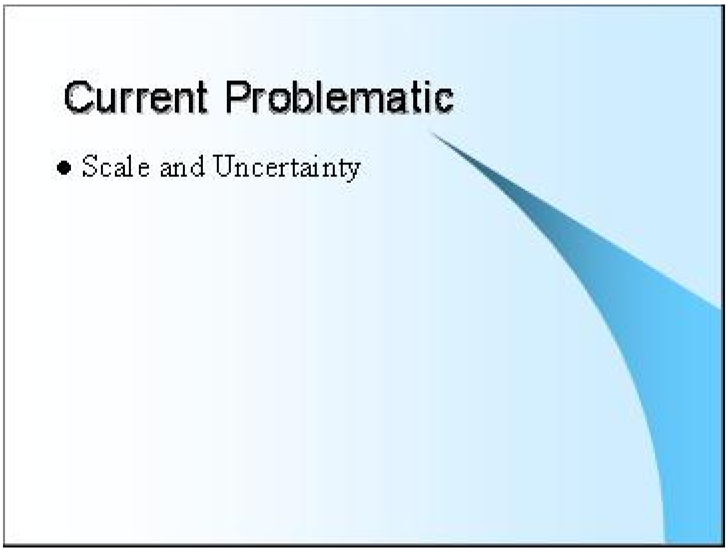

Thank You

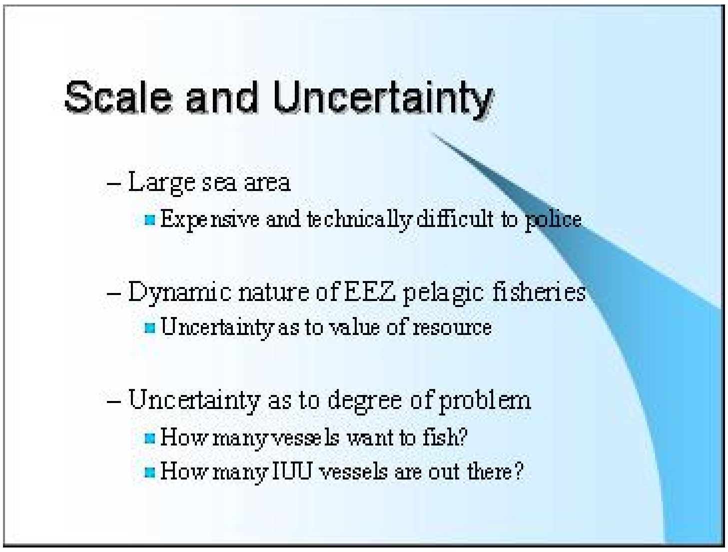
Appendix E: Regional perspectives: SADC MCS Programme (By James Wilson)

Note: Some of the information and data presented in the following slides are preliminary and should not be cited.

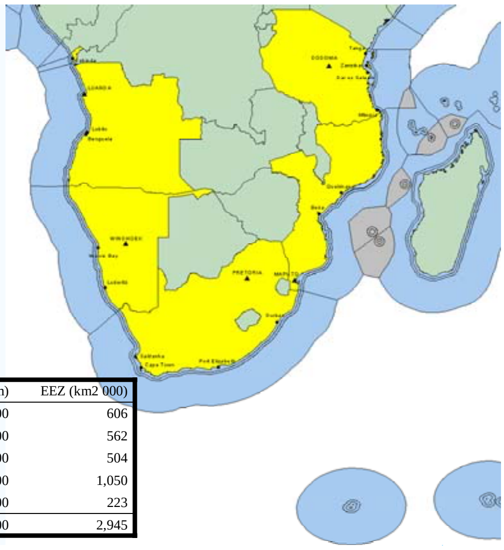





Current Problematic
Scale and Uncertainty

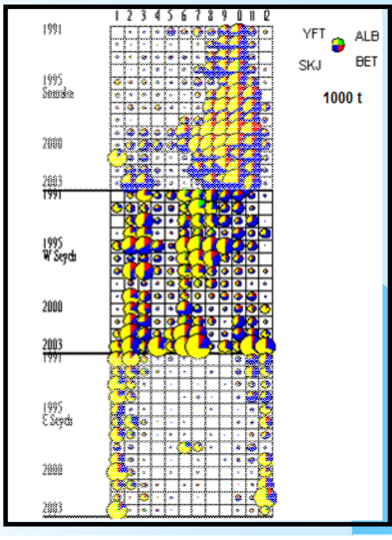

Scale and Uncertainty
– Large sea area
Expensive and technically difficult to police
– Dynamic nature of EEZ pelagic fisheries
Uncertainty as to value of resource
– Uncertainty as to degree of problem
How many vessels want to fish?
How many IUU vessels are out there?

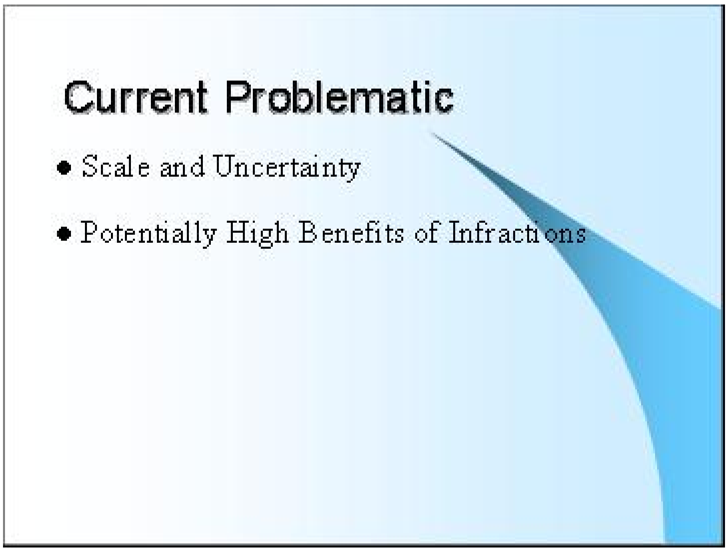
Coastlines and EEZs

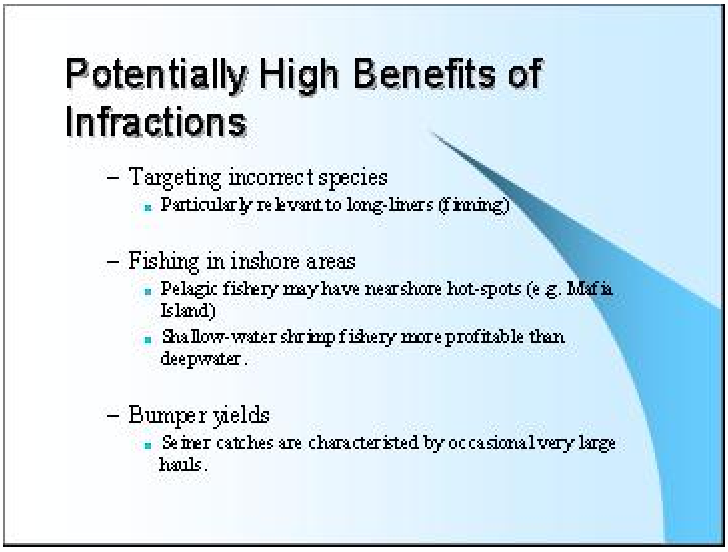


Country	Coastline (km)	EEZ (km2 000)
Angola	1,700	606
Mozambique	2,800	562
Namibia	1,500	504
South Africa	2,900	1,050
Tanzania	1,400	223
Total	10,200	2,945

Historical Tuna Data

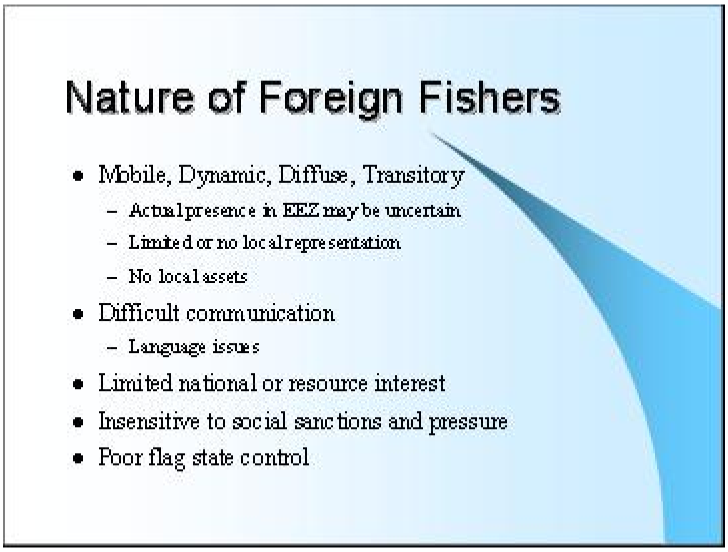


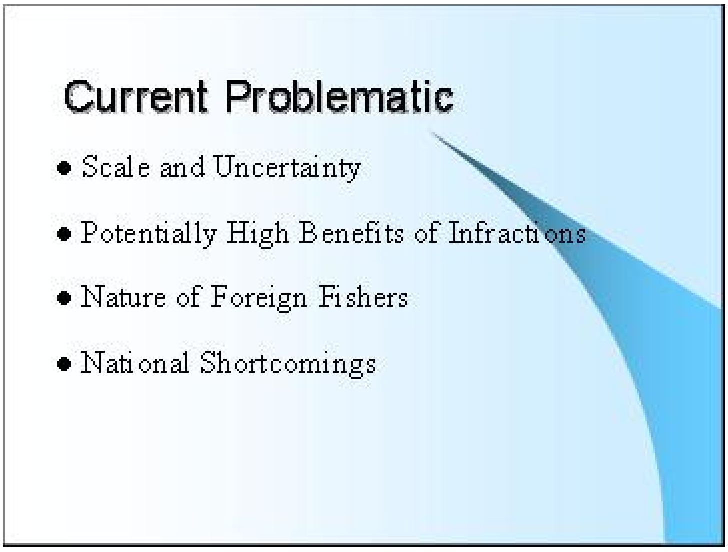

Current Problematic
Scale and Uncertainty
Potentially High Benefits of Infractions

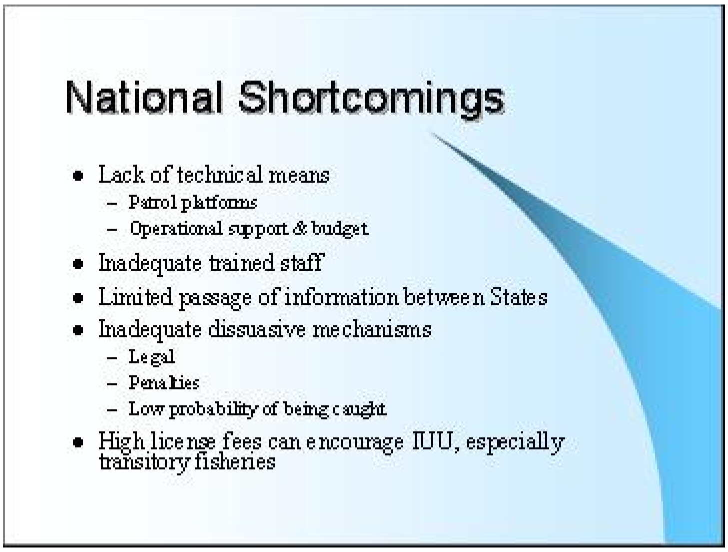

Potentially High Benefits of Infractions
– Targeting incorrect species
Particularly relevant to long-liners (finning)
– Fishing in inshore areas
Pelagic fishery may have nearshore hot-spots (e.g. Mafia Island)
Shallow-water shrimp fishery more profitable than deepwater.
– Bumper yields
Seiner catches are characterised by occasional very large hauls.

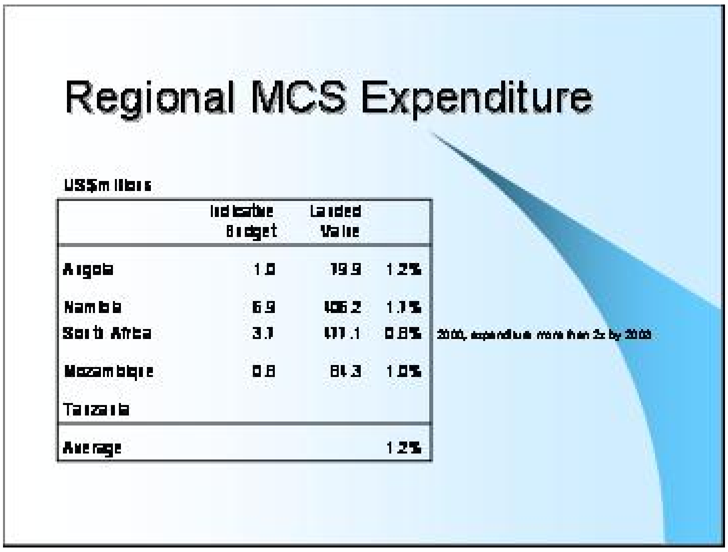
Current Problematic

- Scale and Uncertainty
- Potentially High Benefits of Infractions
- Nature of Foreign Fishers


Nature of Foreign Fishers
Mobile, Dynamic, Diffuse, Transitory
Actual presence in EEZ may be uncertain
Limited or no local representation
No local assets
Difficult communication
Language issues
Limited national or resource interest
Insensitive to social sanctions and pressure
Poor flag state control


Current Problematic
Scale and Uncertainty
Potentially High Benefits of Infractions
Nature of Foreign Fishers
National Shortcomings





	Indicative Budget	Landed Value	
Angola	1.0	79.9	1.2%
Namibia	6.9	406.2	1.7%
South Africa	3.7	477.1	0.8%
Mozambique	0.8	84.3	1.0%
Tanzania			
Average			1.2%

Regional Financial Penalties

Unlicenced Operation Penalties (EEZ Seiner)

Country	Basis	Min (US$)	Max (US$)	License (US$)	Min (x Lic)	Max (x Lic)	Min (xAAR)	Max (x AAR)
Tanzania	Min Defined	400,000		18,000	22.2		7%	0%
Mocambique	Min/Max Defined	36	3,571	20,000	0.0	0	0%	0%
RSA	Max Defined		307,692	n/i			0%	5%
Namibia	Max Defined		769,231	5,398		143	0%	13%
Angola	License	150,000	15,000,000	150,000	1.0	100	3%	250%

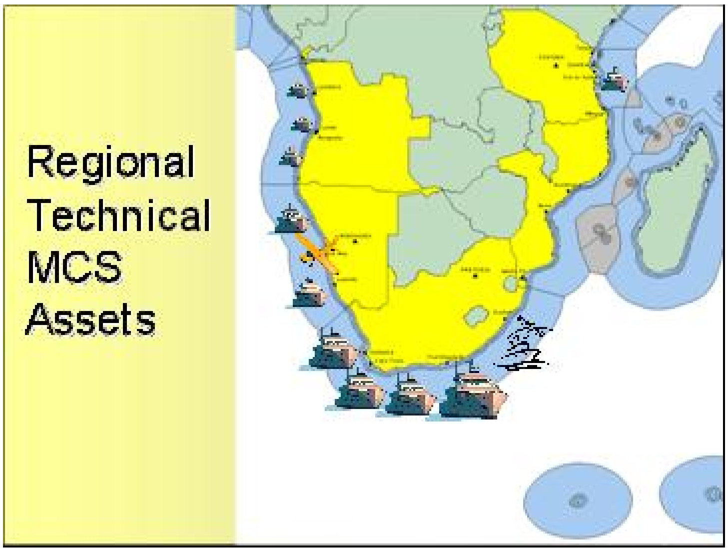
AAR=Average Annual Gross Revenue/vessel

Fee Estimate, Indian Ocean Seiner

Annual Catch	7,500	tons/yr
Gross Value	6,000,000	USD
Net Margin	5%	
	300,000	USD
Operating days/yr	300	
Net Margin/day	1,000	USD/day

National License Fee	20,000	USD
Equivalent to	20	Days
Time spent in National EEZ	90	
of which	22%	spent paying for the license

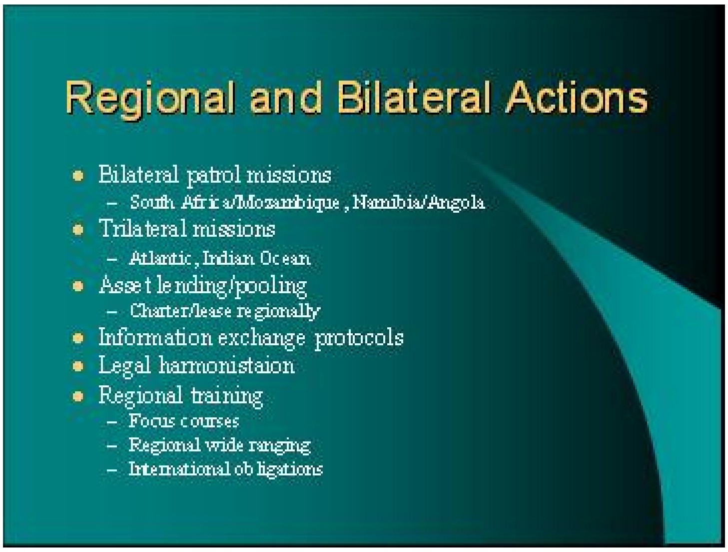

Regional Technical Resources
• Vessels
• Aircraft
• Inspectors
• Observers
• VMS Systems

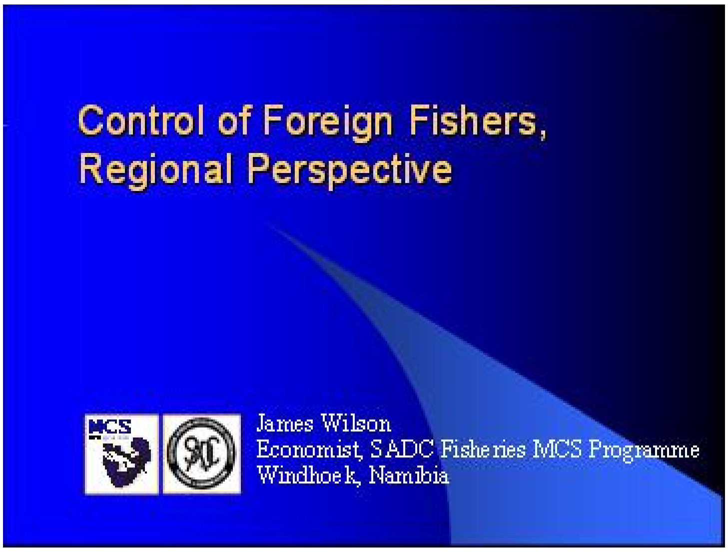

Regional Technical MCS Assets


Strategy Possibilities
Technical development
– VMS
– Vessels
– Information systems
Regional and bilateral cooperation
Revision of legal frameworks
– Penalties and sanctions
Rationalisation and harmonisation of fees
Regional associations


Strategy Possibilities (ctd)
Technical Options
– Owning vs Sharing
Problems of availability, admin, status, sovereignty
Benefits of reduced costs
Regional Cooperation
– Information exchanges
Benefits from operating VMS systems
– Legal harmonisation
– Dialogue


Strategy Possibilities (ctd)
Revision of legal frameworks
– Changing face of EEZ fisheries
– Accrediting new technologies (eg VMS) and neighboring officers
– Harmonisation of sanctions and penalties (?)
Regional associations
– IOTC
– ICCAT
– CAMLAR
– SEAFO


Regional and Bilateral Actions
• Bilateral patrol missions
– South Africa/Mozambique, Namibia/Angola
• Trilateral missions
– Atlantic, Indian Ocean
• Asset lending/pooling
– Charter/lease regionally
• Information exchange protocols
• Legal harmonistaion
• Regional training
– Focus courses
– Regional wide ranging
– International obligations


Control of Foreign Fishers, Regional Perspective
James Wilson
Economist, SADC Fisheries MCS Programme
Windhoek, Namibia

Appendix F: Practical 1: Numerical Examples of CFF Model

Practical 1: Numerical examples of CFF model

1. Introduction

This is the first practical session which builds on the theory already presented on the decision rules and optimal control parameters for the Control of Foreign Fishing model. It is designed to provide a fuller appreciation of some of their implications by providing a numerical example using a Microsoft Excel spreadsheet model (Practical_1.xls). All these examples consider the case of a single fishing vessel.

2. Model parameters

Consider a longline fishery for a tuna species taking place within a country's EEZ. To make it attractive to fish in inside the EEZ, we will assume that the typical catch rates achieved inside the EEZ are greater than those outside the zone.

The following show some typical values of fishery parameters for a single longline vessel.

Season length = 100 days
Daily catch rate inside EEZ = 5t/day
Daily catch rate outside EEZ = 4.9t/day
Value of catch = $8,000/t

With these figures, the values of the expected catch inside the EEZ each year would be $4,000,000 (i.e. Season length*catch rate inside EEZ*value of catch) and the gross benefit to the fishers for fishing within the EEZ would be $80,000 (i.e. 5-4.9t/day*season length*catch value). The latter sum would also be the maximum they would be prepared to pay for a licence. These values should be inserted into cells C5 to C8 of the spreadsheet model.

3. Exercises

Four simple exercises have been written to show the implications of changing one or more of the CFF fishery parameters.

a. Changes to catch rates inside EEZ

The assumed difference in catches rates inside and outside the EEZ is very small (0.1t/day). The first exercise is designed to question what would happen if the advantage of fishing inside the EEZ is increased.

Use the spreadsheet model to help complete the following table. The first column shows the default set of values. [Hint: This can be achieved by changing the value of cell C6 by increments of 0.1. In addition, assume that the annual catch value within the EEZ remains constant at $4,000,000].

Table 3.1 Changes in maximum licence fee ($) with changes in catch rate inside EEZ (t/day).

	Inside EEZ catch rate advantage (t/day)				
	0.1	0.2	0.3	0.4	0.5
Licence fee ($)	80,000				
Fee as % of catch value	2.0				

b. Changes to the maximum fine

Previous Control of Foreign Fishing reports have shown that a consistent optimal policy is to set the fine for illegal fishing at its maximum value. Under normal circumstances, this could include the value of the vessel, its fishing gear and the catch in its hold. If the vessel is a modern purse seiner with a hold of yellowfin tuna or a longliner with a hold of top grade sashimi tuna, this value could be quite considerable. However, some coastal states will be reluctant to set such fines at this level. This example shows the effect of reducing the maximum fine.

Recall that the optimal surveillance expenditure is such that the expected fine (probability of detection*fine) equals the licence fee (i.e. cell F3 equals C2).

For this exercise, reset the fishing parameters to their original values (see model parameters section above) and use the spreadsheet model to complete the following table. [Hint: The maximum fine ($) can be changed by altering cell C10].

Table 3.2 Changes in optimal surveillance cost ($) with changes in maximum fine ($).

	Maximum Fine (million $)				
	1	0.8	0.6	0.4	0.2
Opt. Surveillance cost ($)	27,763				
Cost as % of licence fee	35				

c. Changes to the surveillance efficiency

This example looks at the possible effects of changing the cost-efficiency of surveillance operations. In the model, this is mimicked by changing the surveillance efficiency parameter, K, in cell F5. At present, the default value of K is set at $3.0*10^{-6}$.

Reset all the fishing parameters to their original values. Use the spreadsheet model to explore the outcome of improving the surveillance efficiency from $3.0*10^{-6}$ to $1.0*10^{-5}$. Now re-run the previous exercise above, and complete the table below to show the effect of decreasing the maximum fine on the optimal surveillance cost.

Table 3.3 Optimal surveillance costs ($) with changes in maximum fine ($) with an increase in surveillance efficiency (from $3.0*10^{-6}$ to $1.0*10^{-5}$).

	Maximum Fine (million $)				
	1	0.8	0.6	0.4	0.2
Opt. Surveillance cost ($)	8,289				
Cost as % of licence fee	10				

d. Changes to the licence fee

This final example looks at the possible outcomes of changing the maximum licence fee from $80,000.

Recall that the optimal expected fine is equal to the optimal licence fee (i.e. value in cell F3 equals C2). It follows in this example that if the maximum the state is prepared to spend on surveillance is $27,763 (i.e. cell F3, the optimal level when the maximum fine was $1,000,000) the maximum licence fee will be reduced from $80,000 by the same proportion as the maximum fine is reduced from $1,000,000.

Reset all the fishing parameters to their original values. Use the spreadsheet model to explore the outcome of changing the level of maximum licence fee by manipulating the maximum fine and complete the following table. [Hint: In the spreadsheet model this can be done by changing the fine proportion in cell C9 rather than the maximum fine directly. This is a "fix" in the spreadsheet only, to ensure the surveillance cost remains constant at $27,763.]

Table 3.4 Maximum licence fees ($) with changes in maximum fine ($).

	Max. Fine (million $) ≡ Fine proportion				
	1	0.8	0.6	0.4	0.2
Maximum licence fee ($) ≡ E(f)	80,000*				
Surveillance cost as % of licence fee	35				

*Values in cell F3 must be rounded up to nearest $1,000 due to errors caused by having to use discrete class intervals in spreadsheet (see cell C89).

4. Discussion

a. Changes to catch rates inside EEZ

The results should indicate that as the advantage of fishing inside the zone increases, the maximum amount the fisher would be prepared to pay for a licence fee naturally increases. Since we assumed that the annual catch value inside the EEZ remains constant at $4,000,000, which means the percentage that the maximum licence fee is of the annual catch value increases from a low value of 2% to a high of 10%.

Licence fees of 10% of catch value are extremely rare in tuna fisheries. However, it is important to note that in principal, the licence fee should be set as a proportion of the marginal revenue accruing to the fisher rather than as a proportion of the total catch value.

b. Changes to the maximum fine

Given the default parameter value for the surveillance function ($500,000) and the maximum fine value ($1,000,000), the expenditure needed to produce the required probability of detection (0.08 in this case) is quite a high percentage of the licence fee (35%). As the maximum fine decreases, the corresponding probability of detection needed increases, and thus so does the surveillance costs.

In this numerical example, by the time it reaches $800,000 (or 0.2 as a proportion), the surveillance expenditure greatly exceeds the licence fee (and thus income to the state). This situation would be intolerable to the state. However, the state cannot just reduce expenditure on surveillance, because if it did so, the fishers would find it more attractive to fish illegally in the EEZ and refuse to buy a licence.

c. Changes to the surveillance efficiency

Increasing the cost-efficiency of surveillance (i.e. value of K) substantially reduces the cost as a proportion of the licence fee. For example, even when the maximum fine is reduced to $200,000 (or 0.2 as a proportion), the cost of optimal surveillance remains below that of the maximum licence fee (i.e. 64%). However, caution should be given where the surveillance cost approaches the licence fee at low values of maximum fine.

The possible response by the state of retaining the licence fee at its current level but only spending what can be afforded on surveillance was dismissed above, because it will only lead to illegal fishing and no licence revenue. Another alternative might be to reduce the licence fee itself. This was considered in the final exercise.

d. Changes to the licence fee

By comparing table 3.4 with table 3.2, there is an overall improvement in the results by changing the licence fee rather than maximum fine, but not much. This exercise shows that there is a trade off between reduced licence fees with reduced surveillance expenditure, but this becomes impossible when the maximum fine is set too low.

It has to be emphasised that these numerical examples are not based on “real” fishery parameter values, so little should be read into the individual values. However, it is clear that this strong interaction between surveillance costs, maximum fine levels and licence fees will carry over to real fisheries. In particular, if the maximum fine is set too low, it may prove almost impossible to effectively deter illegal fishing.

Appendix G: Practical 1: Numerical Examples of CFF Model - Results

The following tables present the expected results from changing one or more of the CFF fishery parameters.

Table 3.1 Changes in the maximum licence fee ($) with changes in catches inside the EEZ (t/day)

	Inside EZZ catch rate advantage (t/day)				
	0.1	0.2	0.3	0.4	0.5
Maximum licence fee ($)	80,000	160,000	240,000	320,000	400,000
Fee as % of catch value	2	4	6	8	10

Table 3.2 Changes in optimal surveillance cost ($) with changes in maximum fine ($)

	Maximum Fine (million $)				
	1	0.8	0.6	0.4	0.2
Opt. Surveillance cost ($)	27,763	35,000	47,632	60,789	203,289
Cost as % of licence fee	35	44	60	76	254

Table 3.3 Optimal surveillance costs ($) with changes in maximum fine ($) following an increase in surveillance efficiency (K, from 3.0 e^{-6} to 1.0 e^{-5})

	Maximum Fine (million $)				
	1	0.8	0.6	0.4	0.2
Opt. Surveillance cost ($)	8,289	10,526	14,211	22,237	51,053
Cost as a % of licence fee	10	13	18	28	64

Table 3.4 Maximum licence fees ($) with changes to maximum fine ($)

	Maximum Fine (million $)				
	1	0.8	0.6	0.4	0.2
Maximum licence fee ($) (Expected Fine)	80,000	64,000	48,000	32,000	16,000
Surveillance cost as % of licence fee	35	43	58	87	174

Appendix H: Practical 2: Control of Foreign Fishing Demonstration

1. Introduction

This is the second practical session which builds on the theory and experience of practical 1: Numerical examples of CF model. Participants are divided into two or more teams each representing a hypothetical Coastal State with an interest in licensing foreign fishing. A series of foreign fishing scenarios will be played out using the Excel spreadsheet model game (Practical_2.xls) to help develop both National and Regional CFF strategies. Unlike practical 1, these exercises consider a single fleet with multiple vessels.

2. Model parameters

Consider a purse seine fishery for a tuna resource taking place within the Coastal State's EEZ. To make it attractive to fish inside the EEZ, we will assume that the typical catch rates achieved inside the EEZ are greater than those outside the zone.

The spreadsheet model game is more complex than the first practical and requires a number of additional parameters. The following show some typical values of fishery parameters for multiple purse seine vessels.

Fleet Characteristics
Catch rate inside EEZ (t/day) = 12.0
Catch rate outside EEZ (t/day) = 10.0
Product Price ($/t) = 1,500
Value of vessel ($) = 500,000
Number of vessels = 40
Honesty coefficient* = 0.5
No. months fishing = 2
Avg. days per month = 15

Surveillance
Vessel speed (km/h) = 26
Trip duration (days) = 21
Observed width (km) = 20
Area (km^2) = 200,000
Trips per season = 3
Running cost per day ($) = 10,500

* Recall that the honesty coefficient is a parameter ranging from 0 to 1 and is used to simplify the model by not having to estimate other more difficult parameters which concern the level of risk fishers take. See MRAG (1995) for more information.

3. Exercises

A series of exercises have been written to represent potential foreign fishing scenarios that will enable participants to develop both National and Regional CFF strategies. Participants will be assigned to a group that represents a hypothetical Coastal State with an interest in licensing foreign purse seine vessels.

Each Coastal State has access to the same highly migratory tuna resource, which may or may not enter their EEZ during the course of the fishing year. The resource is shared between each Coastal State and it is in their best interest to manage the stock on a Regional as well as National basis. For this practical, participants will be divided into three groups (A, B and C), each representing a Coastal State, as suggested in Annex 1.

In the spreadsheet model game, changes to the expected catch rates, maximum fine and surveillance efficiency will be made by members of each Coastal State and the results compared and discussed at the end of each exercise.

The parameter values may, or may not, be the same for each Coastal State. Details of each model parameter will be handed out separately and should remain confidential to each group, unless specified otherwise.

Within the spreadsheet, the model is run and the main results presented for each exercise in a worksheet called 'Optimum'. The Maximum State Revenue (cell C8) is calculated by the sum of the total licence revenue (cell C20) and value of fines from successful prosecution of illegal vessels (cell C21), after subtracting the cost of surveillance (cell C4).

Recall the fleet decision to purchase licences will depend on the Marginal Revenue from fishing inside the EEZ and the Expected Fine from fishing illegally inside the zone, given the probability of detection (i.e. Surveillance cost). Changes to the following will have a marked effect on the total State Revenue (cell C8):

(i) Probability of detection (via the Surveillance cost, cell C4),
(ii) Licence fee (Licence Proportion, cell C5) and,
(iii) Level of fine (Fine Proportion, cell C6).

A series of CFF diagnostic charts have been produced to look at the sensitivity of changing each variable described above in turn with changes in total State Revenue (see worksheets 'Surv_Opt', 'Lic_Opt' and 'Fines_Opt').

With the new set of CFF parameters (see separate sheet), use the spreadsheet model game to find the Maximum State Revenue by pressing the 'Find Maximum' button on the worksheet 'Optimum'. [Hint: it may be necessary to change the intervals for some parameters within the pop-up dialogue box].

The results of each exercise (1-4) should be recorded in the following table. [Hint: the optimal number of surveillance trips (determined by the optimal surveillance cost), can be found in cell C16 on worksheet 'Surveillance'].

Parameter	**Exercise**			
	1	**2**	**3**	**4**
Fleet decision rule				
Total catch value ($)				
Licence fee ($)				
Total licence revenue ($)				
Total fine revenue ($)				
Surveillance cost ($)				
No. surveillance trips				
Licence proportion				
Fine proportion				
Max State Revenue				

Discussion

a. Changes to catch rates inside the EEZ

The results should indicate that as the advantage of fishing inside the zone increases, both the optimal amount a fisher would be prepared to pay for a licence fee and the number of fishers wanting access increases.

With the value of the total catch inside the zone varying according to the catch rate, the percentage the optimal licence fee is of the annual total catch value increases from 1% to a high of 6%. The highest optimal licence fee of 6% is not uncommon within tuna fisheries.

Increased catch rates inside the zone also attract an increase in the level of illegal fishing (cf. Table 3.1, Exercise 2). However to counter this, increasing the catch value also increases the maximum fine imposed (i.e. F_{max}, sum of vessel cost and vessel catch value). In the model, this results in an increase in the total State Revenue available to spend on surveillance (probability of detection) from 0.05 to 0.149.

It should be noted that when the advantage of fishing inside the zone decreases to 0.1 t/day the optimal licence revenue ($81,000) is situated below the optimal surveillance cost ($208,000). If no fine revenue was generated that year (i.e. $879,118) the Coastal State would have made an overall loss.

Specific changes to the maximum fine, via the cost of the vessel, are dealt with in the example discussed below.

b. Changes to the maximum fine

In the model, the maximum fine imposed by the Coastal State is determined by a proportion of the sum of catch value and the value of the fishing vessel. Since catch value is also determined by the catch rates, the maximum fine can be changed by altering the fine proportion or the value of the vessel.

In this example, the maximum fine has been changed by decreasing the value of the fishing vessel from $500,000 to $200,000 (see Table 3.4).

The immediate effect of decreasing the maximum fine reduces the expected fine. To prevent an increase in illegal fishing, and optimise fine revenue, an increase is required in the probability of detection. In consequence, this means a higher level of surveillance is required (survey trips from 1.84 to 2.29).

Without an opportunity to increase licence fee revenue, and not much scope to increase the total fine revenue, the proportion of surveillance cost increases with a decline in maximum fine. This exercise supports the thinking that the level of fine should be set as high as possible.

It should also be noted in this example, that the current level of catch rate inside the zone (12.0 t/day) is insufficient to set a licence fee high enough to recover the cost of surveillance (cf. Table 3.5). Under these circumstances it would be necessary to set the fine at a very high level (i.e. equivalent the value of a fishing vessel being approximately $1,000,000).

c. Changes to the surveillance efficiency

In the model, increasing the cost-efficiency of surveillance by reducing the vessel daily running costs by 50% (from $10,500 to $5,250) substantially reduces the optimal surveillance cost and proportion of the Maximum State Revenue (cf. Tables 3.6 with Table 3.4).

The cost of optimal surveillance now also remains below that of the optimal licence fee revenue (cf. Table 3.7 and Table 3.5). This is good news for the Coastal State, which no longer has to rely on successful prosecutions to generate the Maximum State Revenue.

One approach to increase the cost-efficiency of surveillance might be to look at regional cooperation of surveillance platforms and information, such that overall costs can be reduced and the benefits are clearly shown here.

Reference

MRAG (1995) Control of Foreign Fisheries: Adaptive Research. Final Technical Report R.5049. Produced under the Fisheries Management Science Programme of the UK Department for International Development. 125p.

Annex 1: Suggested participants for each Coastal State; Group A, Group B or Group C.

Group A

1. Michel Marguerite (Seychelles)
2. Joao Noa Senete (Mozambique)
3. Robert Sululu (Tanzania)

Group B

1. Manuel Vicente Castiano (Mozambique)
2. Gaudence Kalikela (Tanzania)
3. Kennedy Shikami (Kenya)

Group C

1. Rashid Aman (Somalia)
2. Martha Mukira (Kenya)
3. James Wilson (Namibia)

Group A

Parameter	Exercise			
	1	2	3	4
Fleet Characteristics				
Catch rate inside EEZ (t/day)	12.0	**11.0**	12.0	12.0
Catch rate outside EEZ(t/day)	10.0	10.0	10.0	10.0
Product Price ($/t)	1,500	1,500	1,500	1,500
Value of vessel ($)	500,000	500,000	**400,000**	**400,000**
Number of vessels	40	40	40	40
Honesty coefficient	0.5	0.5	0.5	0.5
No. months fishing	2	2	2	2
Avg. days per month	15	15	15	15
Surveillance				
Vessel speed (km/h)	26	26	26	26
Trip duration (days)	21	21	21	21
Observed width (km)	20	20	20	20
Area (km^2)	200,000	200,000	200,000	200,000
Trips per season	3	3	3	3
Running cost per day ($)	10,500	10,500	10,500	**5,250**

GROUP B

Parameter	Exercise			
	1	2	3	4
Fleet Characteristics				
Catch rate inside EEZ (t/day)	12.0	**13.0**	12.0	12.0
Catch rate outside EEZ(t/day)	10.0	10.0	10.0	10.0
Product Price ($/t)	1,500	1,500	1,500	1,500
Value of vessel ($)	500,000	500,000	**300,000**	**300,000**
Number of vessels	40	40	40	40
Honesty coefficient	0.5	0.5	0.5	0.5
No. months fishing	2	2	2	2
Avg. days per month	15	15	15	15
Surveillance				
Vessel speed (km/h)	26	26	26	26
Trip duration (days)	21	21	21	21
Observed width (km)	20	20	20	20
Area (km^2)	200,000	200,000	200,000	200,000
Trips per season	3	3	3	3
Running cost per day ($)	10,500	10,500	10,500	**5,250**

GROUP C

Parameter	Exercise			
	1	2	3	4
Fleet Characteristics				
Catch rate inside EEZ (t/day)	12.0	**14.0**	12.0	12.0
Catch rate outside EEZ(t/day)	10.0	10.0	10.0	10.0
Product Price ($/t)	1,500	1,500	1,500	1,500
Value of vessel ($)	500,000	500,000	**200,000**	**200,000**
Number of vessels	40	40	40	40
Honesty coefficient	0.5	0.5	0.5	0.5
No. months fishing	2	2	2	2
Avg. days per month	15	15	15	15
Surveillance				
Vessel speed (km/h)	26	26	26	26
Trip duration (days)	21	21	21	21
Observed width (km)	20	20	20	20
Area (km^2)	200,000	200,000	200,000	200,000
Trips per season	3	3	3	3
Running cost per day ($)	10,500	10,500	10,500	**5,250**

Appendix I: Practical 2: Control of Foreign Fishing Demonstration – Results

The following table (Table 3.1) presents all parameter values used during Practical 2. The expected results are presented in Tables 3.2 - 3.7.

Table 3.1 Table of model parameter values used by each Group A, B and C.

Parameter	Exercise											
	1			2			3			4		
	A	B	C	A	B	C	A	B	C	A	B	C
Fleet Characteristics												
Catch rate inside EEZ (t/day)	12.0	12.0	12.0	**11.0**	**13.0**	**14.0**	12.0	12.0	12.0	12.0	12.0	12.0
Catch rate outside EEZ(t/day)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Product Price ($/t)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Value of vessel ($)	500,000	500,000	500,000	500,000	500,000	500,000	**400,000**	**300,000**	**200,000**	**400,000**	**300,000**	**200,000**
Number of vessels	40	40	40	40	40	40	40	40	40	40	40	40
Honesty coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.6	0.7
No. months fishing	2	2	2	2	2	2	2	2	2	2	2	2
Avg. days per month	15	15	15	15	15	15	15	15	15	15	15	15
Surveillance												
Vessel speed (km/h)	26	26	26	26	26	26	26	26	26	26	26	26
Trip duration (days)	21	21	21	21	21	21	21	21	21	21	21	21
Observed width (km)	20	20	20	20	20	20	20	20	20	20	20	20
Area (km^2)	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Trips per season	3	3	3	3	3	3	3	3	3	3	3	3
Running cost per day ($)	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	**5,250**	**5,250**	**5,250**

Table 3.2 Aggregated results showing the expected values from Groups A, B and C.

Exercise	Group	Decision rule	Catch Value ($)	Lic. Fee	Licence Revenue ($)	Fine Revenue ($)	Surv. trips	Surveillance Cost ($)	Licence Proportion	Fine Prop.	Maximum State Revenue
1	A	3	540,000	14,250	285,000	1,687,137	1.62	356,500	0.158	0.96	1,615,637
	B	3	540,000	14,250	285,000	1,687,137	1.62	356,500	0.158	0.96	1,615,637
	C	3	540,000	14,250	285,000	1,687,137	1.62	356,500	0.158	0.96	1,615,637
2	A	3	495,000	4,050	81,000	879,118	0.94	208,000	0.09	0.88	752,118
	B	3	585,000	30,375	607,500	2,616,971	2.51	554,500	0.225	0.94	2,669,971
	C	3	630,000	37,125	990,000	3,376,551	2.96	653,500	0.275	1.0	3,713,051
3	A	3	540,000	14,220	285,000	1,690,239	1.84	406,000	0.158	0.94	1,569,239
	B	3	540,000	14,220	285,000	1,684,409	2.07	455,500	0.158	0.94	1,513,909
	C	3	540,000	14,220	285,000	1,704,874	2.29	505,000	0.158	0.98	1,484,874
4	A	3	540,000	14,400	288,000	1,720,663	1.76	193,750	0.158	1.0	1,814,313
	B	3	540,000	14,400	288,000	1,721,149	1.93	218,250	0.16	1.0	1,790,899
	C	3	540,000	14,400	288,000	1,720,711	2.31	255,000	0.158	1.0	1,753,711

a. Changes to catch rates inside the EEZ

Table 3.3 Changes in the optimal licence fee ($) with changes in the catch rate inside EEZ (t/day).

	Inside EEZ catch rate advantage (t/day)			
	1	2	3	4
Catch value ($)	495,000	540,000	585,000	630,000
Licence fee ($)	4,050	14,250	30,375	37,125
Fee as a % of catch value	1%	3%	5%	6%

b. Changes to the maximum fine

Table 3.4 Changes in optimal surveillance cost ($) and Maximum State Revenue with changes in the maximum fine ($).

	Maximum Fine (~Fishing vessel value $m)			
	0.5	0.4	0.3	0.2
State Revenue ($)	1,615,637	1,569,239	1,513,909	1,484,874
Surveillance cost ($)	356,500	406,000	455,500	505,000
Cost as a % of State Revenue	22%	26%	30%	34%

Table 3.5 Changes in optimal surveillance cost ($) compared to total licence fee revenue ($) with changes in the maximum fine ($).

	Maximum Fine (~Fishing vessel value $m)			
	0.5	0.4	0.3	0.2
Licence fee revenue ($)	285,000	285,000	285,000	285,000
Surveillance cost ($)	356,500	406,000	455,500	505,000
Cost as a % of State Revenue	125%	142%	160%	177%

c. Changes to the surveillance efficiency

Table 3.6 Changes in optimal surveillance cost ($) and Maximum State Revenue ($) with changes in the maximum fine ($) following an increase in surveillance efficiency (running cost of surveillance from $10,500 to $5,250 per day).

	Maximum Fine (~Fishing vessel value $m)			
	0.5	0.4	0.3	0.2
State Revenue ($)	1,823,036	1,814,313	1,790,899	1,753,711
Surveillance cost ($)	169,250	193,750	218,250	255,000
Cost as a % of State Revenue	9%	11%	12%	15%

Table 3.7 Changes in optimal surveillance cost ($) compared to total licence fee revenue ($) with changes in the maximum fine ($) following an increase in surveillance efficiency (running cost of surveillance from $10,500 to $5,250 per day).

	Maximum Fine (~Fishing vessel value $m)			
	0.5	0.4	0.3	0.2
Licence fee revenue ($)	288,000	288,000	288,000	288,000
Surveillance cost ($)	169,250	193,750	218,250	255,000
Cost as a % of licence fee revenue	59%	68%	77%	89%

Appendix J: CFF Introduction and Background


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Agenda
11:15 Practical Session 1
12:45 Discussion
13:00 Buffet lunch
14:00 Regional perspectives
- SADC MCS Programme
14:30 Practical Session 2
15:30 Coffee Break
16:00 Practical Session 2 (cont'd)
16:45 Discussion
17:00 End of day 1


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Agenda
Tuesday 15th November
08:30 Meet at reception, Hotel White Sands
09:00 Depart for field visit: MCS Operations Centre, Mbegani
10:00 Guided tour of Operations Centre
12:30 Lunch (Bagamoyo)
14:00 Depart for Hotel White Sands
15:00 Lessons learned from CFF exercises
15:30 Coffee Break
16:00 Discussion & Workshop Summary:
National & Regional CFF Priorities
17:00 End of Workshop

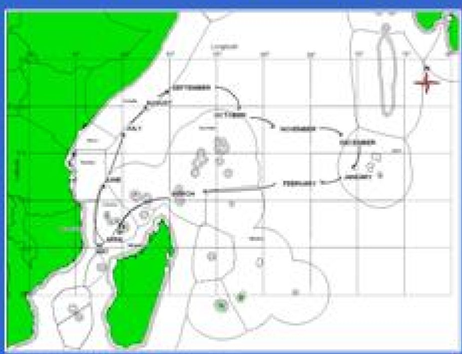
Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005

The Need for Control of Foreign Fisheries

- Global over-capacity
- UNCLOS
- Highly migratory stocks
- The experience in developing countries
- The Control of Foreign Fisheries project

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005

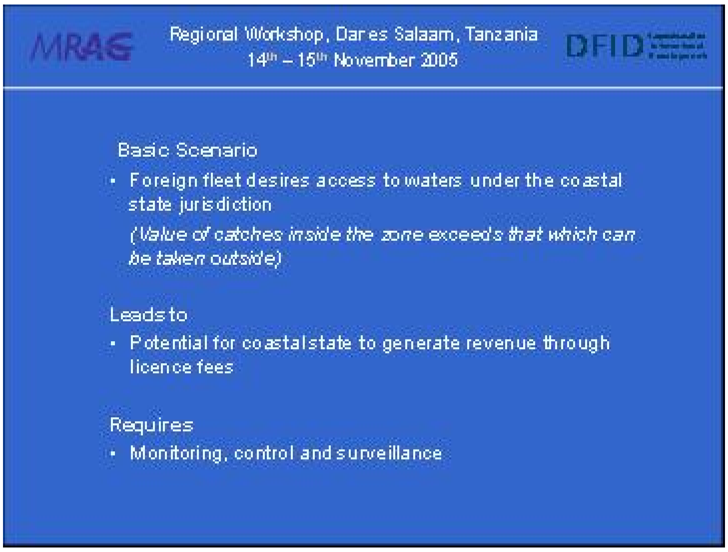
Highly Migratory Fish Stocks: A Regional Problem



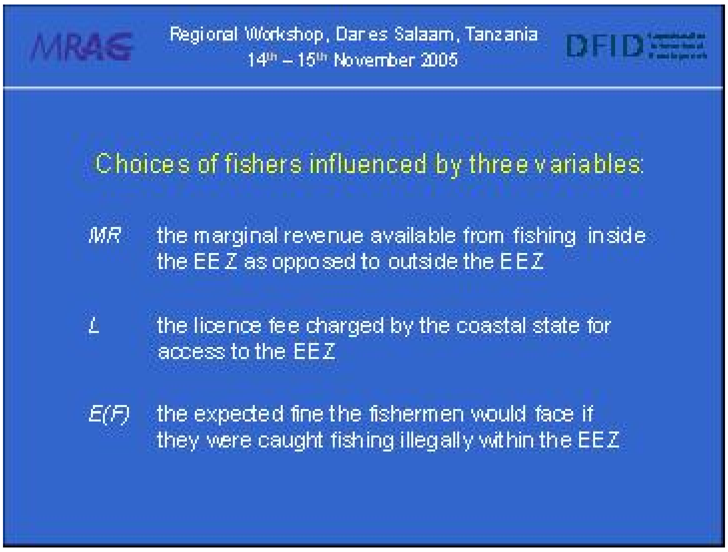

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Project Background
1993 (Project R4775)
Developed a methodology for evaluating net benefits from licensing.
1996 (Project R5049CB)
Tested the above methodology in a number of case studies (e.g. Seychelles, South Georgia, BIOT).
2005 (Project R8463) 'Uptake & promotion"
New case studies in East Africa (Kenya and Tanzania) and regional workshop.

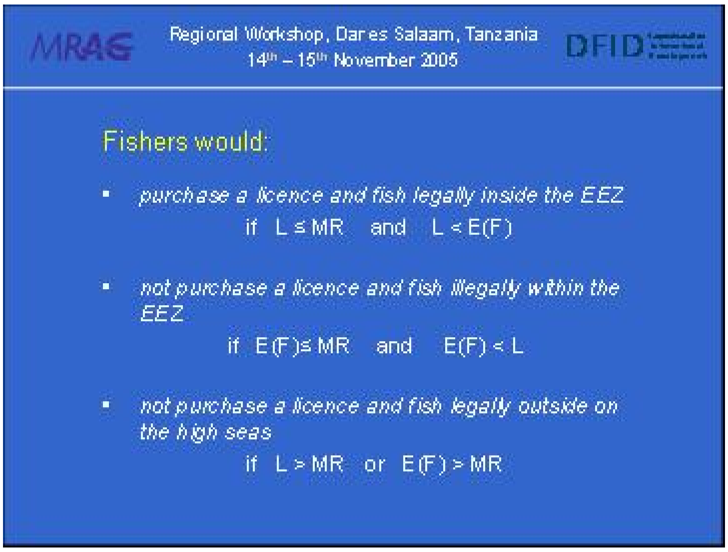

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Objectives of Workshop
The primary aim of the workshop is to increase regional awareness of economic models to maximise benefits through CFF.
Main Activities
i Provide an overview of the CFF model.
ii Share and discuss national and regional perspectives of MCS.
iii Practical sessions using CFF spreadsheet model game to develop hypothetical MCS strategies.
iv Field visit to MCS Operations Centre, Mbegani

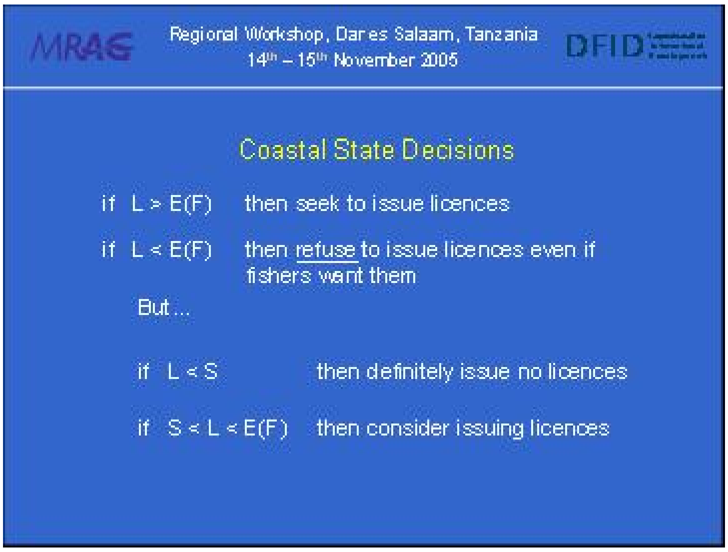
Appendix K: Introduction to the CFF Model

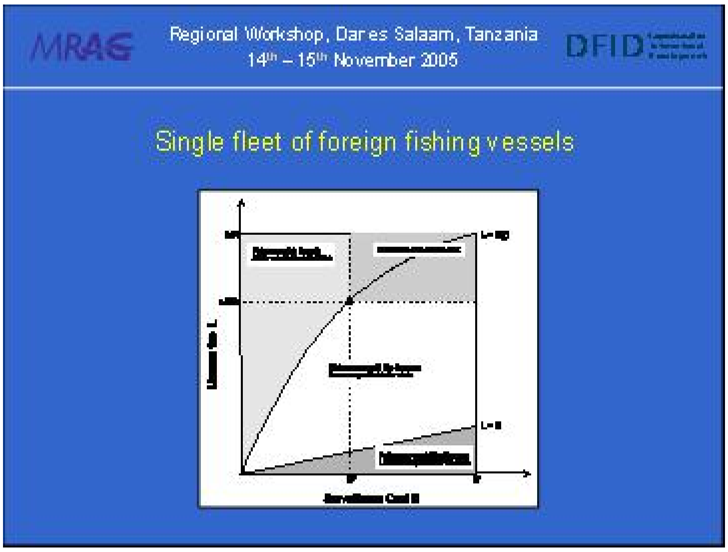


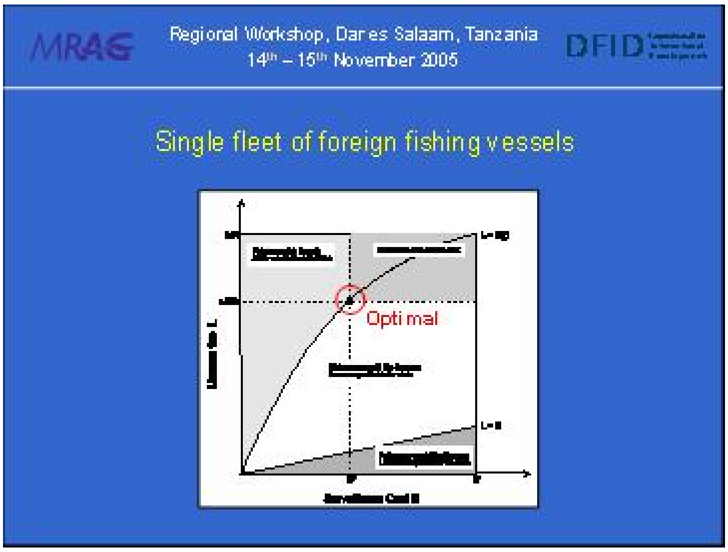

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Possible choices for the Foreign Fishers:
Purchase a licence and fish legally inside the EEZ
Not purchase a licence and fish illegally inside the EEZ
Not purchase a licence and fish legally outside on the High Seas

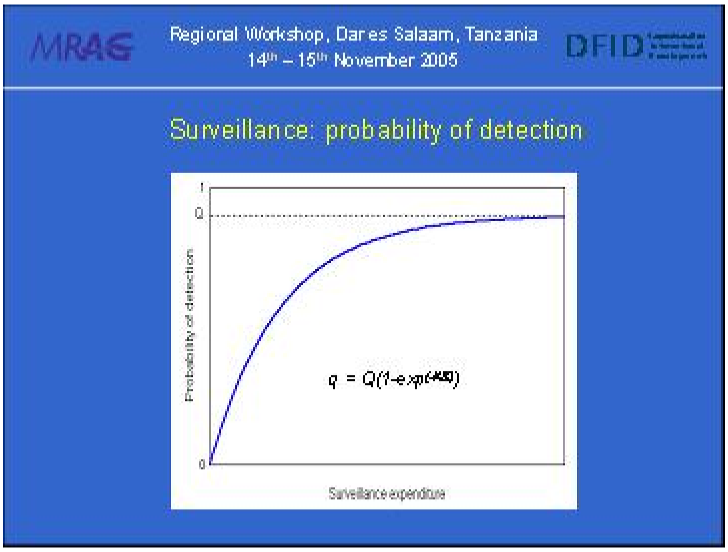

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Choices of fishers influenced by three variables:
MR the marginal revenue available from fishing inside the EEZ as opposed to outside the EEZ
L the licence fee charged by the coastal state for access to the EEZ
E(F) the expected fine the fishermen would face if they were caught fishing illegally within the EEZ

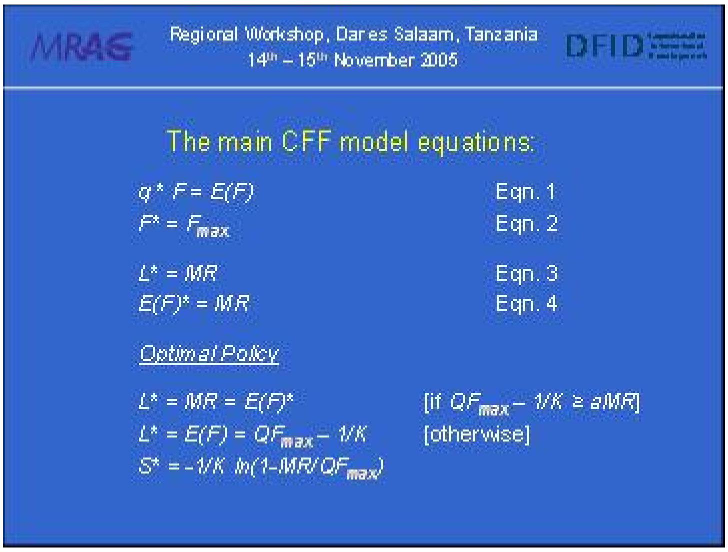

MRAG
Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
DFID
Fishers would:
▪ purchase a licence and fish legally inside the EEZ
if L ≤ MR and L < E(F)
▪ not purchase a licence and fish illegally within the EEZ
if E(F) ≤ MR and E(F) < L
▪ not purchase a licence and fish legally outside on the high seas
if L > MR or E(F) > MR

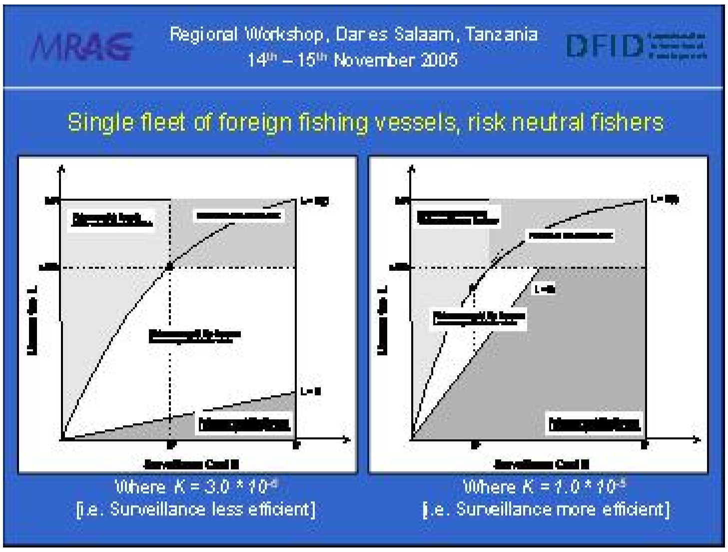

MRAG
Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
DFID
Coastal State Decisions
if L > E(F) then seek to issue licences
if L < E(F) then refuse to issue licences even if fishers want them
But ...
if L < S then definitely issue no licences
if S < L < E(F) then consider issuing licences

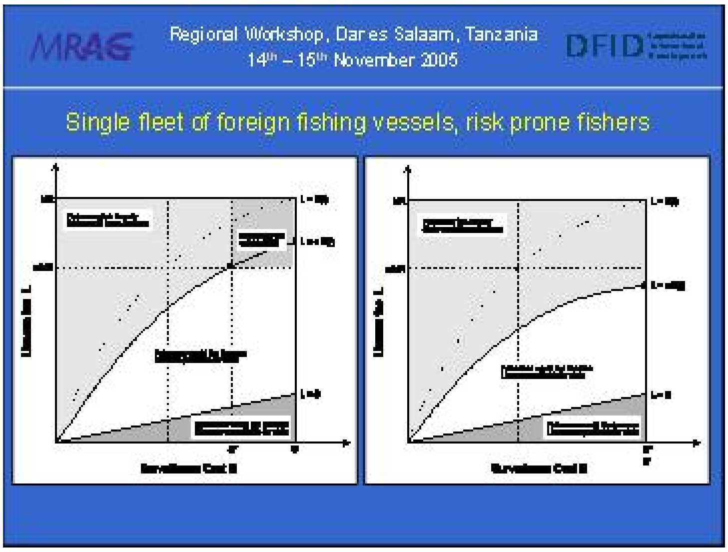

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Single fleet of foreign fishing vessels


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Single fleet of foreign fishing vessels
Optimal

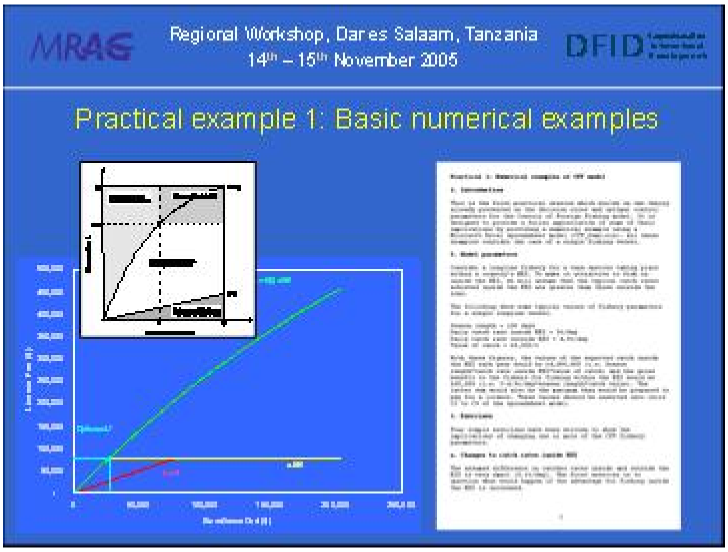

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Surveillance: probability of detection
1
Q
Probability of detection
q = Q(1-exp(-KS))
0
Surveillance expenditure

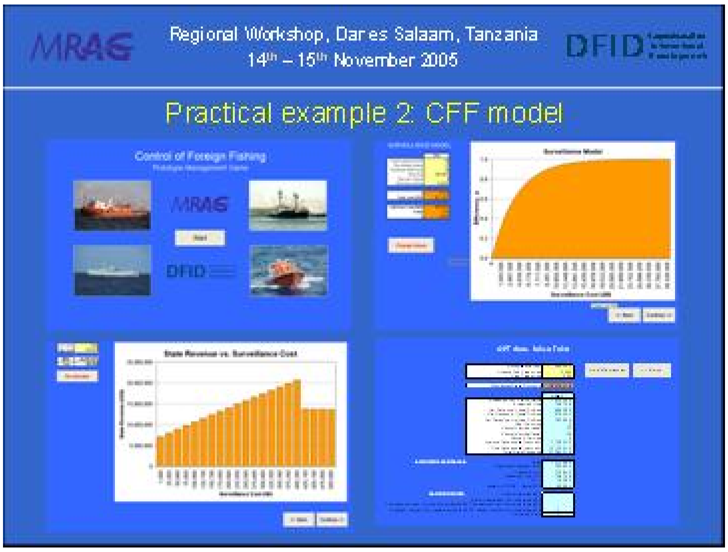

Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
The main CFF model equations:
q * F = E(F) Eqn. 1
F* = Fmax Eqn. 2
L* = MR Eqn. 3
E(F)* = MR Eqn. 4
Optimal Policy
L* = MR = E(F)* [if QFmax – 1/K ≥ aMR]
L* = E(F) = QFmax – 1/K [otherwise]
S* = -1/K ln(1-MR/QFmax)


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Single fleet of foreign fishing vessels, risk neutral fishers
Surveillance Cost
Where K = 3.0 * 10-6
[i.e. Surveillance less efficient]
Where K = 1.0 * 10-5
[i.e. Surveillance more efficient]


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Single fleet of foreign fishing vessels, risk prone fishers


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Management Game: Input parameters
Season length (days)
Vessel type (PS or LL)
Value of vessel type ($)
Number of vessels (#)
Catch rate inside EEZ (t/day)
Catch rate outside EEZ (t/day)
Catch value ($/t)
Fleet 'honesty coefficient'


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Practical example 1: Basic numerical examples


Regional Workshop, Dar es Salaam, Tanzania
14th – 15th November 2005
Practical example 2: CFF model
Control of Foreign Fishing
Surveillance Model
State Revenue vs. Surveillance Cost

Appendix L: Field visit to MCS Operations Centre, Mbegani

The MCS Operations Centre, Mbegani.

Workshop participants at MCS Operations Centre in Mbegani, Tanzania. From left to right: Martha Mukira; Robert Wakeford; Michel Marguerite; James Wilson (behind); Razack Lokina; Ranwel Mbukwa; Manuel Castiano; Kennedy Shikami; Noa Senete; Rashid Aman. **Photographers:** Ian Shea and Rebecca Mitchell