



**The Relationship between the World
Price for Skipjack and Yellowfin Tuna
Raw Material for Canning and Supply
from the WCPO and
FFA Member Countries EEZs.**

ANTHONY D OWEN

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Prepared by:
ANTHONY D OWEN
School of Economics
The University of New South Wales
Sydney, NSW 2052
AUSTRALIA

For
PACIFIC ISLANDS FORUM FISHERIES AGENCY
P.O.BOX 629 HONIARA SOLOMON ISLANDS
TELEPHONE (677) 21124
FAX (677) 23995
WEB <http://www.ffa.int>

EXECUTIVE SUMMARY

- The objectives of the project are to:
 - 1) Investigate the relationship between the world price for skipjack and yellowfin tuna raw material for canning and supply from the WCPO and FFA member countries' EEZs; and
 - 2) To assess the ability of FFA member countries individually or collectively to influence world 'light meat' tuna raw material for canning prices.
- Successful restriction of supply by a group of resource owners in order to force up prices requires that two fundamental conditions must be satisfied. First, the total demand for the product must be relatively insensitive to changes in its price. Second, either the group of resource owners must control nearly all of the world's supply or, if they do not, the supply from non-member resource owners must also be relatively insensitive to price changes. Most collusive international commodity agreements based upon supply restrictions have failed because few world markets would meet both these conditions, particularly in the long term.
- Based upon the analysis contained in this report, it is possible to identify a number of key criteria that would contribute towards the success of collective action in restricting catches by FFA member countries in order to maintain skipjack and yellowfin tuna prices at levels higher than those that would be determined by a freely operating market.
 - 1) Total demand for canned tuna must be relatively insensitive to changes in its price, both in the short and long term (that is, there should be no close substitutes);
 - 2) The FFA must control the vast bulk of the world supply of the product or, if it does not, the supply of non-FFA members must be relatively insensitive to changes in the price of raw tuna;
 - 3) The FFA should have the support of all member country governments when imposing catch restrictions;
 - 4) There should be an absence of broad-based political conflict between FFA member country governments;
 - 5) Market entry of new suppliers should be difficult (e.g. very high cost and/or risk);
 - 6) There should be a high level of vertical integration in the industry (i.e. the FFA should control all stages of canned tuna production).

At best, most of these conditions are only partially met in the context of the FFA-region fishery.

- Econometric evidence on relevant price elasticities of supply and demand is weak, limited in scope, or non-existent. The primary reason for this situation is the lack of data for the major factors that impact on supply and demand, and the limited data series available on tuna prices. In the absence of strong quantitative information, this report has had to be based upon a more qualitative assessment of likely market reaction to catch restrictions imposed by FFA member countries.
- Catch restriction by FFA member countries would undoubtedly produce a short-term increase in the price of both skipjack and yellowfin tuna. The extent to which this increase can be sustained in the long-term depends on a number of factors relating to the size of the restriction, the sensitivity of supply to price increases in other tuna fishing regions, and the sensitivity of demand to increases in the price of canned tuna.

- This study found that the world price of skipjack tuna raw material for canning exhibits a relatively high (inverse) correlation with the world catch of skipjack. A similar relationship was not found for yellowfin. The implication of this result is that if FFA member countries, operating collectively, were to place quantity restrictions on catches of skipjack and yellowfin tuna within the FFA region, then the price of skipjack tuna could be expected to rise by (on average) about US\$94 per metric ton for a total of one hundred thousand metric tons withdrawn from the market.
- If FFA member countries, operating collectively, were to place quantity restrictions on catches of skipjack and yellowfin tuna within their EEZs, as the price of raw tuna increased there would be two offsetting influences:
 - 1) Higher world tuna prices would act as an incentive for increased levels of fishing effort in other tuna fishing areas, including non-FFA areas within the WCPO. The resulting increase in catches would tend to have an offsetting dampening impact on price. If exploitation rates in these other areas were below those of sustainable yield, then even in the long term these increased catches could be maintained.
 - 2) Higher prices for the tuna raw material would flow on to the final consumer of canned tuna and hence reduce demand, although the extent of the impact on retail prices is likely to be relatively small compared with that of price induced changes for raw tuna.
- The WCPO is the world's dominant skipjack fishing area, accounting for about two-thirds of the total annual world catch. However, the FFA region accounts for only around two-thirds of the WCPO catch (or 40 per cent of the world total). Thus, while the fishery in the FFA region will be a major beneficiary in the advent of an increase in prices, the market power of the fishery is limited. Without co-operation from other fishing areas, including those within the WCPO, withholding of supply unilaterally is likely to encourage other areas to fill the shortfall by increasing fishing effort even if this may be non-sustainable in the longer term.
- Scientific evidence suggests that the annual catch of yellowfin appears to have reached, or be close to, maximum sustainable catch levels in all fishing areas. As a consequence, if any one fishery were to impose catch controls that reduced catch below these levels, then the price of yellowfin tuna could be expected to rise. The extent of any such rise would depend upon the sensitivity of price to changes in the supply of yellowfin tuna and to changes in the supply of skipjack tuna (as a substitute product). However, the FFA region accounts for only around 20 per cent of both recent catches of yellowfin and the estimated maximum sustainable catch. This is a relatively low market share and, without co-operation from other fishing areas, catch restrictions on yellowfin imposed by FFA member countries would be likely to encourage other areas to fill at least some of the shortfall by fishing at non-sustainable levels.
- In the short term it is possible that any restrictions on catches in the WCPO could be offset by greater effort elsewhere in the world. Although this could imply catches being made at non-sustainable levels, it would permit short-term financial benefits in these areas. However, in the longer term such actions would be, by definition, non-sustainable and catches would fall as a result of growing scarcity, thus giving an upward impetus to prices.

- There has been a long history of under-reporting and non-reporting of catches in the FFA region by distant water fishing nations. Whilst the situation is less of a problem today, catch restrictions may encourage a return to such practices in order to avoid limits on catch. In addition, distant water fishing nations operate outside member countries' EEZs in high seas areas in what is defined in this paper as the FFA region. If FFA member countries are unable to restrict catches in these high seas areas as well as within their EEZs this may result in increased fishing effort on the high seas. Clearly, if either of these factors come to pass they would reduce the effectiveness of any attempt to restrict catches.
- Unilateral action to restrict annual catch of skipjack and yellowfin by FFA member countries would give other fishing regions a “free ride” to higher prices. This could encourage enhance levels of fishing effort in these areas and more extensive use of FADs and other technologies to capture the higher levels of rent that would become available. As a consequence, it could also lead to fishing practices in other regions that involved catches higher than the maximum sustainable catch (particularly for yellowfin).
- An alternative approach could be collective action by an association of all resource-owning nations representing the entire world tuna fishery. Essentially this would give monopoly power to such an organisation, although this would not guarantee the success of any price maintenance scheme based upon catch restrictions. The coffee industry cartel has had similar power for many decades and still has been unable to stabilise prices at levels acceptable to member countries. However, the collective approach does ensure, in the absence of cheating, that all countries make similar sacrifices.
- Demand-side action, such as advertising or “new tuna product” lines, is also an option, either singularly or in conjunction with catch restrictions. Here the intention would be to attract new consumers, hence raising demand and ultimately strengthening raw tuna prices.

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LIST OF ABBREVIATIONS

ACPC	Association of Coffee Producing Countries
c&f	cost and freight
CPUE	Catch Per Unit of fishing Effort
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EPO	Eastern Pacific Ocean
EU	European Union
FAD	Fish Aggregation Device
FFA	Forum Fisheries Agency
IBA	International Bauxite Association
ICA	International Coffee Agreement
ICO	International Coffee Organisation
kg	kilograms
LME	London Metal Exchange
mbd	million barrels per day
MSY	Maximum Sustainable Yield
Mt	Metric ton (or tonne)
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries
SPC	Secretariat of the Pacific Community
WCPO	Western and Central Pacific Ocean
WTPO	World Tuna Purse Seine Organisation

1 Introduction

In 1998 global catches of skipjack reached 1.91 million metric tonnes (Mt) a rise of nearly 23 per cent compared to the previous year and around 14 per cent higher than the previous record catch of 1.67 million Mt landed in 1995. In 1999 global skipjack catches continued to increase and were just short of 2.0 million Mt, around 5 per cent higher than the previous years' record (SPC 2001). In 2000 catches in the Western and Central Pacific Ocean and Eastern Pacific Ocean were down by around 4 per cent compared with 1999 but still 15 per cent higher than the highest catch recorded prior to 1998.¹

From August 1998 through to the end of 2000 the price of frozen skipjack used in the production of 'light meat' canned tuna fell dramatically. The Bangkok benchmark price (that is, for fish sized 4-7.5lbs, c&f) declined from around US\$1150/Mt in August 1998 to around US\$390/Mt by December 2000. The average monthly Bangkok skipjack benchmark price for 2000 was around US\$490/Mt, the lowest on record², and substantially below that seen over the decade prior to 1999³. The price of yellowfin used in the production of 'light meat' canned tuna also fell between August 1998 and the end of 2000, albeit less dramatically, declining from around US\$1425/Mt in August 1998 to around US\$940/Mt by December 2000.

In response to the decline in skipjack prices the World Tuna Purse Seine Organisation (WTPO)⁴ was formed in December 2000. The objective of the WTPO is to reduce skipjack supplies and ensure a 'more normal' balance between supply and demand and to increase and/or stabilise prices; that is, in effect, to act as a "cartel". To do this the members of the WTPO adopted various resolutions to reduce the amount of fishing activity undertaken by their fleets over the course of 2001. In early 2001, Bangkok benchmark skipjack prices began to recover reaching around US\$980/Mt in late March before declining to around US\$750/Mt by June. Prices in the latter half of 2001 remained relatively stable in a range of US\$700-800/Mt. There is some debate as to whether the actions of the WTPO were the principal cause of the increase in prices observed during 2001. Nonetheless, the recent price increases and the fact that around 65 per cent and 40 per cent of global skipjack supply is caught respectively within the WCPO and the FFA region gives rise to the possibility that restricting or reducing catch levels in these areas may result in higher world prices.

The decline in the prices also resulted in pressure on member countries of the South Pacific Forum Fisheries Agency (FFA) to reduce access fees levied on the purse seine fleets of Distant Water Fishing Nations (DWFNs) operating within their Exclusive Economic Zones (EEZs). This and the formation of the WTPO highlights the need for FFA member countries, as they seek to manage their tuna fishery in order to maximise economic benefits from its exploitation, to take into consideration issues relating to the formation of world tuna prices. This report address two such issues, that is, "the relationship between world prices for skipjack and yellowfin tuna raw material for canning and supply from the WCPO and FFA

¹ Catch data for 2000 were only available for these fisheries at the time of publication of this report.

² Production of canned tuna in Thailand commenced in the early 1980s and monthly price data series are available from 1984.

³ Between 1988 and 1998 the Bangkok skipjack benchmark price averaged between US\$810/Mt and US\$1050/Mt.

⁴ Members of the WTPO include purse seine vessels owners from Colombia, Ecuador, France, Japan, Korea, Philippine, Panama, Spain, Taiwan and Venezuela.

member countries' EEZs" and "the ability of FFA member countries individually or collectively to influence world 'light meat' tuna raw material for canning prices".

In an unregulated competitive market, consumers and producers buy and sell at the prevailing market price. No single buyer or seller of a commodity can affect its price, and thus all buyers and sellers are price takers. Clearly, the existence of a competitive market is not conducive to price manipulation by individual producers or resource owners, and therefore associations of producers or resource owners must be formed if market intervention is to be effective. Such associations are often referred to as "cartels".

If FFA member countries were to act collectively to influence world 'light meat' tuna raw material for canning prices, this would in effect represent the formation of a *de-facto* cartel. Therefore, in order to assess the ability of FFA member countries to collectively influence world 'light meat' tuna raw material for canning prices it is necessary to identify market characteristics and other factors that will determine whether the operation of such a *de-facto* cartel is likely to be successful.

In Section 2 of this report the operation and performance of cartels, in both theoretical and practical contexts are reviewed. From this review, market characteristics and other factors that are required for the successful operation of a cartel are identified, and the reasons behind their limited success in practice or, more often, their failure are addressed. A number of examples illustrate how difficult it is for cartels to secure a successful long-term existence.

Section 3 assesses the supply situation for skipjack and yellowfin tuna. It traces catch profiles of the two species over recent years and the relative importance of catches in the WCPO and within the FFA region⁵. An assessment of sustainability of each of the world's major tuna fishing regions is also given. Finally, the relationship between world prices for skipjack and yellowfin tuna raw material for canning and supply from the FFA region is assessed.

Section 4 considers the demand for canned tuna, by major consuming nations.

Section 5 reviews previous economic studies of markets for marine resources, with emphasis on econometric results that may have relevance for this study.

Finally, Section 6 provides an overview of the results generated from the analysis. It also presents a discussion of the potential to increase world 'light meat' tuna raw material for canning through a reduction in catch levels within the FFA region.

⁵ In this report the FFA region is defined as the "SPC statistical area" (Map 2). As almost all of the catch landed in the SPC statistical area are landed in the EEZs of FFA member countries or high seas areas adjacent to these zones they provide a good reflection of the level catch over which FFA member states could potentially exert some degree of control.

2 Analysis of Cartels: Theory and Practice

2.1 Introduction

A cartel is a collection of producers in an industry that explicitly agree to co-operate in setting prices or output levels. If producers within the cartel adhere to the cartel agreements, and if the supply elasticity of producers or nations outside of the cartel and market demand elasticity are sufficiently inelastic, the cartel may drive up prices significantly above those that would otherwise prevail under competitive market conditions. In simple terms, supply is said to be inelastic where an increase in the price of a good or commodity leads to an increase in supply of lower magnitude than the increase in price. Thus, for example, if the actions of a cartel lead to a 10 per cent increase in price, and this in turn leads to a 5 per cent increase in supply from producers or nations outside of the cartel, then the supply elasticity of non-cartel members is said to be inelastic.⁶

Although cartels are often international in membership, US antitrust laws prohibit American companies from participating in such acts of collusion. However, US companies operating in the same industry as the cartel can clearly not be isolated from the benefits of higher prices resulting from cartel behaviour. Similarly, other producers or nations that choose to remain outside the cartel will benefit from higher prices that result from the actions of the cartel.

There are two requisites for a cartel to be a success. First, the cartel members must agree on production levels (and their corresponding desired price, which at that stage will not be known with any degree of precision) and adhere to that agreement (that is, no significant cheating should occur). Agreement among cartel members may not be an easy achievement. Different members may have different costs, different assessments of market demand, and even different objectives. Furthermore, each member of the cartel will be tempted to cheat by increasing production above its allotted level in order to benefit from the higher prices. The threat of a long-term return to competitive prices is the major deterrent to this form of cheating. If the profits from forming a cartel are large enough, that threat may be sufficient.

The second requisite for success is the potential for monopoly power⁷. Even if a cartel can solve all organisational problems, there will be little opportunity to force up prices if it faces a highly elastic demand curve. That is, if a small increase (decrease) in the price of the good or commodity leads to a large decrease (increase) in the level of demand for the good or commodity. Potential monopoly power is the most important condition for success, since it is then that the potential gains from co-operation are large and thus cartel members will have more incentive to adhere to the agreement.

2.2 Theoretical Analysis of Cartels

In this section a brief and highly simplified description of the market forces that determine whether a cartel is able to effectively influence the price of a commodity is provided. From this description the market conditions that are required to allow a cartel to operate effectively are drawn out.

⁶ The concept of “elasticity” is more fully explained in Appendix I.

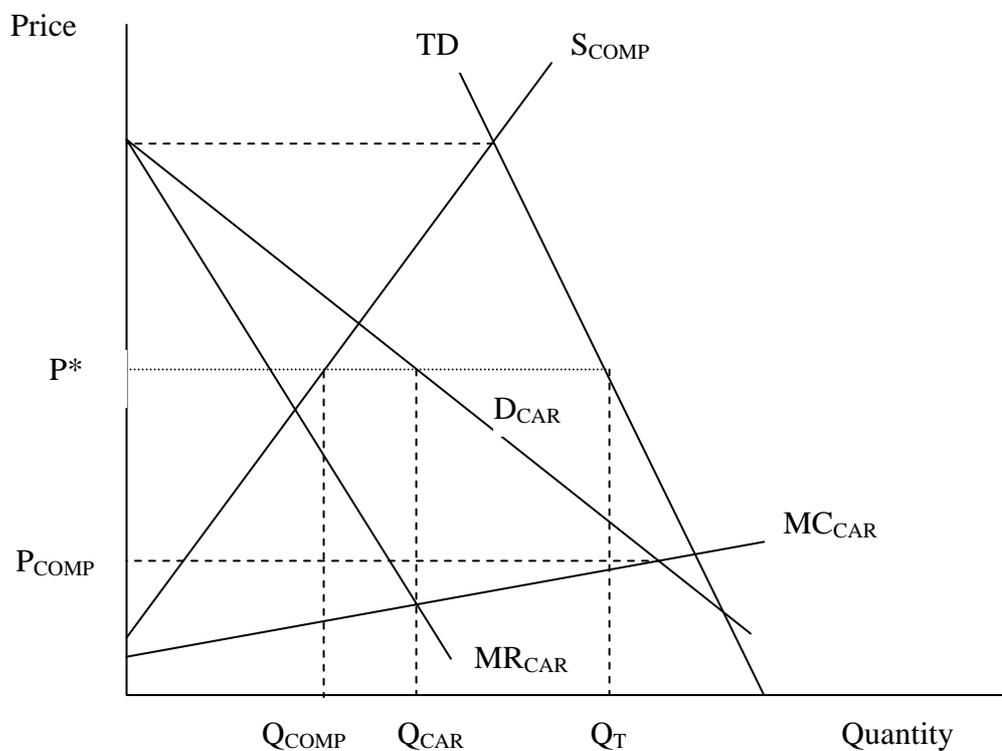
⁷ A monopoly is a market that has only one seller, but many buyers. Since the monopolist is the sole producer of the product, it has control over the price it can charge (but not over the resulting level of demand). Its ability to affect the price of the product gives the monopolist “market power”. Pure monopoly is unusual, but many markets only have a few producers (a situation known as an oligopoly). Collaboration between these few producers could effectively create a pure monopoly.

The analysis assumes that:

- the demand side of the market is perfectly competitive; that is, there are many buyers in the market and these buyers cannot on their own influence the market price; and
- the market is supplied by two groups: the competitive suppliers who do not take account of the effects of their output decisions on the market price, and the cartel that attempts to manipulate the market price by regulating the output of its members.

Figure 1 illustrates the case of a cartel where both the price elasticity of demand and the price elasticity of supply of non-cartel members are both highly inelastic. Demand (TD) is the world total demand for the product, and S_{COMP} is the competitive (non-cartel) supply curve. The demand for the cartel product D_{CAR} is the difference between total demand and competitive supply, since the cartel controls supply by restricting its own output after supply from non-cartel members has been exhausted. MR_{CAR} is the corresponding marginal revenue curve; that is, the additional revenue earned by the cartel from supplying an extra unit of the commodity. MC_{CAR} is the cartel's marginal cost curve; that is, the additional cost incurred by the cartel in supplying an extra unit of the commodity or good, which is assumed to be significantly below that of the competitive producers. The cartel's marginal revenue and marginal cost are equal at quantity Q_{CAR} , which is the quantity that the cartel will produce as the cost of producing an additional unit of the commodity beyond this point will be greater than the additional revenue earned from its production. From the cartel's demand curve it can be seen that the market price will be at P^* . At this price, supply from the competitive producers will be equal to Q_{COMP} and total supply equal to Q_T

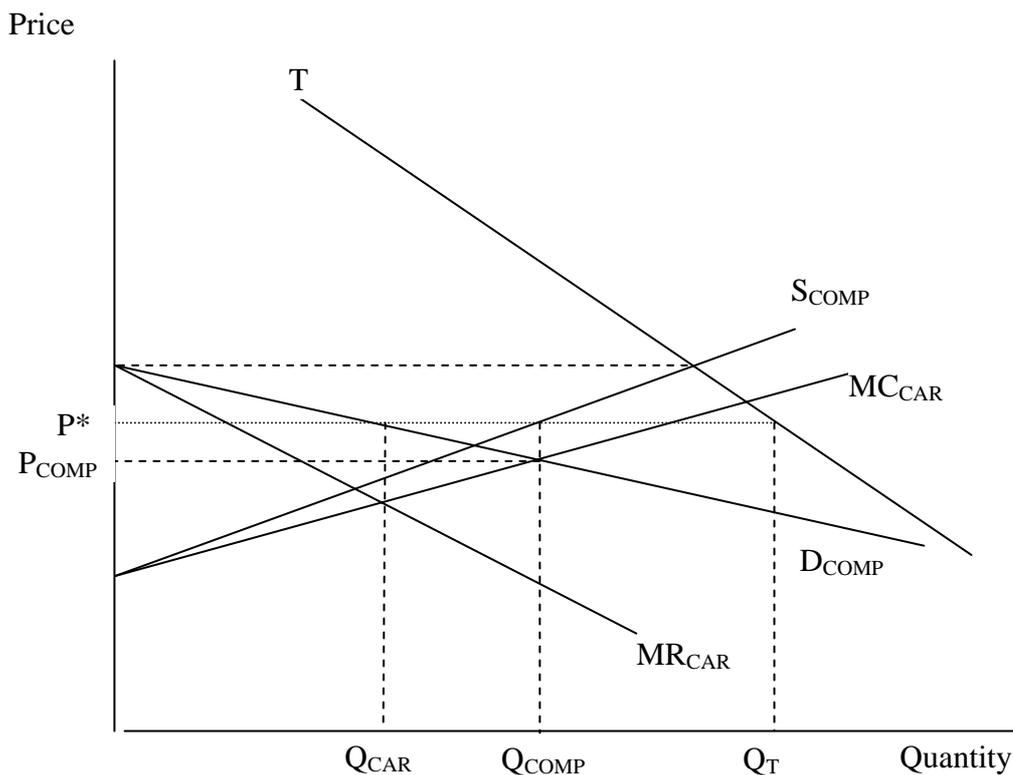
FIGURE 1



If no cartel had been formed, and instead the market outcome was determined by competitive market prices, price would then have equalled marginal cost. Thus the competitive outcome would be where the cartel's demand curve intersects its marginal cost curve. That price, P_{COMP} , is much lower than the cartel driven price, P^* . Thus, due to the highly inelastic supply and demand curves, the cartel has substantial monopoly power that can be used to drive prices well above competitive levels. Note, however, that all producers receive this higher price, so non-cartel members benefit equally in terms of price with cartel members. In the long term, however, both demand and supply will tend to become more elastic, which means that the cartel's demand curve will also become more elastic. As a result, maintenance of prices substantially above competitive levels can not be sustained indefinitely.

Figure 2 provides a similar analysis but with both demand and supply elasticities far higher (i.e. more elastic) than for Figure 1. In addition, it is assumed that the marginal cost curve of the cartel only lies slightly below that of the supply curve of the other producers. The explanation follows similar lines to that for Figure 1, but now the competitive price is very close to the cartel price. Thus relatively elastic supply and demand curves have reduced the impact of the cartel's monopoly power relative to that existing with the inelastic supply and demand curves presented in Figure 1.

FIGURE 2



In summary, successful operation of a cartel requires that two conditions must be satisfied. First, the total demand for the product must be price inelastic; that is, for example, a 10 per cent increase in the price of the commodity must result in a decline in the total amount demanded of less than 10 per cent. Second, either the cartel must control nearly all of the world's supply or, if it does not, the supply of non-cartel producers must also be price inelastic; that is, for example, a 10 per cent increase in the price of the commodity must result in an increase in supply from the non-cartel producers of less than 10 per cent. Most

international commodity cartels have failed because few world markets meet both these conditions in the long term.

2.3 Operation and Performance of Resource Cartels

While the existence of suitable market conditions is a necessary condition to allow for a cartel to operate successfully, the existence of these conditions is not by itself sufficient to ensure such success. In this section a review of the operation of resource cartels in general, and for a range of actual resource cartels, is provided. This is done in order to establish the key criteria for the formation of a cartel that can successfully influence a commodity's price.

Export cartels have a close association with resource products. Over the years, there have been many attempts to form export cartels, in commodities ranging from coffee to oil to tin. Primary-product cartels first became prominent after World War I. The measures employed by these primary product, multi-country, cartels are directed at controlling the supply of a given product on the market. Depending on the circumstances, the techniques employed are decreed prices, production cutbacks, selective embargoes, increased royalty payments, negotiated prices, direct market intervention, stockpiling and export taxes.

Most export cartels failed for want of one or another of the requisite conditions listed above, even after producer governments became active participants in the 1930s. Producer countries often argue that associations of producers should be tolerated or even encouraged in order to stabilise commodity prices. Their stated objectives may include: a sharp increase in receipts from the commodity itself, protection against price declines, greater price stability, conservation of a depleting resource, more domestic processing, and/or more local control over the industry. There may be real economic gains from building up buffer stocks to raise prices in periods of excess supply and selling the stocks to mitigate price increases when demand exceeds production. However, stabilisation can be hard to distinguish from plain monopolistic price increases.

The operation of international commodity agreements since World War II reflects this ambiguity of objectives and also illustrates the ways in which export cartels can fail. Reflecting their unclear objectives, the cartels have employed a mixture of policy instruments—buffer stocks (usable mainly for price stabilisation) and export quotas (needed to secure monopoly prices). Even those cartels that succeeded for some time collapsed through the failure of one or the other mechanism.

In the 1970s and 1980s, producers of primary products made an intense effort to maximise their market power by forming cartels in order to boost their earnings. Some of the more prominent efforts have been to cartelize:

- oil-exporters through the Organisation of Petroleum Exporting Countries;
- leading bauxite producers through the International Bauxite Association;
- phosphate producers;
- leading copper producers through the Council of Copper Exporting Countries;
- tin producers, through the International Tin Agreement; and
- the leading coffee producers, through a series of interlocking market companies and stockpile-financing arrangements.

In addition, efforts have from time to time been undertaken regarding iron ore and mercury and a number of other products such as tea, tropical timber, natural rubber, nickel, tungsten,

cobalt, columbium, tantalum, pepper and quinine. Some arrangements have enjoyed some success: oil, phosphates and coffee. Others faltered rapidly: bananas, copper and tin. The average life expectancy of a multi-country resource sector cartel is relatively short. In view of this, the economics literature stresses the inevitability of their collapse. Diamonds has been the most cartelized resource product to date. Until recently, De Beers, a South African private cartel, managed the marketing of South African, Australian and Russian diamond ores. However, even this highly successful cartel ultimately collapsed (for reasons outlined in the next section).

A number of examples of cartels, the motivation for their formation, and their comparative strengths and weaknesses are given below.

2.3.1 Exhaustible Resources

2.3.1.1 Organisation of Petroleum Exporting Countries

The Organisation of Petroleum Exporting Countries (OPEC) is an organisation of eleven oil producing and exporting countries, from Africa (Algeria, Libya, and Nigeria); Asia (Indonesia); the Middle East (Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates); and Latin America (Venezuela).

Prior to the formation of OPEC, the major international oil companies (the so-called Seven Sisters) were frequently accused of acting as a cartel and attempting to raise prices by restricting output of crude oil. Ironically, it was an attempt by these companies to reduce prices that led major oil exporting nations to establish OPEC in 1960.

The OPEC nations required private oil companies to reduce production, thereby preventing prices from falling. Subsequently, the exporting nations solidified their control over pricing and production, in effect expropriating the private oil concessions. Thereafter, the private oil companies operating in OPEC countries received only what amounted to handling fees for extraction and marketing services. For example, in 1973 the Saudi Arabian government took all but about 60 cents of the \$2.59 price of a barrel⁸ of crude oil. From 1960 to 1973 the benchmark price of oil (Arabian light crude) gradually rose from \$1.80 to \$2.59 a barrel.

Following an armed conflict between Israel and Egypt and Syria in late-1973, the Arab countries that dominated OPEC reduced output and imposed a selective embargo in an attempt to influence diplomatic policies of Western nations. As a result, oil prices more than quadrupled, reaching \$11.63 a barrel by the beginning of 1974. The problem for OPEC was (and still is) to hold production down to levels that would maintain such high prices. In reality, most OPEC members were not restricting their production to their allotted quota and price maintenance relied upon the major producers, Saudi Arabia and to a lesser extent Kuwait, keeping their own production at relatively low levels (Saudi Arabia was acting as a so-called “swing producer”, adjusting its own output to ensure price maintenance). Over the next 5 years prices only rose slightly, reaching \$13 a barrel by 1979 (although a significant depreciation of the US\$ over the same period meant that, in real terms, prices actually fell substantially from their peak).

The 1979 Iranian Revolution paralysed oil production in that country and oil prices increased dramatically, aided by severe cutbacks in production in other Arab OPEC countries, reaching

⁸ A barrel of oil is equivalent to 158.987 litres.

\$34 a barrel in late 1981. However, two factors were now starting to operate against OPEC producers, both resulting from historically high post-1973 oil prices. First, the long-run price elasticity of demand proved to be significantly higher than in the short run, as industrialised nations substituted other fossil fuels for oil in many end-uses and placed a greater emphasis on the efficient use of energy. Second, the high prices had stimulated oil exploration activity elsewhere in the world, particularly in Mexico and the North Sea, and these fields were now coming on-stream. Thus, to maintain oil price levels, OPEC countries (and particularly Saudi Arabia) had to cut production severely. By early 1983 OPEC production was less than half its peak 1979 output of 32 million barrels a day (mbd), with Saudi Arabia's individual production falling from 10.2 mbd to less than 4 mbd. By March 1983 the price of oil had fallen to \$29 a barrel.

By late 1985, Saudi Arabia's frustration with other OPEC nations cheating on quotas finally led it to abandon its role of "swing producer". As a result, between November 1985 and February 1986 the price of oil plummeted from \$30 to \$15 a barrel. OPEC output also fell, to its lowest level in 20 years. With the exception of the relatively short period associated with Iraq's invasion of Kuwait and the subsequent military intervention of Western powers, the price remained relatively stable (at historical lows) through to 1998.

By early 1999, oil prices were at their lowest level for 25 years and OPEC members agreed on a major reduction in output to bolster them. In addition, some major non-OPEC producers, and importantly Norway, also agreed to cut output. At the same time, the US Department of Energy announced that a major addition to its Strategic Petroleum Reserve would take place over the ensuing nine months. Prices doubled by year-end 1999 and a unified OPEC was able to maintain these levels into 2001. However, the industrial recession in major industrial economies weakened demand and prices slipped down again in mid-2001. Recent attempts by OPEC to cut production have been thwarted by the unwillingness of non-members Mexico, Norway, and Russia to reciprocate.

Despite the disparate interests of its members and the increasing competition from non-OPEC suppliers, the OPEC cartel has remained remarkably solid. To a large extent this is due to it being operated at government level, however there are many factors that contribute towards its comparative strengths and weaknesses. Briefly these are:

Strengths of OPEC:

- 1) Political cohesiveness
 - The member states believed that they were being exploited;
 - Gulf Arab states formed a solid core to the agreement;
 - Producers had a common aim, in terms of both financial and political objectives.
- 2) Concentration of supplies
 - Kuwait and Saudi Arabia had potential production levels that could adversely affect price and punish defecting states (such as Iran and Iraq in the mid-1980s);
 - Oil companies already had concentrated marketing.
- 3) Price inelasticity
 - Few opportunities for short-term substitution;
 - Limited opportunities for long-term substitution in the transport sector;
 - Non-OPEC reserves relatively small.
- 4) Nature of the product
 - Low storage costs.

Weaknesses of OPEC

- 1) Long term impact of higher prices and/or supply disruption
 - Encourage conservation;
 - Switch out of oil for some end-uses;
 - New suppliers following increased exploration and, in addition, high cost fields become economic
- 2) Military conflict between member states; viz: Iran-Iraq and Kuwait-Iraq wars;
- 3) Third world debt problems for Nigeria, Venezuela and Indonesia encouraged them to exceed their quotas;
- 4) Third world pressure on OPEC over high prices hindering their development.
- 5) Internal disagreements and distrust over political role of oil.

2.3.1.2 International Bauxite Association

Bauxite is the predominant ore from which alumina is extracted. Aluminium results from processing of the latter. Annual world production of aluminium exceeds that of all other metals with the exception of iron ore. In addition, it has a very diverse range of end uses, most of which have higher priced (or, equivalently, less efficient) substitutes. Bauxite is mined throughout the world, although the major producers are Australia, Brazil, Guinea, and Jamaica, with smaller quantities produced by other Caribbean countries, some European countries, and countries of the former Soviet Union. Aluminium smelting requires substantial inputs of electricity, which is a major cost in its production. Thus smelting tends to be concentrated in countries that have access to large suppliers of power, and the bauxite producers generally export their product to such countries in the form of alumina.

Throughout the first half of the twentieth century, price determination via collusive practices between Alcoa (the world's largest aluminium producer with a monopoly in the USA) and Pechiny (with a monopoly in Europe) was an on-going feature of the world aluminium market. Both monopolies were based upon exclusive patent rights for processing aluminium. Despite being a US company, Alcoa avoided prosecution for such practices by colluding via its Canadian subsidiary, Alcan. Although its monopoly of the technology eventually ended, it retained an economic monopoly through economies of scale. However, anti-trust activity eventually caught up with Alcoa, and after the Second World War other aluminium producers were encouraged to establish a presence in the US. Nevertheless, until the 1970s, the industry remained oligopolistic in nature (with 6 companies accounting for around 70% of world smelting and refining capacity), and an informal producer alliance would still have provided opportunities for collusion. Historically, all companies had been vertically integrated, thus controlling the industry from the bauxite mine to the final refined product (and often to the fabrication of consumer goods too).

The 1973/74 OPEC-induced oil price hikes encouraged seven bauxite producing countries to establish the International Bauxite Association (IBA) in 1974 with the declared intention "to secure for member countries fair and reasonable returns from the exploitation, processing, and marketing of bauxite". Jamaica immediately imposed a bauxite production levy of 7.5%, linked to the price of aluminium ingot (the extreme level of vertical integration in the industry accounted for the absence of a 'free' market price for bauxite). The other Caribbean producers introduced similar levies shortly afterwards, and all started negotiations designed to give some domestic control over local mining operations. The multinational aluminium producers appear to have simply passed on the levy to the ultimate consumers, since the demand for aluminium is relatively price inelastic.

In the short term, the levy raised considerable revenue for the Caribbean producers and additional revenue for the IBA 'free riders', Australia and Guinea. However, with Brazil not joining the cartel, and Australia refusing to impose the levy, opportunities for raising the levy were severely restricted, and in 1979 it was lowered to 6%. Both Australia and Brazil increased their market shares, largely at the expense of Jamaica, although up to this time the levy had produced significant benefits for those members who had imposed it.

However, the economic recession in the early 1980s had a major adverse impact on the aluminium industry, and by 1983 pricing collusion amongst the majors had come to an end. This led to increased dissatisfaction from aluminium producers with the bauxite levy, and a trend to purchase bauxite/alumina from, and site smelters in, Australia, Brazil, and other non-levy imposing countries. Nevertheless, the Caribbean producers of bauxite have a distinct transport cost advantage over their more distant competitors when shipping bauxite to the US, and the levy remains in place today. The levy is worth around US\$3 billion a year in revenue to the Jamaican government. Thus, although substantial sales have been lost due to the imposition of the levy, it continues to deliver significant additional (to bauxite sales) revenue to those Caribbean nations that impose it.

2.3.1.3 De Beers' Diamond Cartel

The De Beers diamond cartel was established in 1934 by Sir Ernst Oppenheimer, a South African mining magnate, at a time when gems were flooding the market and prices had collapsed, although Cecil Rhodes had established a diamonds cartel in the previous century.

Its survival until the end of the twentieth century is testimony to the ingenious way in which De Beers dominated the trade. The basic element of market control is to make it hard for producers to desert the system. De Beers paid producers higher prices than they could find elsewhere when prices were weak, so they had little incentive to undercut De Beers in pursuit of market share. De Beers backed up this carrot with a stick: its ability to increase the supply to the market of particular types of diamond. Every diamond mine has its own characteristic output. If a mine with lots of medium-sized stones were tempted to go it alone, it would face the likelihood that De Beers was able to flood the market with just that sort of diamond. Nearly all producers opted to stay with De Beers and, in return, De Beers treated them with utmost discretion. For instance, during the years of apartheid, diamonds from Russia found their way through the De Beers system and into the hands of cutters without Russia suffering any embarrassment over collaboration with the South African regime.

De Beers dealt with the problem of possible overproduction by cartel members with a quota system. The biggest producer is Australia, followed by Zaire, Botswana, Russia and South Africa. Most significant producers had a contract to supply a certain proportion of De Beers' annual diamond sales. When sales were weak De Beers' own mines could act as swing producers, thus moderating the adverse impact for other producers.

Another ingredient of De Beers' production control was that its own mines are one of the world's cheapest sources of fine diamonds. Down the line from production, De Beers also dominated the trade in rough diamonds. It reinforced its role as buffer stock manager through its external buying offices, particularly in Kinshasa and Antwerp. These operated in the market for diamonds mined outside De Beers' own production network.

The trade's middlemen, the rough-diamond cutters, were also cajoled to play along with the system. De Beers sells over 3,000 types of diamonds, but did not allow the cutters freedom to

select what they wanted. The rough stones were sold at "sights". A buyer took a whole box, or they turned down a whole box. Nor could they bargain over price (boxes were worth from \$1 million to \$25 million each). The box method kept the flow of diamonds going in lean times. Just as important, it kept the right mix of diamonds flowing.

This box system was based upon an intimate knowledge of the state of the diamond pipeline. Such was De Beers' influence that it could check whether cutters were secretly building up stocks of a certain type of gem through the spot checks of its clients' books. De Beers recorded the capacity of cutters, their requirements and their stocks. De Beers claimed that more than 80% (by volume) of the world's diamonds flowed to the market through this system.

The final element in De Beers' grasp of the diamond market was the way it shaped diamond demand by spending vast amounts of money on advertising. This focused the consumer's attention specifically on the stones that De Beers needed to sell. For instance, to shift lots of small diamonds in one go, De Beers invented the diamond-studded wedding anniversary ring: "a band of diamond that says you'd marry her all over again".

Thus De Beers controlled production, dominated the trade, and influenced demand through what amounted to enforced vertical integration of the industry.

However, by the year 2000, the De Beers cartel had collapsed. A combination of lower demand (the Asian Crisis), the withdrawal from the cartel of Australia's Argyle mine (the world's largest producer of diamonds), and the establishment of off-market exchanges of "conflict gems" (diamonds for weapons) in a number of African countries effectively made market stabilisation too expensive. Henceforth, De Beers is to concentrate on saturation advertising and marketing, designed to make it the diamond industry's "preferred supplier".

2.3.1.4 The International Tin Agreement

Of all commodities, tin is probably the one where conditions are most conducive to the success of a commodity agreement. There are relatively few major exporters, tin is important to all of them (so they have a strong incentive to co-operate), the market is thin enough to be very responsive to intervention and the stocks available for intervention are large relative to the market.

Malaysia, Indonesia, Thailand and Bolivia produce the bulk of the world's tin. The largest producer is Malaysia. The country most dependent on tin is Bolivia. The most important end uses of tin are in cans and in solder. Substitutes, such as plastics and aluminium, have become more and more important for containers, while the resmelting of tin scrap has increased.

International attempts to regulate the tin market began back in the 1920s. In the face of depressed prices caused by an oversupply of tin after World War I, the main producing firms established voluntary production quotas. These did not work, and so the countries concerned negotiated an agreement in 1931. This involved mandatory quotas, enforced by the member governments and a buffer stock. The members of the agreement accounted for about 90% of world output. The agreement was successful in supporting prices, but this success induced expanded operations by "free riders", tin producers who did not participate in the agreement even though they benefited from the higher prices it brought about. Thus by 1933, the members' market share had fallen to about 73%. Successive agreements followed, up to

World War II, with outsiders being brought in (for a price) and more features were added to the agreement.

Negotiations after the War for a new arrangement culminated in the International Tin Agreement of 1956. Consumer countries were also included. Every five years, a new agreement came into being, with the most recent being the 1981 Sixth International Tin Agreement, which included 22 producing and consuming nations. The agreement set floor and ceiling prices and provided for a Council to oversee operations. There was a buffer stock (usually about 15% of world production), whose manager bought and sold tin to keep the world price between designated floor and ceiling prices. The Council also set export quotas and levied fines on members who violated them. The floor and ceiling prices had to be changed repeatedly and the buffer stock had been depleted several times. Nonetheless, there was modest success in limiting price fluctuations.

In the early 1980s, the price of tin began a long downward slide. The buffer stock manager bought tin steadily to support the price. This was successful, but with the price artificially held up producers were tempted to cheat or to free ride. Consumers were tempted to substitute for tin. Production expanded greatly in Brazil and China, both non-members, while Britain took more tin from its ancient Cornish mines. Britain was actually a member of the Agreement, but as a consumer rather than a producer. There were also allegations that the US, a non-member, was selling from its stockpile and that firms in member countries were cheating. All of this put pressure on the market.

In October 1985, the International Tin Council ran out of cash and announced that it could not honour commitments it had made to buy tin at the floor price: about 80,000 tons valued at around \$1 billion. Many of these contracts had been made on the London Metals Exchange (LME). The Council had dealt with about half of the twenty-eight members of the LME. These members are not brokers but dealt as principals. So when the Council reneged, the members it had dealt with were left holding the debt. The LME suspended all trading in tin, and negotiations began to bail out the Council. But the consumer countries and small producers had little incentive to contribute for this purpose and other countries, such as Bolivia, were themselves in desperate financial shape. Despite this spectacular collapse, the tin cartel had lasted for almost thirty years and was perhaps the least unsuccessful of the many attempts at commodity market price stabilisation.

2.3.2 Renewable Resources

2.3.2.1 The International Coffee Agreement

Excess supplies of coffee and a consequent slump in world prices led to the UN-sponsored (first) International Coffee Agreement (ICA) in 1962, between producer and consumer nations. This was followed by a second five-year Agreement in 1968. These two Agreements contained provisions for the application of a quota system whereby coffee supplies in excess of consumer requirements were withheld from the market. Under other provisions, production and diversification policies were initiated to limit supplies of coffee and promotion activities instituted to increase consumption. The operation of these Agreements helped prices to remain relatively stable, and contributed significantly to strengthening the economies of the coffee producing countries.

The International Coffee Organisation (ICO) is an intergovernmental organisation of 63 Member countries and is the trade association for the international coffee community. Established in 1963, when the first ICA came into force, it currently has 45 producing

members and 18 consuming members that account for 97% and 66% of world coffee production and consumption respectively.

Higher prices led to the collapse of the ICA quota system in 1973, and the 1968 Agreement was extended with all economic provisions deleted. When the ICA of 1976 was negotiated in 1975, serious frost in Brazil, the world's largest producer, had caused a supply shortfall and prices increased significantly. As a consequence, the principle new feature of the 1976 Agreement was that it allowed for the suspension of quotas if prices were high and their reintroduction if prices became too low.

Quotas were reintroduced in 1980, and remained in effect for most of the decade under the 1983 Agreement. As a result, prices were maintained within the agreed range. However, negotiations for a new Agreement in 1989 failed, largely because producers could not agree on reallocating quotas among themselves in favour of suppliers that were raising their efficiency (lowering marginal cost) or producing varieties in growing demand. After maintaining high and stable prices during 1980-1989, the agreement collapsed (and wholesale prices fell 40%) when Brazil left it. Brazil, a large but not high-quality producer, was unwilling to accept a reduced output quota and market share. The failure to reach a new Agreement led to the formation of the Association of Coffee Producing Countries (ACPC) in 1993. The declared aim of the ACPC was "to stabilise coffee prices at levels that are fair and remunerative to producers and yet consistent with increasing consumption" by controlling production. Although a new Agreement came into effect in 1994, the absence of any consensus on price regulation meant that it had to focus on other forms of international co-operation.

In May 2000, in the context of coffee prices reaching a seven-year low, the 14-member ACPC, supported by five non-member producers and a number of associate countries, agreed to hold back 20% of coffee exports until the average coffee price set by the ICO had increased by 30%. The members of this new cartel accounted for 90% of world coffee production. On news of the agreement, coffee prices shot up sharply.

However, by May the following year coffee prices had slumped to a 30-year low. ACPC's attempts to get growers to hold back 20% of their exports had only been partially successful. Only 70% of the retention target had been met, whilst a number of countries were suspected of cheating on export levels. The ACPC suspended the scheme and the ICO responded with a proposal to destroy a large quantity of low-grade coffee to prevent it from reaching the market. However, compensation payments have still to be determined. In addition, the stock of "withheld" coffee is further depressing prices. In late September 2001, prices had fallen to a 36-year low.

Most coffee producers are poor farmers, who face destruction if their business fails. Some farmers, especially in South America, have turned to alternative cash crops for which the demand appears to be relatively price inelastic (illicit drugs).

Demand-side attempts to raise coffee prices include initiatives by some countries to emphasise quality through brand names and country of origin (e.g. Café de Colombia). Colombian coffee receives a quality premium on its export price. Another initiative is to extend markets for coffee to countries where its consumption is not traditional (e.g. China).

2.4 Criteria for Establishing a Successful Cartel

Based upon the above theoretical analysis and the ensuing empirical analysis it is possible to identify a number of key criteria that would contribute towards the success of a cartel in maintaining prices at desired levels.

- 1) Total demand for the product must be price inelastic, both in the short and long term (i.e. there should be no close substitutes);
- 2) The cartel must control the vast bulk of the world supply of the product or, if it does not, the supply of non-cartel members must be price inelastic;
- 3) The cartel should have the support of all member country governments;
- 4) There should be an absence of broad-based political conflict between member country governments;
- 5) Market entry of new suppliers should be difficult (e.g. very high cost and/or risk); and
- 6) There should be a high level of vertical integration in the industry (i.e. the cartel should control all stages of production).

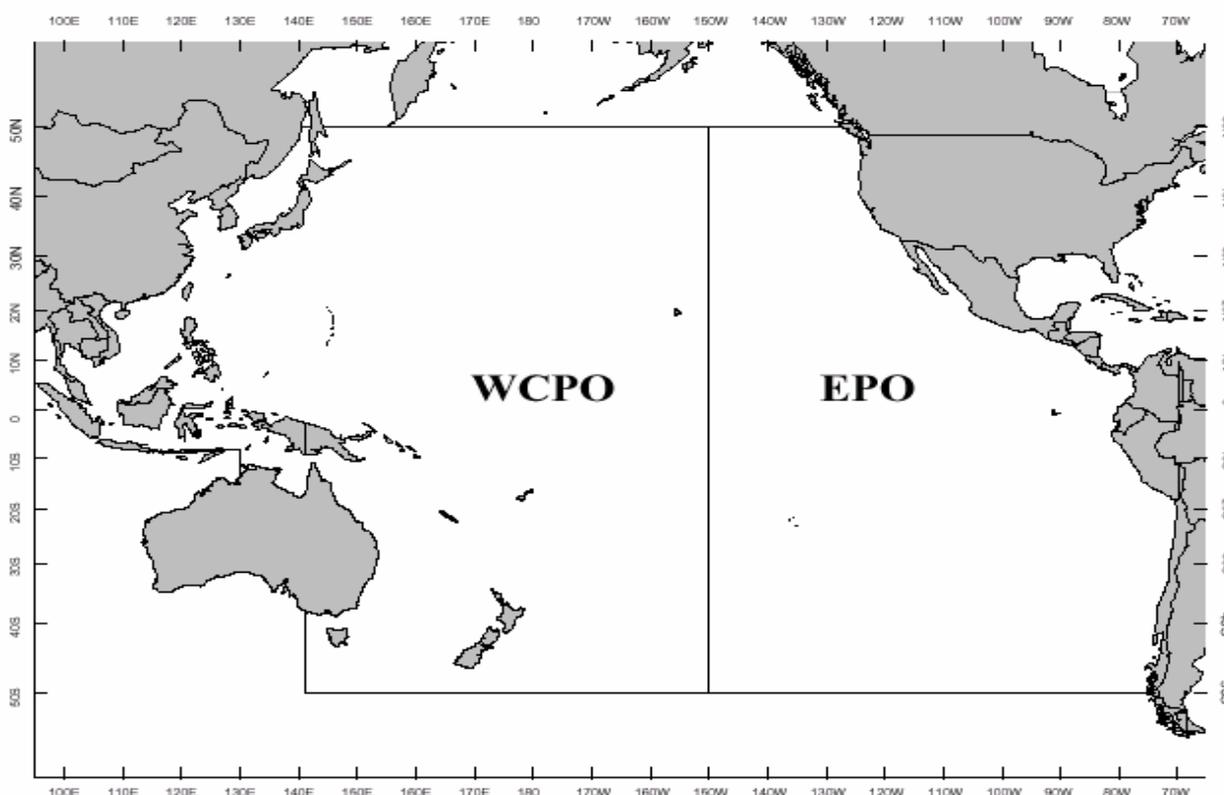
3 The Supply of Tuna

3.1 Introduction

In order to investigate the impact of possible restriction on supplies from the FFA region on skipjack and yellowfin tuna prices, it is necessary to derive an estimate of total world potential sustainable catch of both species. The share in these totals of the FFA region's catch combined with estimates of the price elasticity of supply will give an indication of potential market power of FFA member countries. Combining this information with estimates of the price elasticity of demand for canned tuna in the major world markets would then enable an assessment to be made of the prospects for FFA members to have a significant and sustained influence on world prices for skipjack and yellowfin tuna.

This section of the report traces the growth in skipjack catch and yellowfin and bigeye⁹ "surface catch"¹⁰ in the FFA region within the WCPO, the WCPO as a whole (Map 1) and other major world tuna fisheries over the past two decades, and associated changes in catch per unit of fishing effort. For this report the FFA region is defined as the "SPC statistical area" (Map 2). As almost all of the catch landed in the SPC statistical area is landed in the EEZs of FFA member countries or high seas areas adjacent to these zones they provide a good reflection of the level of catch over which FFA member states could potentially exert some degree of control.

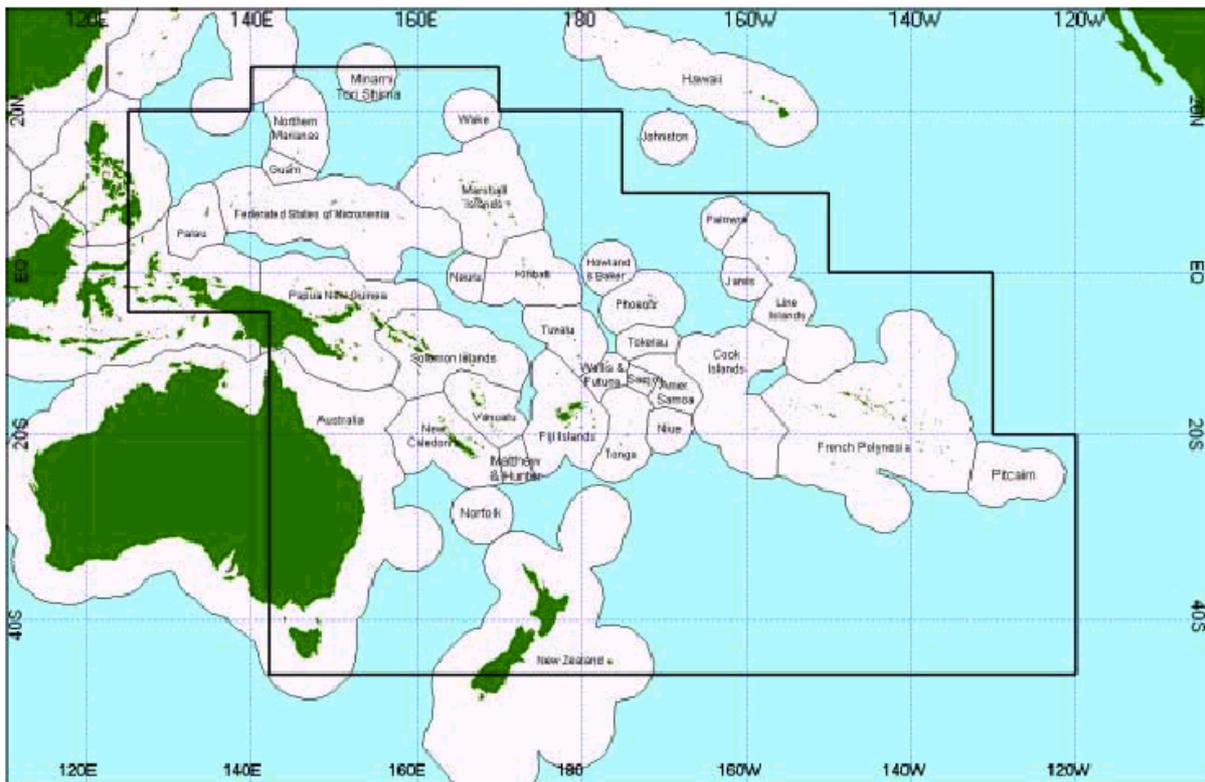
Map 1: Western and Central Pacific Ocean (WCPO) and Eastern Pacific Ocean (EPO)



⁹ Bigeye is also used in canning, albeit in much smaller volumes than yellowfin. As juveniles, yellowfin and bigeye are often indistinguishable and attract the same prices.

¹⁰ "Surface" catch of bigeye and yellowfin is defined as the total catch net of the catch taken by longline vessels. The distinction is made to differentiate between tuna for canning and for other end uses.

Map 2: SPC Statistical Area



Catch trends, stock levels and the potential annual sustainable catch of skipjack and yellowfin are then assessed. Historical canned tuna price data for both species are also illustrated. The section concludes by deriving quantitative estimates of the relationship between the price and the level of catch of raw tuna.

3.2 Catch Profiles: Skipjack and Yellowfin

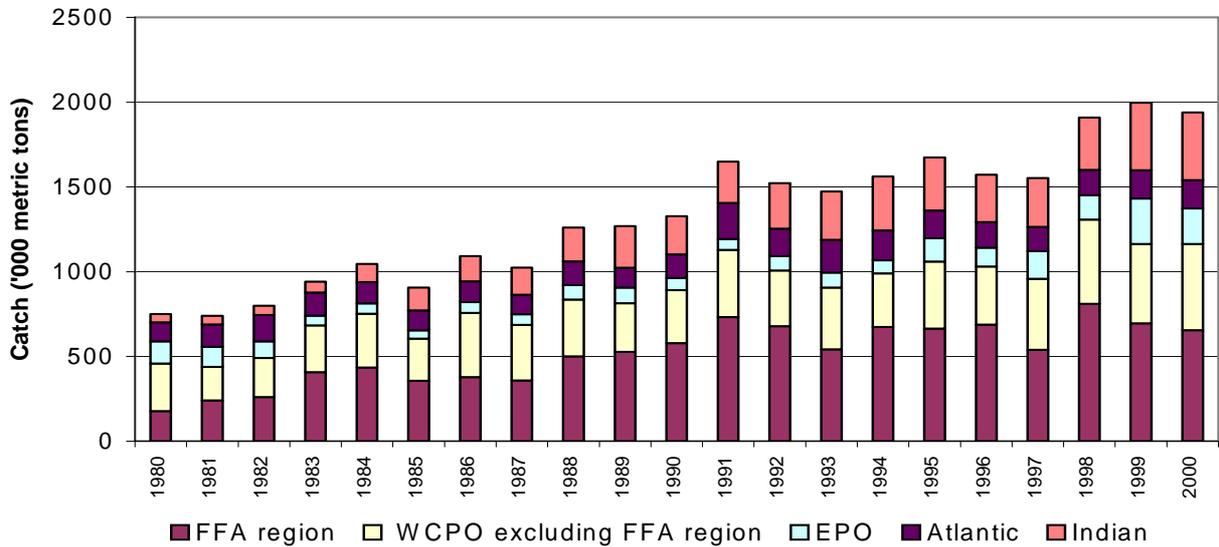
This analysis is concerned with the world supply of skipjack, yellowfin and bigeye tuna raw material for canning, and the relative market power of the tuna fishery within the FFA region. Figures 1 and 2 show the relative shares (by volume) of the four major tuna fishing areas for these two species of tuna with the WCPO catch divided into catch within and outside of the FFA region.¹¹ Skipjack data are based upon total catches as provided by the SPC. Yellowfin and bigeye data are based upon surface catches only; that is, they exclude catches taken by longline vessels.

Figures 3 and 4 show the same data as Figures 1 and 2, but with supply from non-WCPO areas aggregated to reflect the relative position of the WCPO area and the FFA-region tuna fisheries to all other areas (in aggregate) of the world. Over the past two decades, the WCPO has consistently accounted for approximately two-thirds of the world's catch of skipjack with the FFA region accounting for just over 60 per cent of the total WCPO skipjack catch (or around 40 per cent of the world's catch of skipjack). For bigeye and yellowfin surface catches, the WCPO share has been lower, varying between 30 to 50 per cent of the world total. Similarly, the FFA region's share of the WCPO and global catch is substantial lower

¹¹ Data for the year 2000 for the Atlantic and Indian Oceans were not available when this report was written. The data for 1999, for both areas, were used as estimates for the year 2000.

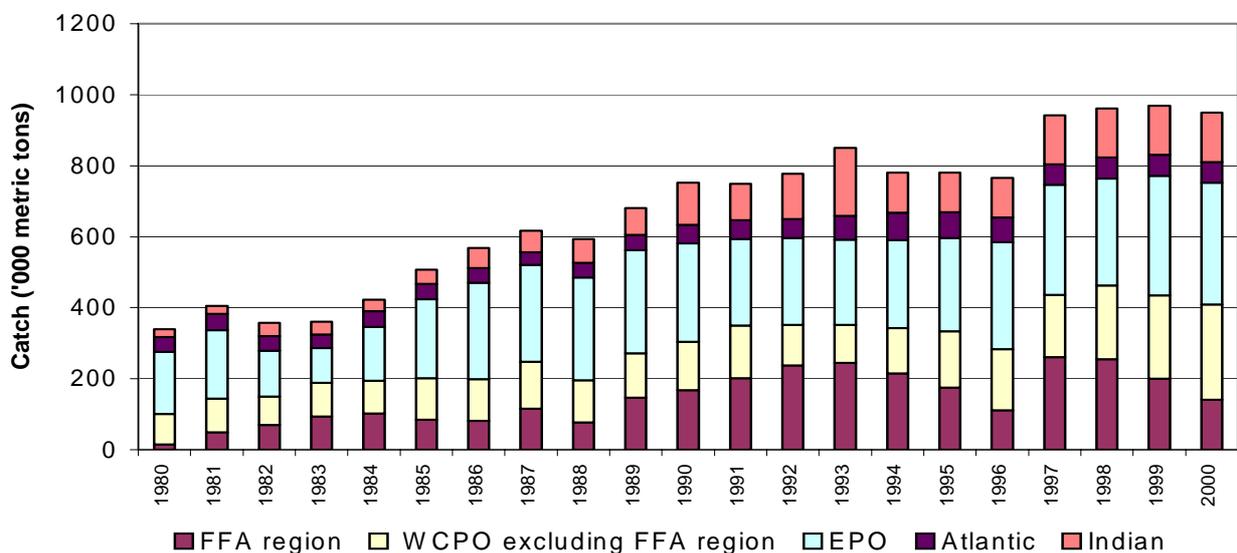
than that for skipjack, with around 50 per cent of the WCPO catch (about 20 per cent of the global catch) being landed in this area.

Figure 1: Skipjack catch by area



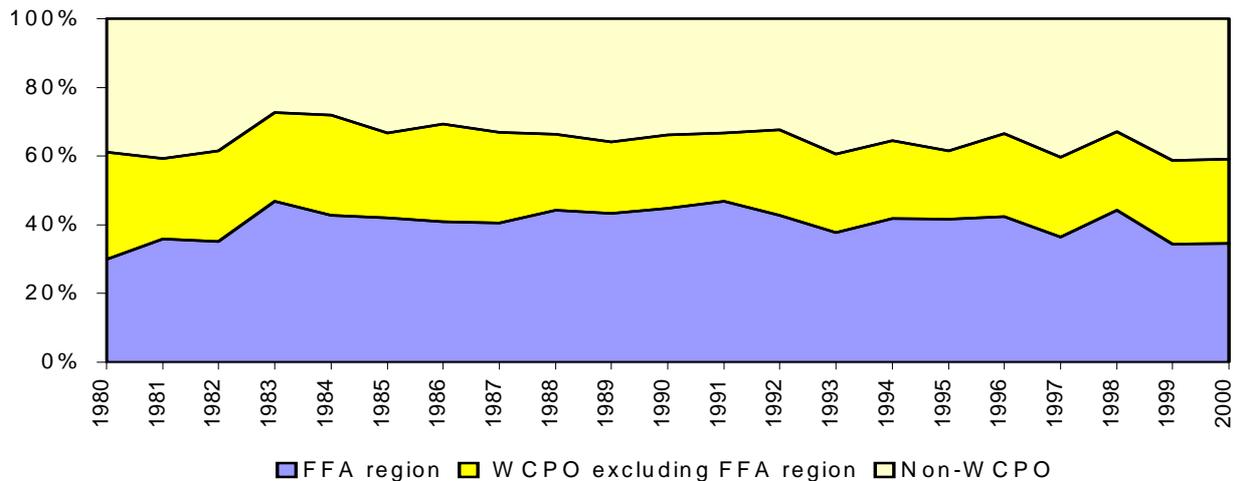
Source: SPC Tuna Fishery Yearbook 2000.

Figure 2: Yellowfin and bigeye surface catch by area



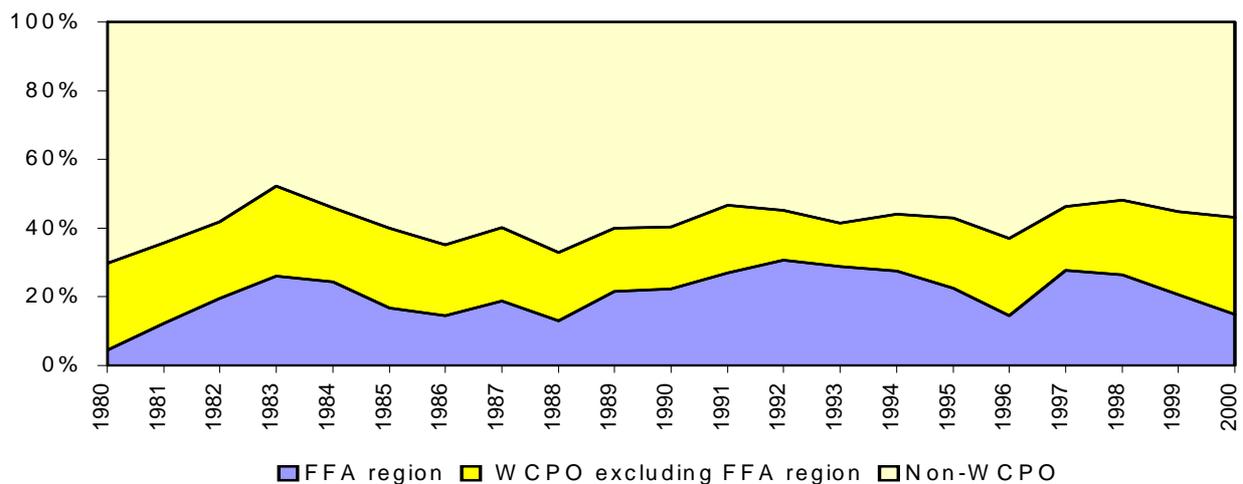
Source: SPC Tuna Fishery Yearbook 2000; FAO (Indian Ocean) and ICCAT (Atlantic Ocean) databases.

Figure 3: Share of FFA region and WCPO in Global Catch of Skipjack



Source: SPC Tuna Fishery Yearbook 2000.

Figure 4: Share of FFA region and WCPO in Global Catch of Bigeye and Yellowfin Surface catches



Source: SPC Tuna Fishery Yearbook 2000; FAO (Indian Ocean) and ICCAT (Atlantic Ocean) databases.

3.3 Catch Per Unit of Effort

Trends in 'catch per unit of fishing effort' (CPUE) could be expected to reflect changes in stock availability and fishing practices. CPUE will vary according to variations in stock migratory patterns, depth of thermocline, recruitment and other environmental aspects of the fishery, as well as characteristics and technology of the fishing vessels and changes in fishing practices.

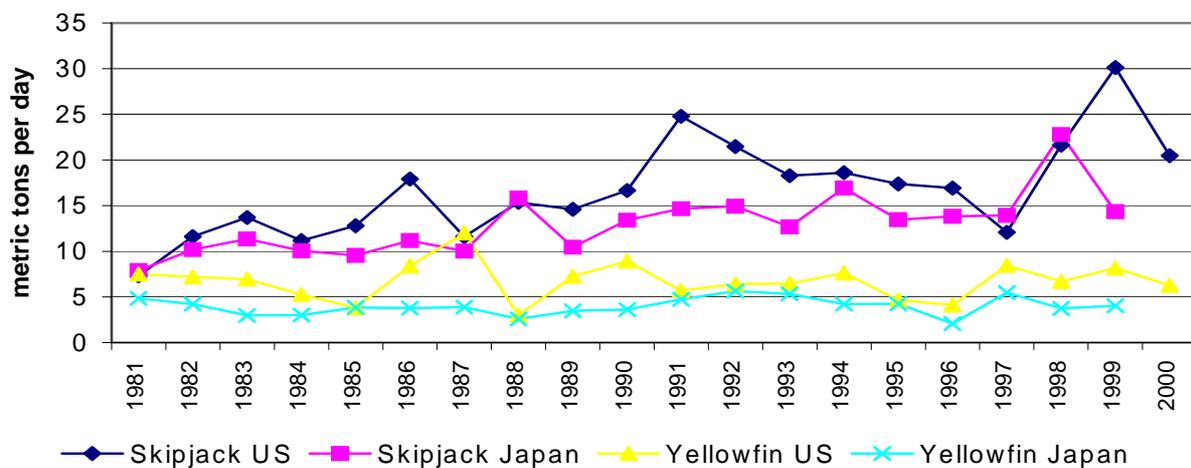
Various skipjack and yellowfin CPUE time series are available from the SPC database. Nominal CPUE series (i.e. catch divided by reported effort) for Japanese and US purse seiners were considered more reliable than corresponding data on the Korean and Taiwanese fleets. These four fleets are the major purse seine fleets fishing in the WCPO and the FFA region. The US, Korean and Taiwanese fleets operating in the WCPO work solely within the

FFA region, while the Japanese WCPO fleet also operates within the Japanese EEZ and high seas areas adjacent to Japan’s EEZ (SPC 2001).

The simplest measure of CPUE is ‘catch per fishing day’. Purse seine data on CPUE for skipjack and yellowfin in the WCPO are illustrated in Figure 5 for both the US and Japanese fleets. Despite considerable volatility, the skipjack data exhibit a rising trend for both nations. In contrast, the yellowfin data appear to be “flat”.

More specific factors that would reflect enhanced technological approaches would be average vessel size and use of FADS. In addition, stock levels are estimated on an annual basis and these could also be used in any attempt to explain variations in the quantity of the annual catch.

Figure 5: Catch per unit of effort (CPUE) for US and Japanese purse seine fleets



Source: SPC Tuna Fishery Yearbook 2000.

3.4 Catch Trends, Stock Levels and Sustainable Exploitation

During recent years, skipjack has accounted for around 48% (on average) of the total world catch of the principle commercial species of tuna. The rates of natural mortality and population turnover of skipjack are higher than those of most other tuna and this, together with their wide distribution, results in huge biomasses of the species and high levels of potential production. Ever since the beginning of heavy commercial exploitation in the early 1970s, the consensus among scientists has been that the population of skipjack in all oceans of the world were lightly exploited and could sustain much higher catches. This has been reflected by the fact that annual catches have increased from about 400,000 Mt in 1970 to around 1.85 million Mt in 1998 (Joseph, 2000). Of this latter total, about 1.25 million Mt was taken from the western Pacific, of which around two-thirds was taken from the FFA region. The remainder was largely taken from the EEZs of Indonesia, Japan and the Philippines and adjacent high seas.

Yellowfin is the second most important species of tuna in terms of total catch volume, accounting for about 34% of the world catch. Most of the commercial catch is used for canning. From the early 1970s until the mid-1980s, world catches of yellowfin increased only marginally, but with the development of new fishing grounds in the WCPO and western Indian Ocean in 1985, the catch increased sharply until 1993. Annual catches of yellowfin remained relatively static until 1997, when another surge occurred.

- **Western and Central Pacific Ocean**

Studies based on tagging experiments conducted by the SPC suggest that the stock of skipjack in the WCPO is under-exploited and that it may be possible to increase sustainable catches significantly over levels experienced during the last decade. Joseph (2000) estimates the potential increase to be in the region of 200,000 to 300,000 Mt, thus putting the potential sustainable annual catch for skipjack at around 1.5 million Mt. Such increases would, of course, depend on demand for raw material, on price, on the availability of vessels to harvest the increase, the ability of the fishermen to locate additional fishing areas, and the vulnerability to capture of the fish in these areas.

After relatively stable catch levels from the early 1970s to the mid-1980s, annual catches of yellowfin in the Pacific increased from 400,000 Mt to about 700,000 Mt from 1985 to 1990. Since then, they have fluctuated around that level. Around 450,000 Mt of this total is currently taken from the WCPO area, of which around 50 per cent is taken within the FFA region. SPC (2000) research suggests that the yellowfin tuna stock is close to being fully exploited in the WCPO, indicating that the stock is reaching its sustainability limit.

- **Eastern Pacific Ocean**

In 1999, 262,000 Mt of skipjack was taken from the EPO, the highest catch in the history of the fishery. However, much of this catch has been taken by purse-seine vessels fishing on FADS, a method that catches almost exclusively skipjack and juvenile yellowfin and bigeye. There is a concern that increasing fishing effort on FADs in the EPO, and elsewhere, in order to increase the skipjack catch could result in increased catches of small yellowfin and bigeye, which might affect the abundance and future catches of those species. Thus, although the skipjack stock could possibly sustain increased average catches, this could lead to over-fishing of both yellowfin and bigeye.

In the EPO catches of yellowfin have averaged around 265,000 over the past decade. Scientists have indicated that the stock of yellowfin appears to be fully exploited.

- **Indian Ocean**

Skipjack catches in 1999 in the Indian Ocean were the highest in the history of the fishery, reaching around 400,000 Mt a year. Although studies of the stock do not show clear evidence that it is fully exploited, scientists have expressed some concern about the possibility of increased fishing levels adversely affecting stock abundance.

Catches of yellowfin peaked in 1993 at 350,000 Mt and since then have gradually declined to current levels around 300,000 Mt. Scientists have suggested that the stock in the western Indian Ocean is fully exploited, or perhaps even over-exploited. The increased use of FADs has been blamed for increasing the catch of yellowfin juveniles, and hence reducing the total potential yield. It is not known whether yellowfin from the eastern and western Indian Ocean belong to the same stock, but if the two are independent of each other increased catches of yellowfin may be possible in the eastern area.

- **Atlantic Ocean**

In 1998, about 145,000 Mt of skipjack was taken in the Atlantic Ocean. This is well below the record catch of 200,000 Mt in 1991 and a little less than the average catch for the 1990s. About 85% of the catch is taken in the Eastern Atlantic, with the remainder taken primarily off Brazil.

Yellowfin tuna are widespread in the Atlantic Ocean, and the population is regarded as a single intermingling stock. Catches rose gradually over the two decades prior to 1984, but declined thereafter as European vessels moved to the Indian Ocean. After 1989, effort in the Atlantic increased again. The peak catch of yellowfin was about 190,000 Mt in 1990, but since then catches have decline to around 150,000 Mt. The bulk of the catch is taken in the eastern Atlantic. Recent scientific analysis estimates that the stock is capable of supporting yields of around 150,000 Mt on a sustainable basis. At current catch levels, therefore, the population is fully exploited.

3.5 WCPO Share of Sustainable Catch

In order to assess the market power of the FFA region in the international market for tuna for canning, it is necessary to assess the degree to which the FFA region has control over market supply.

Table 1 provides estimates of the maximum sustainable catch, by major tuna fishing areas of the world (where such estimates were not available, the highest recorded catch since 1990 was entered). This may be viewed as an estimate¹² of the total available resource in any one year. The degree to which world tuna resources outside of the FFA region can satisfy world demand in any year will give an indication of the degree to which the FFA region can influence supply at the margin.

Table 1: Estimated Maximum Sustainable Catch (Mt)

Fishing Area	SKIPJACK	YELLOWFIN
WCPO	1,500,000	450,000
EPO	268,000 ¹	260,000
Atlantic	213,000 ¹	150,000
Indian	399,000 ¹	300,000
TOTAL	2,380,000	1,160,000
WCPO % of Total	63	39
ROW (outside WCPO) % of TOTAL	37	61
FFA region % of total²	42	20
ROW (outside FFA region) % of TOTAL	58	80

1. Highest recorded catch since 1990.
2. Assumes potential supply from FFA region is equal to two-thirds of the total WCPO estimated sustainable catch for skipjack and one half of the total WCPO estimated sustainable catch for yellowfin.

3.5.1 Skipjack

The WCPO is the dominant skipjack fishing area, accounting for about two-thirds of the total annual (1999) catch. In addition, opportunities for increasing current catch levels of skipjack appear to be restricted to the WCPO as other areas have reached, or exceeded, their maximum sustainable catch. However, the FFA region's catch accounts for only around two-thirds of the WCPO and based on the rough estimates provided in Table 1 just over 40 per cent of potential global supply. Thus, while the fishery in the FFA region will be a major beneficiary in the advent of an increase in prices, the market power of the fishery is limited. Without co-operation from other fishing areas, including those within the WCPO,

¹² Clearly, this "estimate" is a very crude construct and subject to a significant level of uncertainty.

withholding of supply unilaterally is likely to encourage other areas to fill the shortfall by increasing fishing effort even if this may be unsustainable in the longer term.

3.5.2 Yellowfin

Currently, the annual catch of yellowfin appears to have reached, or be close to, its sustainability level in all fishing areas. As a consequence, if any one fishery were to impose catch controls that reduced catch below these levels, then the price of yellowfin tuna could be expected to rise. The extent of any such rise would depend upon the price elasticity of supply for yellowfin tuna, and the cross-price elasticity of supply for skipjack tuna (as a substitute product).

In the short term, however, it is possible that any restrictions on catches in the FFA region could be offset by greater effort elsewhere in the world. Although this would imply catches being made at non-sustainable levels, it would permit short-term financial benefits in these areas. However, in the longer term such actions would be, by definition, non-sustainable and catches would fall as a result of growing scarcity, thus giving an upward impetus to prices.

The WCPO and the FFA region account for around 40 and 20 per cent respectively of both recent catches of yellowfin and the estimated maximum sustainable catch. These are relatively low market shares and, without co-operation from other fishing areas, withholding of supply unilaterally from either of these fisheries is likely to encourage other areas to fill at least some of the shortfall by fishing at non-sustainable levels.

3.6 Tuna Prices

Skipjack and yellowfin tuna prices (since 1984 and 1989, respectively) are illustrated in Figures 6 and 7. These prices are unweighted annual averages expressed in current year (or nominal) US dollars. Averaging, however, tends to mask significant volatility in monthly prices in some years. For example, although the average price for skipjack in 1999 was US\$642/Mt, monthly prices ranged from a high of US\$900/Mt in March of that year down to a low of US\$380/Mt in November.

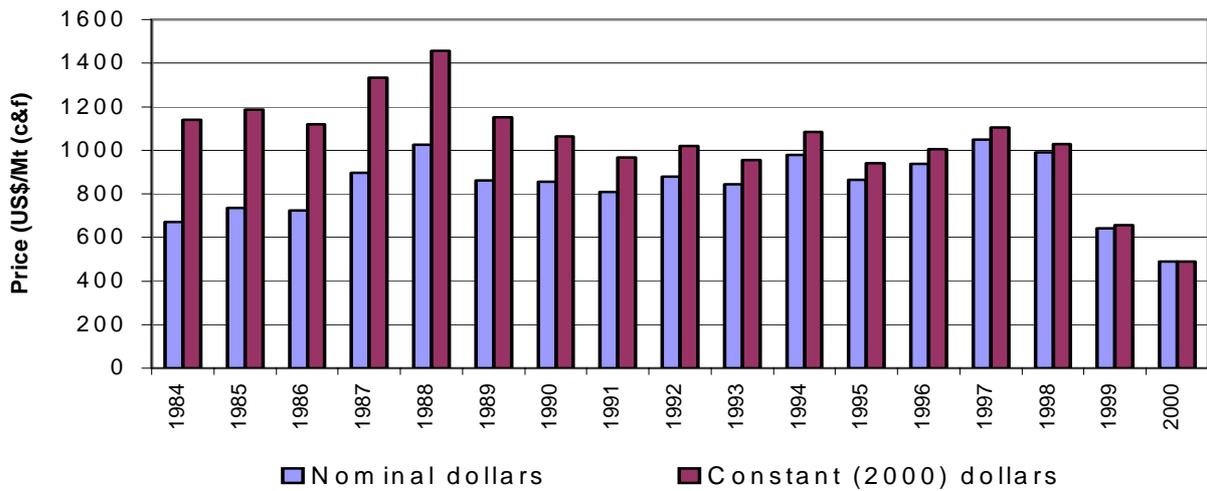
The indicative market price for skipjack was taken to be: 4 to 7.5 lbs., Bangkok (c&f), annual unweighted averages, in constant (year 2000) US\$/Mt. The indicative market price for yellowfin was taken to be 10 kg and up, Italian¹³ (c&f) annual unweighted averages, in constant (year 2000) US\$/Mt.

In order to express these prices in 'real' (or constant) dollar terms it was necessary to deflate them by an appropriate index of purchasing power. In this study, the OECD (seven major countries) implicit price deflator (with base year adjusted to 2000) was used. The resulting constant price series are also illustrated in Figures 6 and 7. In both nominal and real terms the year 2000 witnessed the lowest (annual average) price since Bangkok and Italian prices were first recorded in 1984 and 1989 respectively.

As might be expected, the two price series exhibit remarkably similar trends since 1989. The simple correlation between the two variables of 0.73 confirms this observation.

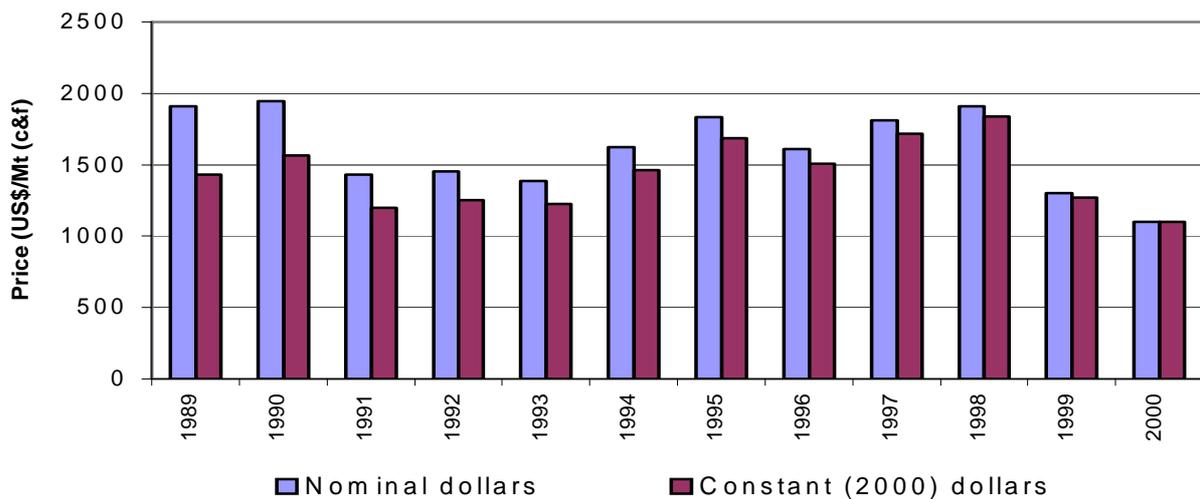
¹³ Yellowfin prices, Bangkok (20 lbs and up, c&f) have only been available since 1995, so the series is too short to be practical for this study.

Figure 6: Bangkok skipjack prices (4-7.5lbs, c&f)



Source: FFA

Figure 7: Italian yellowfin prices (10kgs and up, c&f)



Source: GLOBEFISH databank.

3.7 Supply Elasticities

The critical parameter with regard to the ability of FFA member countries to force up prices through restricting fishing activity within its region is the supply elasticity of the fisheries outside of the FFA region in aggregate. The sum of this figure and that of the world elasticity of demand for tuna gives the price elasticity of demand for tuna from the FFA region¹⁴. If this latter figure is less than unity, then higher prices resulting from restricting supply will result in an increase in revenue that would more than offset reductions brought about by lower quantities resulting from the higher prices. Conversely, if the figure were greater than one, total revenue would fall. Ironically, non-cartel members would experience an increase in revenue under both scenarios provided the price elasticity of demand for their product remained below unity.

¹⁴ The proof is given in most texts on microeconomics; e.g. Pindyck and Rubinfeld (1992).

It is also important to distinguish between short and long run elasticities, since the latter is likely to be higher, and in some instances much higher, than the former. Both supply and demand elasticities are likely to increase with price increases, as non-cartel producers increase their efforts to capture higher rents whilst consumers attempt to seek substitutes.

A simple regression of total world skipjack catch on the landed Bangkok (real) price of tuna and total catch with a one-period time lag would give estimates of both short and long-run price elasticities of demand. However, the results yielded a negative (but statistically insignificant) estimate of the price elasticity of supply of skipjack. Similar results were obtained when catches of skipjack from the FFA region were regressed on the price of skipjack tuna. When the same exercise was repeated using yellowfin data, the estimated elasticities were positive but statistically insignificant.

These results indicate that price has not been a major factor in determining the level of canning-grade tuna supplied to the world market. This is not as unreasonable as it may at first appear, as price is not the main determinant of supply. Rather it is economic rent; that is, the amount of profit made by vessel owners above the return they require to maintain their investment in the fishery. Supply levels will increase regardless of price provided that the price is above a level that allows vessel owners to earn rents from the fishery. This is because so long as rents are available to be made from operating in the fishery there will be an incentive for existing operators to expand their operations and new entrants to enter the fishery. However, without cost data, it is impossible to calculate rents, and thus price is generally used as an imperfect surrogate variable. The distinction is particularly important in the context of technological change that may raise CPUE at little or no extra cost, as it has over recent years with the introduction of FADs. In such a situation, lower unit prices may not imply lower unit rents and hence may not lead to a reduction in supply levels.

“Reverse”¹⁵ regressions were also run to measure the degree to which prices respond to changes in catch levels. The correlation between the two variables is relatively high and the coefficient of “catch” is statistically significant for all three regressions involving skipjack (see Table below). This gives support to the hypothesis that the price of skipjack tuna is strongly driven by catch levels, rather than price determining the catch (but, as noted above, it is economic rent that is important in determining supply relationships, rather than price). For the FFA region, these results imply that an increase in catch of 100,000 Mt would drive down the Bangkok price of skipjack by US\$94/Mt (in 2000 dollars).

Reverse regressions for yellowfin catch and prices yielded correctly signed but statistically insignificant estimates for the catch variable in all three applications.

¹⁵ The name “reverse” regression arises because a conventional supply analysis would specify the price of a commodity as determining the amount that would enter the market. This regression reverses that relationship; that is, it specifies the amount of the commodity entering the market as determining the price.

REVERSE REGRESSIONS: SKIPJACK

World

$$\text{Price}_t = 1661 - 0.00041\text{Catch}_t \quad \bar{R}^2 = 0.54$$

(11.14) (-4.01)

FFA Region

$$\text{Price}_t = 1598 - 0.00094\text{Catch}_t \quad \bar{R}^2 = 0.27$$

(6.55) (-2.33)

World Excluding FFA Region

$$\text{Price}_t = 1307 - 0.00053\text{Catch}_t \quad \bar{R}^2 = 0.59$$

(13.03) (-4.53)

Notes:

1. The data used in the FFA region regressions are from 1984 to 2000. As no data for catches in the Indian and Atlantic Ocean were available for 2000 the data used for the "World" and "World excluding FFA Region" regressions cover the period 1984 to 1999.
2. The catch variable represents catch in metric tons.

3.8 Implications

If skipjack catches from the FFA region were to be reduced to (say) 100,000Mt below current levels, given that other factors such as the supply from the rest of the world and the demand for canned tuna remain the same, the above results suggest that the Bangkok price of skipjack would rise by about US\$94/Mt (2000 prices).

The price rise would, however, in time create a sequence of three responses:

1. Fishing effort and hence catch outside of the FFA region would increase due to higher raw tuna prices;
2. Demand for canned tuna would fall when higher raw material prices were eventually passed on to the consumer; and
3. The combination of 1 and 2 would result in prices falling back from the initial increase. It is the relative price elasticities of supply and demand that would determine the precise extent of this rebound.

As canned tuna is in relatively inelastic demand in its major markets, and since the cost of the tuna component of a can of tuna is only around 20% of its retail price, the demand-side response is likely to be relatively minor.

The supply-side response, however, is far more difficult to assess. If the estimated maximum sustainable catch levels given in Table 1 are approximately valid, then enhanced levels of fishing effort and catches will, in the long-run, deplete the stock of skipjack and will ultimately lead to declining catches. Thus, for sustainability reasons, the other fishing regions outside of the WCPO should not attempt to compensate the market for the reduction in supplies from the FFA region. However, the sustainability constraint would not necessarily apply to other areas within the WCPO. As has been previously detailed, it is believed that the WCPO skipjack stock could sustain higher catch levels. In addition, if the estimated

maximum sustainable catch levels have been understated, then other fishing regions would be able to completely compensate the market for the reduction in supplies from the FFA region. In the case of skipjack, the latter appears to be a distinct possibility.

A similar line of reasoning can be attached to the question of restricting catches of yellowfin. The major difference, however, is that scientific opinion on the maximum sustainable catch of yellowfin appears to have stronger support than for skipjack. Thus a restriction of the catch of yellowfin within the FFA region may raise prices to levels that can be sustained. However, the FFA region contributes only around 20% of the total sustainable resource of yellowfin, and thus restricting catch levels within the FFA region is likely to be a costly exercise in terms of revenue foregone.

Finally, the international market for tuna experiences significant fluctuations in annual catches due to a vast range of factors other than tuna prices. Any attempt by FFA member countries to support prices through imposition of catch limits would also have to include close monitoring of these other factors to ensure that the imposed catch limits become flexible if external circumstances changed significantly.

4 The Demand for Canned Tuna

4.1 Introduction

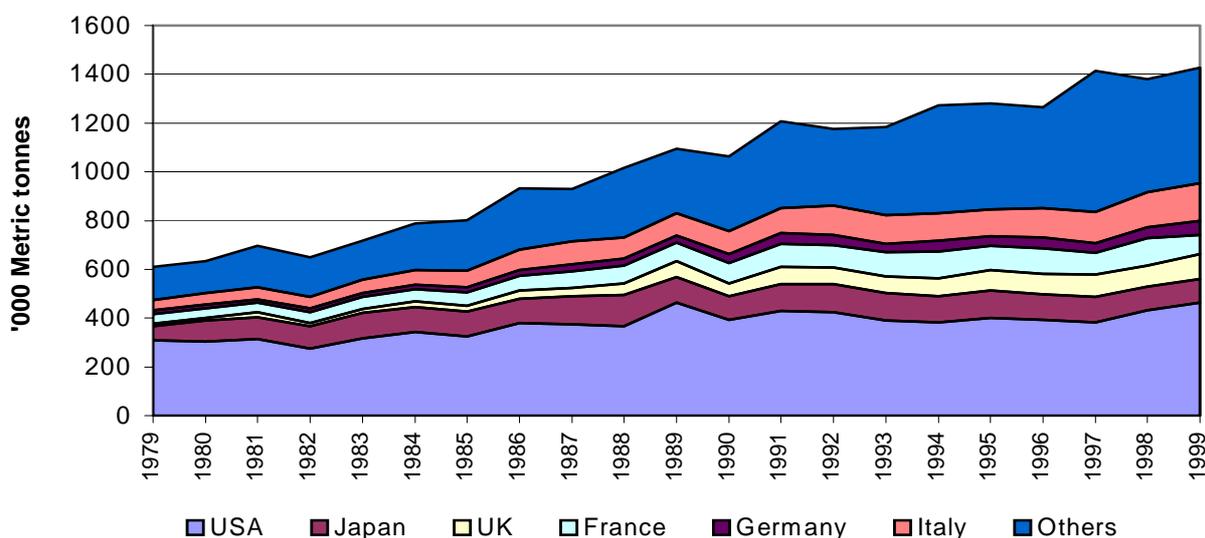
The demand for canned tuna in any country is principally determined by the size of the population, the retail price of canned tuna relative to competing products, real disposable income per capita, consumer preferences, and various marketing factors. Environmental factors may also play a prominent role. For example, in many nations demand has been particularly sensitive to concerns over dolphin mortality arising from the fishing practices of certain fishing nations.

The bulk of canned tuna supplies are marketed through retail outlets, and hence price competition with other food items is strong. In this section of the report, derivation of estimates of the price elasticity of demand for both the USA and the EU are discussed, since these provide the critical measure of the response of demand to variations in the (real) price of a commodity. Essentially, the price elasticity of demand for a commodity is a measure of the percentage change in demand brought about by a unit percentage change in its price (all other factors assumed constant).

4.2 World Consumption of Canned Tuna

The USA is the world's largest single market for canned tuna, and currently consumes a little over 30 per cent of total world production (Figure 8). However, US market share has been falling consistently over recent years, from a level of around 50% twenty years ago. Over the corresponding period, the EU's share of consumption has risen to a level that is now comparable with that of the USA, whilst Japan's market share has experienced a relatively moderate decline from around 10 to 7 per cent.

Figure 8: World consumption of canned tuna



Source: *Globefish*

4.3 Per Capita Consumption Trends

US annual per capita consumption of canned tuna has remained relatively static over the past two decades (Figure 9), exhibiting a gradual increase from 1.4 kg per capita in 1980 to 1.8 kg per capita in 1989. Thereafter a steady decline to 1997 took it back to 1980 levels, with per capita consumption increasing again to 1.6 kg by 2000. Other canned fishery products

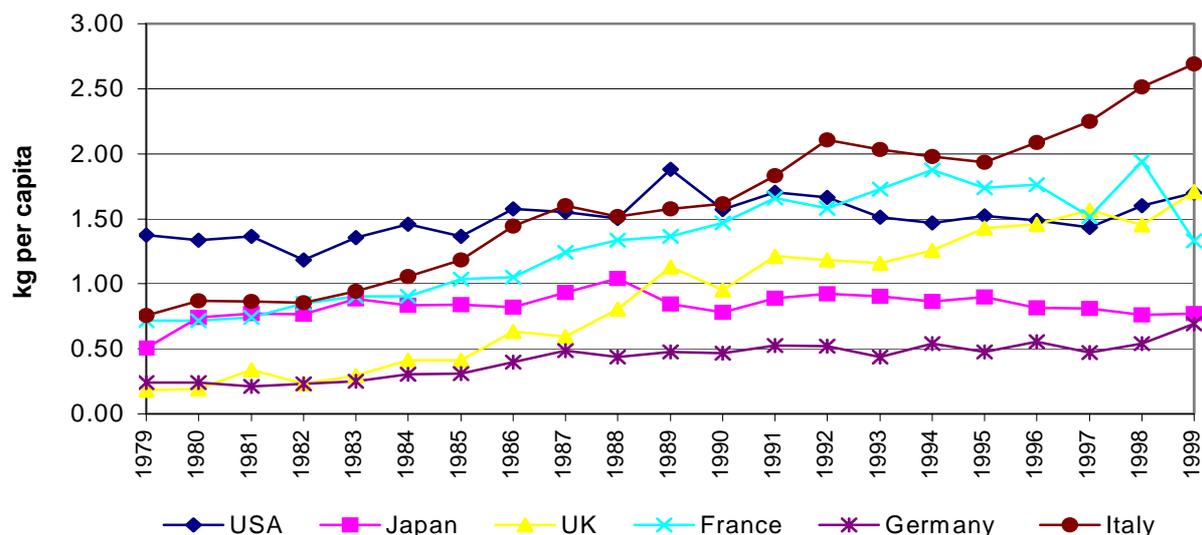
exhibited a similar consumption pattern over this period although tuna is by far the most popular, accounting for around 75% of annual sales (by volume) of canned fishery products.

Corresponding data for Japan and the major canned tuna consuming European nations are also illustrated in Figure 9. In common with the US, Japan's per capita consumption of canned tuna has remained relatively static over the past two decades. However, the major European markets have experienced substantial rates of growth in consumption to the extent that the European Union is now the dominant consuming area in the world.

The EU market can generally be divided between those countries with canned tuna processing industries and those without. The former are generally mature markets, whilst the latter are of relatively recent importance. Mature markets are France, Italy, Spain, Portugal, Greece, Belgium and Luxembourg (the latter two relying on market conditions and characteristics affected strongly by those in France). These markets depend both on domestic production and imports, and have developed well-defined characteristics and preferences over many years. Non mature markets include the remaining EU members and are dominated by Germany and the United Kingdom. These markets rely on imports for virtually all of their canned tuna supplies. Most of the growth in the EU canned tuna market has been accounted for by non-mature markets, with imports supplying the growth.

Although Italy and France are regarded as mature markets for canned tuna, increases in per capita consumption over the past two decades far exceed those of Japan and the US. For the non-mature EU markets such growth has been exceptional in some countries, and specifically the UK (Figure 9). The UK is a relatively recent market for canned tuna, but relatively high prices for canned salmon, and increased sensitivity to health considerations (particularly by the young), has witness a dramatic growth in imports of canned tuna to a per capita level that almost equates to that of the USA.

Figure 9: Per capita consumption of canned tuna



Source: *Globefish* and *The United Nations Monthly Statistical Abstract*.

4.4 Price Elasticities of Demand

There are few estimates of the price elasticity of demand for canned tuna in any markets of the world.

There have been two studies into the demand for canned tuna in the USA, by Owen and Troedson (1994) and by King (1986). Both derived estimates of the price, income, and cross-elasticities of demand, with surprisingly similar results. Owen and Troedson's price and income estimated elasticities were -0.16 and 1.04 , respectively, whilst corresponding estimates by King were -0.20 and 0.99 . The cross-elasticities (with meat) were more diverse, at 0.72 (Owen and Troedson) and 0.33 (King). This difference could well have reflected a growing concern with adverse health impacts of red meat that were not present for much of King's earlier data series.

A price elasticity of around -0.20 implies that the fall in revenue resulting from lower demand following an increase in the (real) price of canned tuna will not offset the increase in revenue derived from a higher price for the product. Conversely, any fall in price will not generate sufficient new sales to offset the total loss in revenue from the cheaper product. Thus demand is said to be "price inelastic". For producers, an inelastic price elasticity of demand is very desirable in times of rising prices, but undesirable when prices are falling.

Estimates of the price elasticity of demand for canned tuna in non-US markets are not available. This is largely due to the lack of appropriate data. However, in the EU, canned tuna has more close substitutes than it has in the US, particularly other canned fish such as salmon, pilchards, and mackerel. Thus price elasticity of demand estimates for EU countries could be expected to be somewhat higher than that of the US.

5 Previous Economic Studies: Marine Resources

5.1 Introduction

Considerable resources were employed to model the world's commodity markets during the decades of the 1970s and 1980s, by which time sufficient post-Second World War time series data had become available to permit econometric estimation utilising the new technologies of computer power and advanced econometric software. The bulk of such studies were concerned with the so-called non-renewable commodities (mainly non-fuel minerals), with renewable commodities being largely of interest only when price stabilisation (such as buffer stock) schemes were in operation. Over the past decade, such studies have become relatively rare, with time series methodology replacing structural economic modelling where data series of appropriate lengths are available.

A survey of commodity market models has been compiled by Labys (1987). However, many of the references are in fairly obscure publications and the survey itself is now rather dated.

5.2 Commodity Price Stabilisation

The seminal work on the theory of commodity price stabilisation is Newbery and Stiglitz (1979). They were primarily concerned with the consequences of attempts to stabilise the price of agricultural products that are subject to systematic variability in either output or demand. However, they explicitly preclude analysis of attempts to increase the price of agricultural products by restricting output, or with any other schemes designed to improve revenue for producers in developing countries. Their analysis was confined to pure price stabilisation schemes, especially those in which prices were stabilised by buffer stocks with no restrictions or taxes on supply or demand. The major result of their study was to question seriously the desirability of price stabilisation schemes, both from the point of view of the producer and of the consumer.

5.3 Previous Econometric Studies: Marine Resources

5.3.1 *Prospects for an International Tuna Resources Owners' Cartel: Campbell (1996)*

Campbell briefly describes the world tuna industry and gives estimates of the elasticities of supply and demand for tuna harvested in the WCPO. His price elasticity of supply of 0.76 was based upon a study by Conrad and Adu-Asamoah (1986) relating to the Eastern Tropical Atlantic tuna fishery. His price elasticity of demand was specified as 0.20, on the basis of results derived by King (1986) and Owen and Troedson (1994). Combining these estimates, Campbell derived a price elasticity of demand for WCPO-sourced tuna of 0.96. This elasticity estimate was used to assess the effect on the revenues received by WCPO countries of a small increase in the royalty charged for access to the resource. His results suggest that there is a potential for the tuna resource owners of the region to improve their returns through collective action and the exercise of market power via increases in access fees.

5.3.2 *The United States Tuna Market: Owen and Troedson (1994)*

Owen and Troedson provided a survey of the US market demand for canned tuna, and identified the major factors that had a significant impact on the market. They specified and estimated an equation explaining US per capita demand for canned tuna in terms of real disposable income per capita, the wholesale price of canned tuna, and the price of "meat". Price and cross-price elasticities for canned tuna were estimated to be relatively low at -0.16 and 0.72 respectively. The income elasticity of demand was estimated to be 1.04 . The price

and income elasticities were very close to those derived by King (1986), although the cross price elasticity was considerably higher than that of King.

5.3.3 *The US Tuna Market, a Pacific Island Perspective: King (1986)*

King describes the US tuna market and the major economic forces that affect this market. The emphasis is on general relationships in the market rather than on recent (i.e. 1980s) trends. An attempt is made to demonstrate how forces in the US tuna market are transmitted to other tuna markets and how they can eventually influence those economic benefits that Pacific Island nations can expect to derive from their tuna resources. King provided demand elasticities, but did not give explicit details of the statistical analysis used to derive them. His price elasticity was quoted as -0.2 , the cross-price elasticity (with respect to meat and poultry) of 0.3 , and an income elasticity of 1.0 .

5.3.4 *Econometric Estimation of World Salmon Demand: Bird (1986).*

This study estimated a single equation model of the world market price of fresh salmon over the period 1958-1982. The estimated equation explained the equilibrium price in terms of world salmon landings, OECD consumer expenditures, and indices representing the price of substitutes (albacore tuna, fish, meat and poultry, of which only tuna appeared in the preferred model).

Table 2: Estimated World Demand Elasticities for Salmon (Data period: 1958-82)

	Elasticity
Short run	
Own price	-2.15
Tuna price	+0.22 ¹
Income	+10.29 ¹
Long run	
Own price	-0.88
Tuna price	+0.81 ¹
Income	+0.33 ¹

Key:

1. Correct sign but coefficient not significantly different from zero at the 5% level.

The author concluded that “the elasticity estimates are meaningful and plausible, and confirm the satisfactory nature of the estimated demand equation”. However, the very high short run price elasticity would appear to reflect salmon’s status as a luxury good. The much lower long run elasticity, which is relatively unusual in models of commodity markets, was put down to “habit”. The relatively high long run price cross elasticity with albacore tuna of 0.88 was explained by substitution at the (cheaper) canned level of the products. No forecasting exercise was undertaken.

5.3.5 *A World Model of Living Marine Resources: Bell et al. (1975)*

This study constructed econometric models (independently) for a range of seafood products, both raw and (where appropriate) canned. The resources included were groundfish, tuna, salmon, halibut, sardines, shrimp, lobster, crabs, clams, scallops, oysters, and “other food fish”. The estimated demand elasticities for tuna are given in Table 3 for the range of countries covered by the study.

Table 3: Estimated Demand Elasticities for Canned Tuna (Data for US: 1947-67; other countries: 1956-67)

Country	Price Elasticity	Income Elasticity
USA	-0.8632	+1.1675
Canada	-0.1353 ¹	-0.0868 ²
UK	+0.8675 ²	-1.4787 ²
EEC	-0.3524 ¹	+0.8313 ¹
Spain	+0.5865 ²	-1.3867 ²
Japan	+0.9953 ²	-1.3954 ³
Taiwan	-0.0583 ¹	5.5071 ⁴

Key:

1. Correct sign but coefficient not significantly different from zero at the 5% level;
2. Incorrect sign and coefficient not significantly different from zero at the 5% level;
3. Incorrect sign and coefficient significantly different from zero at the 5% level;
4. Correct sign but estimated elasticity unrealistically large.

Only results derived using US data could be described as satisfactory. All other elasticity estimates either had the incorrect *a priori* sign, or were insignificant, or both. The income elasticity for Taiwan was unrealistically high. Since the primary aim of the study was to forecast demand through to the year 2000 (from a 1967 base), US estimates for both price and income elasticities were imposed on Canada, the UK, the EEC, and Spain for this purpose. Japan and Taiwan were given indicative values. Lack of degrees of freedom was no doubt a very major factor in the poor results achieved for the non-US markets. Similar problems were experienced in modelling the other marine resources considered in the exercise.

The estimated elasticities for the USA appear to be, *a priori*, of a reasonable size. However the data series upon which they were derived (1947 to 1967) witnessed a significant increase in per capita US consumption of canned tuna that contrasts with its relatively static levels of the past two decades. Thus, intuitively, lower price and income elasticities could be expected as canned tuna reached a “mature” market status.

Projections produced by the model for 1970, 1975 and 2000 have proven to be very inaccurate. At the date of the study, 1970 data were available and the model’s forecast of world tuna consumption in that year underestimated the actual value by 13 per cent. In fact, the actual value for 1970 was also greater than the 1975 value projected by the model, and only marginally below the 2000 projection. Similarly, projections for the US market have also proved to be, *ex poste*, very inaccurate. A major source of inaccuracy was the models built-in MSY resource constraint of 1.8 million Mt of tuna. In fact, this figure was exceeded shortly after the study was completed.

6 Assessment and Conclusions

6.1 Introduction

In this section, the observations and statistics of previous sections are brought together in order to assess the relationship between the world price for skipjack and yellowfin tuna raw material for canning and supply from the WCPO and FFA member countries' EEZs.

6.2 Market Structure of the World Tuna Industry

The theoretical analysis on cartels contained in section 2 of this report was predicated on the assumption of a cartel operating in what was otherwise a competitive market structure. The world tuna industry does not conform to this model, with relatively small numbers of processors, associations of vessel owners, and collectives of resource owning countries. Thus the market situation is closer to that of "competition" based upon the countervailing power of a number of oligopolistic¹⁶ structures. It was also noted that a similar market structure has characterised the international tin market.

Although the world tuna market cannot be considered to operate as a competitive market, nevertheless the principles regarding the two conditions that would permit the formation of a successful cartel by FFA member countries are still valid. Essentially, successful restriction of supply by FFA member countries in order to force up raw tuna prices requires that two fundamental conditions must be satisfied. First, the total demand for the product must be relatively insensitive to changes in its price. Second, either FFA member countries must control nearly all of the world's supply or, if they do not, the supply of tuna from outside the FFA region must also be relatively insensitive to price changes. The following sections consider whether these two conditions are likely to be valid in this context.

6.3 Assessment

Based upon a study by Conrad and Adu-Asamoah (1986), Campbell (1996) has calculated the long-run price elasticity of supply under net present value maximising management to be 0.76 for the Eastern Tropical Atlantic skipjack and yellowfin fisheries. If this value is assumed to be also valid for the FFA region, then combined with (the absolute value of) the estimate of -0.2 for the price elasticity of demand derived independently by the two studies of the US market for canned tuna considered earlier, the resulting price elasticity of consumer demand for FFA-region tuna would be 0.96, or approximately unity. This implies that an increase of 1% in price results in a 1% decline in quantity demanded. In other words, total expenditure on FFA-region tuna would not change following the price increase.

This result should be interpreted as indicative only, since the demand studies are restricted to the USA whilst the Conrad and Adu-Asamoah results are rather dated.

In European markets for canned tuna the price elasticity of demand is likely to be significantly higher than for the USA due to the existence of relatively close substitutes. Thus for EU markets, the price elasticity of consumer demand for FFA-region tuna would be higher, and perhaps much higher, than 0.96. This implies that a 1% increase in price would result in a larger than 1% decline in quantity demanded, and hence a decline in total expenditure on FFA-region tuna.

¹⁶ Oligopoly: few producers.

These conclusions are largely determined by the assumed magnitude of the price elasticity of supply, 0.76. A lower value would favour the supply restriction option by FFA member countries, a higher value the reverse. Although it was not possible to derive an explicit estimate of the price elasticity of supply for tuna in this report, a high correlation between price and catch from the FFA region, as well as the “world” in aggregate, has been shown to exist. This result would argue against the imposition of supply restrictions by FFA member countries as any increase in prices resulting from a reduction in supplies from the FFA region is likely to lead to an increase in supplies from the rest of the world.

6.4 Supply Restrictions and Sustainability

If FFA member countries, operating collectively, were to place quantity restrictions on catches of skipjack and yellowfin tuna within the FFA region, the results in this study indicate that the price of skipjack tuna could be expected to rise by (on average) about \$94/Mt¹⁷ (2000 prices) for a total of one hundred thousand Mt withdrawn from the market. As prices rise, there will be two offsetting trends.

First, higher world tuna prices would act as an incentive for increased levels of fishing effort in other tuna fishing areas and in high seas waters within the FFA region since fishing effort in this area cannot be controlled by FFA member countries. The resulting increase in catches would tend to have an offsetting dampening impact on price. If exploitation rates in these other areas were below those of sustainable yield, then even in the long run these increased catches could be maintained. However, if exploitation rates were above those of sustainable yield, then increased catches in the short run could only be achieved at the expenses of the longer-term sustainability of the fishing area.

Second, higher prices for the tuna raw material would flow on to the final consumer of canned tuna with a resulting decline in demand, although the extent of the impact on retail prices is likely to be relatively small compared with that of the raw tuna. Clearly, the price of canned tuna is determined not only by the price of raw tuna but also by retail margins, transportation costs, processing costs, etc. Campbell (1996) has estimated that the value of the resource in the final product is about 20%. Thus if the price of raw tuna in the hold of the purse seiner is US\$1000/Mt then one tonne (net weight) of the canned product would cost US\$5000. In other words, if FFA supply restrictions were to increase the price of tuna for canning by 10%, the effective increase in the retail price would be just 2%.

6.5 Other Potential Impacts of Catch Restrictions in the FFA region

There has been a long history of under-reporting and non-reporting of catches in the FFA region by distant water fishing nations¹⁸. Whilst the situation is less of a problem today, catch restrictions may encourage a return to such practices in order to avoid limits on catch. In addition, DWFNs fish outside member countries' EEZs in high seas areas in what is defined in this paper as the FFA region. If FFA member countries are unable to restrict catches in these high seas areas as well as within their EEZs this may result in increased fishing effort on the high seas. Clearly, if either of these factors come to pass they would reduce the effectiveness of an attempt to restrict catches.

Lower levels of catch would reduce the level of access fees that FFA members receive, since these would need to be based upon mandated lower catch levels. To the extent that prices

¹⁷ This is a marginal estimate. Thus as the restrictions on catch increase, this value should also increase to reflect the increasing scarcity of supply.

¹⁸ Details can be found in Maxwell and Owen (1994).

would rise following the imposition of catch restrictions, fees would increase correspondingly (although with a time lag based upon the current mode of negotiating access fee agreements), but this may not offset the decline associated with the decline in catch volumes. The potential for offsetting this loss through increasing the percentage was investigated by Campbell (1996), but consideration of that option is outside the terms of reference of this report.

6.6 Conclusions

Based upon the analysis contained in Section 3 of this report, a number of key criteria that would contribute towards the success of a cartel in maintaining prices at desired levels were identified. These will now be reviewed in the context of the terms of reference for this report.

- 1) **Total demand for the product must be price inelastic, both in the short and long term (that is, there should be no close substitutes).** This appears to be the case in the US market, and to a lesser extent in European markets.
- 2) **The cartel must control the vast bulk of the world supply of the product or, if it does not, the supply of non-cartel members must be price inelastic.** The WCPO does not contain the “vast bulk” of the world’s stocks of either skipjack or yellowfin, although around two-thirds of the known stocks of skipjack are located within the region. However, current knowledge of stock data for skipjack is rather sketchy and the WCPO stock lies both within and outside the FFA region. As such, FFA member countries have ‘control’ over a significantly smaller proportion of the world skipjack stock. Although the supply of skipjack and yellowfin from non-FFA fishing areas may reasonably be assumed to be price inelastic, nevertheless historical trends suggest that catch from these areas could increase significantly in response to any short term price (and hence economic rent) stimulus.
- 3) **The cartel should have the support of all member country governments.** It is not clear whether all FFA member countries’ governments would support reductions in catch levels aimed at increasing price levels. Some rely far more heavily than others on receipts from their involvement in various aspects of the tuna fishery.
- 4) **There should be an absence of broad-based political conflict between member country governments.** At present, any such conflicts between FFA member countries appear to be relatively minor as compared with (for example) OPEC cartel member country governments.
- 5) **Market entry of new suppliers should be difficult (e.g. very high cost and/or risk).** It is unlikely that any new tuna fishery areas exist outside of those that are currently known.
- 6) **There should be a high level of vertical integration in the industry (i.e. the cartel should control all stages of production).** There is only a relatively low level of vertical integration in the canned tuna industry. In the absence of such a structure, the common interests of resource owners, boat owners, and processing industries are not encouraged.

In summary, restriction of supply from the FFA region will undoubtedly produce a short-term increase in the price of both skipjack and yellowfin tuna. The extent to which this increase can be sustained in the long-term depends on a number of factors relating to the size of the restriction, the price elasticities of supply of other tuna fishing regions, and the price elasticity of demand for canned tuna.

Unilateral action to restrict annual catch of skipjack and yellowfin within the FFA region would give other fishing regions a “free ride” to higher prices. This could encourage enhanced levels of fishing effort in these areas and more extensive use of FADs and other technologies to capture the higher levels of rent that would become available. It could also

lead to fishing practices in other regions that involved catches higher than the maximum sustainable catch (particularly for yellowfin).

An alternative approach, therefore, could be collective action by an association of all resource-owning nations representing the entire world tuna fishery. Essentially this would give monopoly power to such an organisation, although this would not necessarily guarantee the success of any price maintenance scheme based upon output restrictions. The coffee industry cartel has had similar power for many decades and still has been unable to stabilise prices at levels acceptable to member countries. However, the collective approach does ensure, in the absence of cheating, that all countries make similar sacrifices.

Demand-side actions, such as advertising or “new product” lines, is also an option, either singularly or in conjunction with supply restrictions. Here the intention would be to attract new consumers, hence raising demand and ultimately strengthening raw tuna prices.

Finally, econometric evidence on relevant price elasticities of supply and demand is either weak, limited in scope or non-existent. The major reason for this situation is the lack of data for the major variables that impact on supply and demand, and the limited data series available on tuna prices. In the absence of strong quantitative information, this report has had to be based upon a more qualitative assessment of likely market reaction to supply restrictions imposed by FFA member countries.

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Appendix I: The Concept of Elasticity

The demand for a commodity depends upon its price, as well as on consumer income, the prices of other goods (substitutes and complements), and other variables that determine consumer behaviour. Similarly, supply of a commodity depends upon its price, as well as upon variables that affect production costs. Elasticities measure how responsive supply and demand are to variations in these determining factors (called “variables”).

Specifically, elasticity is a measure of the percentage change that will occur in one variable in response to a one per cent change in another variable. Thus the *price elasticity of demand* gives the percentage change in the quantity of a commodity demanded following a one per cent increase in its price. This will be a negative number since, in general, an increase in price will lead to a fall in demand.

When the price elasticity is greater than one in magnitude, demand is said to be *price elastic* because the percentage decline in quantity demanded is greater than the percentage increase in price. If the price elasticity is less than one in magnitude, then demand is said to be *price inelastic*. In general, the price elasticity of demand for a commodity depends on the availability of substitutes. Where there are close substitutes, a price increase will cause the consumer to buy less of the good and more of the substitute, and hence demand will be price elastic. Where there are no close substitutes, demand will tend to be price inelastic.

Elasticities of supply are defined in a similar manner. The *price elasticity of supply* is the percentage change in the quantity supplied of a commodity resulting from a one per cent increase in its price. This elasticity is usually positive, because a high price gives producers an incentive to increase output.

When analysing demand and supply it is important to distinguish between the short run and the long run. For many commodities, demand is much more price elastic in the long run than in the short run. This is because of habits, time lags, etc., which combine to modify the immediate fall in demand following a price change. However, as consumers adjust to the new (higher) price in the long run, demand adjusts correspondingly.

Elasticities of supply also differ from the long run to the short run. For most commodities, long run supply is much more price elastic than short run supply because, in the long run, producers can overcome short run supply constraints.