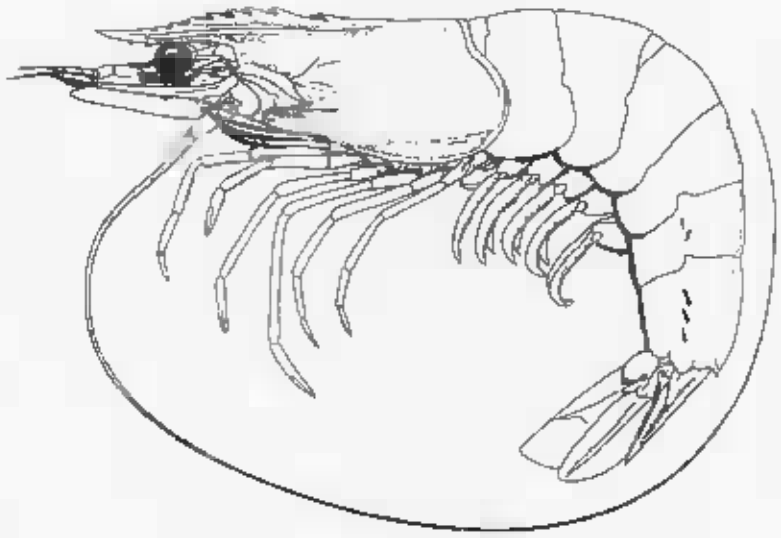
Shrimp Management Project

Tropical Shrimp Production and Market Prices - A Demand Analysis



Report for the Overseas Development Administration

Fisheries Management Science Programme

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INTRODUCTION

2,443,300 metric tonnes of tropical and cold-water shrimp were placed on the world market in 1989. Tropical catches and aquaculture production accounted for approximately 1,700,000 MT and 565,000 MT respectively, with approximately 200,000 MT of cold-water shrimp being landed[1].

In value terms, with imports currently in excess of $US 4.4 billion, shrimp account for approximately 20 per cent of the total world trade in fisheries products. Direction of trade is dominated by developing country exports, which supplies around 90 percent of total shrimp imports by industrial countries (Yang 1992).

For many developing countries the shrimp production sector, which includes both aquaculture and capture fisheries, is an important source of foreign exchange earnings through exports. Furthermore it is a sector which can generate and sustain primary and secondary rural employment.

The past decade has been characterised by heavy investment in shrimp aquaculture. Although the potential return from aquaculture is still attracting investment, greater competition amongst producers and more pronounced volatility in international market prices due to increasing production levels is a potential concern amongst private investors and policy makers in the aquaculture sector

However, the differences in production costs both within and between the competing capture and aquaculture sectors means that any fiscal or financial policy addressing the cost or level of production in one sector must also consider possible impacts on the economic performance in the other. Levels of employment and investment may be altered, as well as methods of production in each of the sectors Therefore this is an important issue for development strategists in understanding the implications of any policy in the light of present and future market conditions.

This study focuses on how changes in market price and quantity demanded due to increased aquaculture production will impact upon revenues and employment, and hence fishing methods, within the shrimp capture fishery industry. Several processes may affect price and quantity demanded, with the important issues being identified as follows:

i Given the probable increases in the level of shrimp production, especially from aquaculture sources, the first issue concerns the effect that overall increases in supply will have on market prices A related issue is the impact that changes in consumer expenditure may have on overall demand for shrimp

ii A second issue stems from the likelihood that any increases in production will come from aquaculture and therefore, given current production strategies, consist of medium sized shrimp. Of interest is the possible impact that an increase in supply of medium size categories will have on the price and quantity demanded of other size categories

The possible changes in market price and quantity demanded which cause concern at the macro-economic level can only be resolved by analysing micro-economic issues using the tool of demand analysis to determine a demand function and relevant elasticities

Estimates of both price and income elasticity of demand are used to identify any relationship between total quantity of shrimp consumed on the US market, changes in the price of shrimp and consumer income levels. Estimates of own and cross-price elasticities of demand for the different size categories of shrimp are used to identify the direction and magnitude of any price-quantity

[1] Figures quoted are from the FAO GLOBEFISH-FISHDAB database.

interactions between the different size categories

The own-price elasticity of demand for a good, in this case shrimp, is a measure of the magnitude of change in price brought about by a change in quantity. If a change in price brings about a less than proportionate change in quantity demanded then the good is said to be inelastic (less than one). In this case lower quantities give rise to higher revenues. On the other hand, demand is considered elastic when a change in price causes a more than proportionate change in quantity demanded. In this case total revenues rise when price falls and falls when price rises. Cross-price elasticities relate the change in price brought about in one good by the change in quantity in another good, or vice versa. Income elasticity is a measure of the change in price of a good due to a change in income.

The strategy normally adopted for the estimation of an aggregative demand function for generic shrimp species which uses some measure of income and relative price is not sufficient to satisfy the aims of this report, which include the estimation of cross price elasticities. Thus an alternative approach using a disaggregated model which looks at the relationships between the different size categories of shrimp in markets is utilised.

The disaggregated demand analysis estimates the values of the income, own and cross-price elasticities of different sized shrimp. These estimated income, own and cross-price elasticities, combined with future production scenarios, allows the direction and magnitude of changes in market share, prices and quantity demanded to be quantified. The future levels of production used in the production scenarios are based on qualitative analysis and previously published predictions.

Being inextricably linked, data limitations may constrain the model specifications and model specifications in turn have strong implications on the data requirements. Knowledge of the "institutional realities" (Johnston 1984) of the specific industry and environment within which is operating is important in the decision over the appropriate data, data period (weekly, monthly, quarterly or annually) and model specification (linear, non-linear, aggregated or disaggregated, quantity or price exogenous).

Thus the first requirement of any demand analysis for a particular commodity is to identify the special characteristics of the market involved in order to arrive at a suitable specification for the demand equation, given the aims of the demand analysis. A general description of the global shrimp market identifying the principal characteristics of each of the main markets (the U.S., Japan and Europe), including price and consumption trends is presented in chapter 2. The most common product forms, their market segments and the direction of trade, including volumes to provide some indication of the importance of different suppliers, are also discussed. A brief review of the major sources of production of Penaeid shrimp species, describing the general historical trends in production from both capture fisheries and aquaculture is provided.

Chapter 3 provides more information on market structure by reviewing the results and main points of published aggregate demand analyses of shrimp demand.

Based on the information collected in chapters 2 and 3, a disaggregated demand analysis is presented in chapter 4. Acknowledging that data availability has been a limiting factor on model specification in nearly all past seafood demand and market analyses, the availability of disaggregated data for modelling the shrimp market is described. For the purposes of this report, the only publicly available sufficiently detailed disaggregated data is that provided for part of the US market by the National Marine Fisheries Service (NMFS). A qualitative demand analysis of the US market is carried out. US market characteristics which may be significant in the demand and supply interaction as identified in chapters 2 and 3 are summarised and restrictions on which factors can be included in the demand model due to data availability are discussed.

In addition to data restrictions and requirements, demand studies for fisheries products have created a debate among economists with respect to the degree to which price or quantity is

considered exogenous (Burton 1992) Conventional empirical demand systems normally take prices to be exogenous and use price, together with income and substitute effects, to determine the quantities demanded. Implicit in this approach, described as "quantity-dependent", is the assumption that supply is perfectly elastic in the region of the prices being considered and that the price a supplier is willing to accept for a given quantity is determined outside the market by cost factors such as production and transport An alternative approach, termed "price-dependent", arises when supply is inelastic and the quantity demanded is constrained. At the individual consumer or supplier level the "quantity-dependent" approach is applied, provided the individual consumers and suppliers are price takers. However, at the market level, if supply is inelastic, prices will alter until the quantity demanded is equal to the quantity supplied. This leads to quantity being considered as exogenous

The two approaches outlined above are the two extremes of a continuum in which the degree to which either price or quantity is exogenous varies. Burton (1992) has shown that demand for wet fish in Great Britain is modelled more convincingly using the "price-dependent" approach. Given that virtually all of the wet fish supplied to the U.K. market is from capture fisheries with catch quotas and that there is little leeway for storage of the given product form it is perhaps unsurprising that quantity is exogenous at a market level However, the structure of the world shrimp market is quite different, with aquaculture production and cold storage facilities introducing considerable flexibility to the supply. The two extremes were therefore tested in section 4 using the standard log-log static linear demand model

Another area of demand analysis in which debate has arisen regards the functional form of the demand function (Burton 1992, De Voretz 1987, and Schrank et al 1988). The use of the standard log-log static linear demand model imposes strong assumptions on the underlying structure of demand A generalised choice model, which relaxes constraints on demand structure, is also presented in chapter 4

Given a known initial price and a speculated change in supply, the own-price, cross-price and market share elasticities determined in chapter 4 for the different size categories of shrimp can be used to determine the future prices of each of the size categories In chapter 5, a review of published predictions of future shrimp production from both aquaculture and capture fishery sources is carried out to determine likely future production scenarios to be used in predicting price changes. Data limitations leading to low precision in estimated elasticities precluded future prices being predicted but production costs were described and the possible impacts with respect to shrimp prices, methods of production, total revenue and employment within the capture fisheries sector are described qualitatively.

Chapter 6 summarizes the overall conclusions from the study and offers recommendations on the basis of the conclusions.

Due to data restrictions discussed in section 4.2, the size categories of shrimp were defined as follows:

Large shrimp	= under 15 to 25 count[2]/lb
Medium shrimp[3]	= 26 to 50 count/lb.
Small shrimp	= over 51 count/lb.

[2] In this case count refers to the absolute number of "head-off" shrimp.

[3] Rackowe (1984) indicates that the approximate shrimp sizes from aquaculture production range between 25 and 50 count per lb.

MARKETS

2.1 Introduction

The aim of this chapter is to describe the shrimp market structure and provide the basis upon which the likely significant factors to be used in the supply and demand relationship will be determined in section 4.3. The following section describes the global market in terms of current directions and volumes of trade and principal sources and product forms. In the third section the characteristics of the main markets determined in section 2.2 are described in more detail, including preferred colours and sizes, price and consumption trends and import restraints. Due to the perceived influence of Japanese prices on the world market, more time is spent on analysing Japanese price trends.

The analysis of current directions and volumes of trade reveals that there are three major import markets for tropical shrimp species; Japan, the USA and Europe. Total volumes of shrimp imports to each of the three markets increased dramatically during the 1980's, with tropical shrimp from developing countries now accounting for approximately 80% of total imports. Traditional supplier and distribution patterns are being eroded under the forces of market competition and changing consumer behaviour with a concentration in the supplier countries base being evident. Increased consumption of domestically produced shrimp by the developing countries themselves during the early 1990's is further altering the patterns seen in the 1980's.

The review of major sources reveals the lack of potential for large increases in capture fishery production and the dramatic increases in aquaculture production during the 1980's and early 1990's. However, various limiting factors, some of which have already been manifested, suggest that this explosive growth is unlikely to continue. The potential for future production from aquaculture is returned to in more detail in section 5.1.

A description of product forms shows that although shrimp is sold by size (expressed as count per lb or kg.), the primary factor in determining market segment, and that traders also categorize according to colour and country of origin. Product form will vary depending primarily on the market into which the shrimp is being sold. The targeting and increased relative production of value added product forms is likely to be a necessity in the future as the shrimp market becomes increasingly more competitive. The importance of building up a reputable brand name is recognized, with virtually all shrimp traded on the international market under a brand name. Producers use brand recognition to reinforce their reputations for consistent quality, uniformity and accurate counts.

Section 2.3 reveals that consumer preferences for colour and species of shrimp vary region by region within the US, Japan and Europe, and markedly differ between each of these markets. Common between each market is the usage of large shrimp predominantly in up-market or specialist restaurants, medium shrimp in supermarkets and less exclusive restaurants, and small shrimp in cheap restaurants, shops and reprocessing. Price volatility in the Japanese market decreases with the size of shrimp being traded, perhaps due to both greater stability in supply of smaller sizes and lower demand elasticity. Price volatility in the US market may also be due to recent departures from traditional distribution methods. There is price variation between species in the same market and between the major markets for the same species, indicating different consumer tastes. Concerns over the quality of imported shrimp are reflected in the different prices for the same product depending on the country of origin. Consumption in the US is seasonal, with some of this variation in demand being soaked up by inventory holding in cold storage. Consumption in each of the main markets increased during the 1980's, with European expansion being the most rapid and Japan the slowest. There are some indications that demand has reached an upper limit in both Japan and the US, and that there have been changes in consumption patterns in all of the main markets.

2.2 The Global Market

2.2.1 Current Direction and Volume of Trade

There are three major import markets for tropical shrimp species; Japan, USA and Europe. The volume of shrimp imports into the three major markets increased by around 95 percent between 1982 and 1989, from 310,900 metric tonnes to 607,259 metric tonnes. The 1989 imports into the major markets were recorded at 234,600 metric tonnes, 226, 660 metric tonnes and 146,000 metric tonnes for the Japanese, US and European import markets respectively (see Table 3). Between 1985 and 1988, consumption increased by 29%, 23% and 59% in Japan, the U S A and Europe respectively (Infofish 1991). In 1991, the Japanese market imported around 284,000 metric tonnes, with a value of over US$ 2.2 billion. This compares with annual US shrimp imports which reached 245,000 metric tonnes in 1991, valued in excess of US$ 1.9 billion (LMR 1992). These imports account for approximately 30% of the value of all imported fisheries commodities. No comparable figures are available for imports into the European market for 1991.

The importance of shrimp supplies from developing countries is illustrated by the fact that in 1989 imported tropical shrimp[4] accounted for over 75 and 85 percent of the total shrimp imports into the US and Japanese markets respectively. Yang (1992) suggests that tropical shrimp has accounted for approximately 50 percent of total shrimp imports into the European market.

The principal traditional directions of trade are as follows: the U.S. is supplied by countries in both Latin America and Southeast Asia; Japan by Southeast Asia, and Europe by Africa and Western Asia. This pattern is primarily due to geographical proximity of the producers and consumers which facilitates transportation and minimises the impact of market fluctuations due to a shorter time lapsing between export and import dates. However, as market information and transport structures improve, this traditional pattern is being increasingly eroded.

The high level of dependence on the international market and the accompanying risk due to market and price movements which shrimp producers in the developing world experience is further altering traditional supply patterns as the trend towards a concentration in suppliers increases. This trend towards a concentration of suppliers, as described below, may eventually marginalise some of the smaller producers and force them out of the industry or into other markets.

As consumer tastes shift, the demand for different species in a given market may also alter traditional supply routes. The increasing consumption of tropical shrimp in Europe, particularly the recent acceptance of black tiger shrimp, is a case in point.

Although Japan and the USA are the major importers of tropical shrimp, it is Europe and the domestic markets of many developing countries which are thought to have the greatest potential for growth. Josupeit (1992) indicates that potential in Europe is based on a general change in food habits towards healthier food products which offer a greater degree of convenience to the consumer. Narrowing margins between international prices and production costs in many developing countries coupled with the strengthening of many Asian economies over the past few years has bolstered interest in their own domestic markets as a way of stabilising future operations. An Asian Shrimp News (1992) report on China, indicated that due to strong domestic demand local prices were inflated causing a reduction in the quantity of shrimp available for export. Chinese shrimp exports to the USA in 1991 were 39 percent lower than the previous year, a trend which is expected to continue during 1992.

Table 1 and Figures 1a to 1d illustrate the trend in the direction of trade in tropical shrimp species

[4] These estimates are derived from data published by Globefish, Fishdab and LMR Market Reports (Total imports of tropical shrimp into the major markets are presented in Table 3)

between 1987 and 1991[5]. The six principal suppliers to each market are listed in order of importance, with respect to 1991 market share.

US Market:

With reference to US market, Indonesian and Thai suppliers were the most dynamic, increasing market shares from 0.8 to 4.8 percent and 5.4 to 18.7 percent respectively (see Table 1a). In terms of volume, Indonesian imports increased by over 600 percent, from 1,500 metric tonnes to over 10,600 metric tonnes within the five year period. Thai imports increased 300 percent from 10,400 metric tonnes in 1987 to 41,600 metric tonnes in 1991. Mexican shrimp imports into the US dropped by 111 percent from 30,200 metric tonnes to 14,300 metric tonnes during the same period, with a 9.3 percent reduction in market share. It should be noted, however, that although there has been concentration in the supplier base, the number of import firms in the US has increased (Filose, 1992).

Japanese Market:

South East Asian shrimp dominated imports into the Japanese market in 1991, Indonesia, Thailand and India being the main suppliers with 49,500, 43,000 and 33,100 metric tonnes respectively (see Table 1b). Thai shrimp achieved the largest expansion in market share, increasing supply from 10,000 metric tonnes, 4.6 percent of total imports in 1987, to 43,000 metric tonnes and 16.6 percent of total Japanese imports in 1991.

European Market:

The real origin of shrimp consumed in the various EEC countries can be difficult to trace given that if a good is imported into one European country, it technically obtains the nationality of that country if re-exported to another country. Much of the tropical shrimp imported to Europe is similar in size and product form to the traditionally used cold water shrimp and is used as a cheaper substitute. The larger sizes of tropical shrimp have effectively had to create their own market in Europe, with a market share in the north of approximately 25%. Principal sources of tropical shrimp in order of amount imported are currently Thailand, India, Argentina, Senegal, Bangladesh, and China.

Changes to the Supplier Base:

Between 1987 and 1991 the US and Japanese markets underwent a substantial concentration in their supplier bases for tropical shrimp. Figures 1a and 1b indicate the growing importance of the six principal suppliers to the US market (Ecuador, Thailand, China, India, Mexico and Indonesia) in terms of market share. In 1991 the six principal suppliers accounted for 71.3 percent of total shrimp imports, compared with 58.6 percent in 1987. The Japanese market underwent a similar process (see Figures 1c and 1d), with the top six suppliers (Indonesia, Thailand, India, China, Philippines and Vietnam) accounting for 74.8 percent of total tropical shrimp imports in 1991 compared with only 53 percent in 1987. It cannot be determined whether there has been a concentration in supplier base to Europe.

Overall there has been a concentration in supplier bases in both the US and Japanese markets. This may be the result of a number of factors, including stricter quality control regulations by the markets, closer links between suppliers and buyers in the respective countries, or effective specialisation in the major producing countries. This trend is likely to continue, assisted by the increasing tendency for larger investors in the major markets to integrate vertically into the production activities in the supplier countries.

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[5] The data analyzed are total imports between January and November in the respective years.

Table 1. **Percentage Change In Imports of Tropical Shrimp from the Six Principal Suppliers, (January to November Totals)**

1.a **USA : Six Principal Suppliers**

COUNTRY	1987 (METRIC TONNES)	% TOTAL IMPORTS JAN-NOV	1991 (METRIC TONNES)	% TOTAL IMPORTS JAN-NOV	1987-1991 % CHANGE JAN-NOV
ECUADOR	40,960	21.32	44,720	20.13	+8.42
THAILAND	10,390	5.41	41,590	18.72	+75 03
CHINA	17,190	8.95	31,030	13.96	+44.59
INDIA	12,340	6.42	16,190	7.29	+23.81
MEXICO	30,210	15.72	14,330	6.45	-110.76
INDONESIA	1,500	0.78	10,660	4.80	+85.96
OTHERS	79,560	41.41	63,690	28.66	
TOTAL	192,140	100.00	222,220	100.00	

1.b **JAPAN : Six Principal Suppliers**

COUNTRY	1987 (METRIC TONNES)	% TOTAL IMPORTS JAN-NOV	1991 (METRIC TONNES)	% TOTAL IMPORTS JAN-NOV	1987-1991 % CHANGE JAN NOV
INDONESIA	28,170	12.85	49,530	19.09	+43.13
THAILAND	9,980	4.55	43,090	16.61	+76.84
INDIA	33,290	15.18	33,160	12.78	-0.41
CHINA	23,900	10.90	31,250	12.04	+23.51
PHILIPPINES	10,430	4.76	20,370	7.85	+48.78
VIETNAM	10,520	4.80	16,780	6.47	+37.30
OTHERS	102,970	46.96	65,320	25.17	
TOTAL	219,270	100.00	259,500	100.00	

1.c Summary

MARKET	1987 (JAN-NOV) METRIC TONNES	1991 (JAN-NOV) METRIC TONNES	SUPPLIER
USA	58.59	71.34	PRINCIPAL SIX
USA	41 41	28.66	OTHERS
JAPAN	53.04	74.83	PRINCIPAL SIX
JAPAN	46.96	25.17	OTHERS

Source: Based on Data from LMR Shrimp Market Report 1992.

Figure 1a U S. Shrimp Imports (January to November 1987)

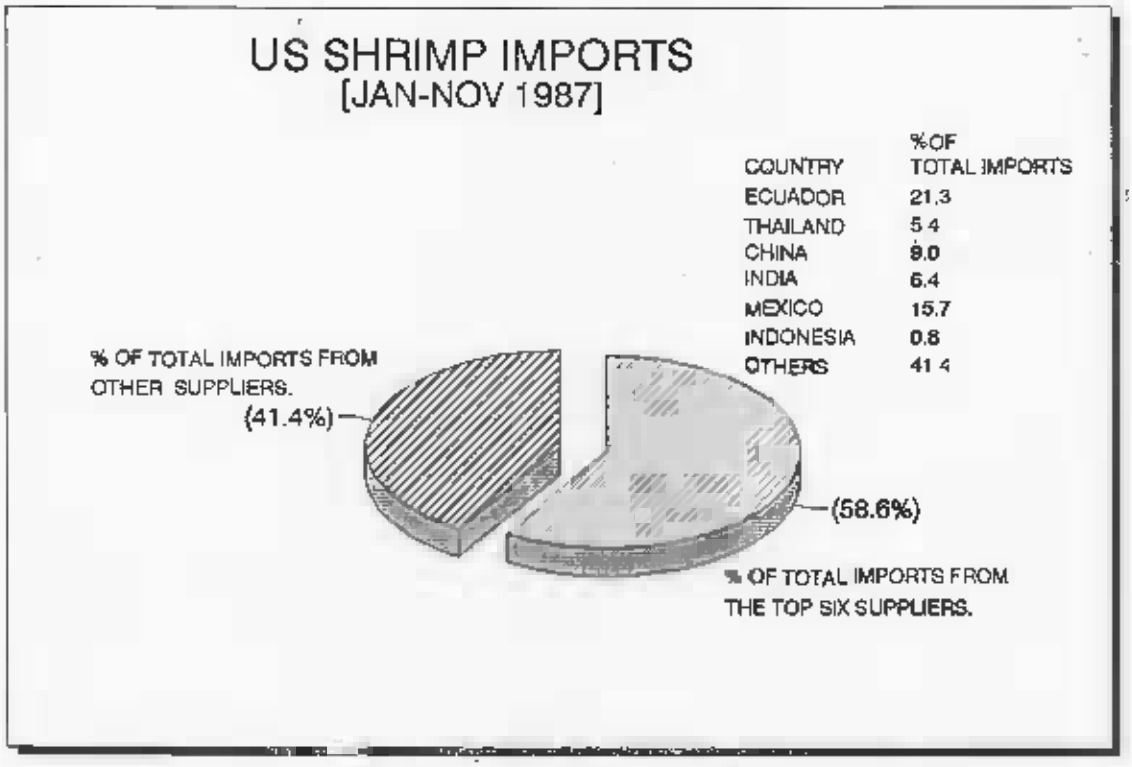


Figure 1b U.S. Shrimp Imports (January to November 1991)

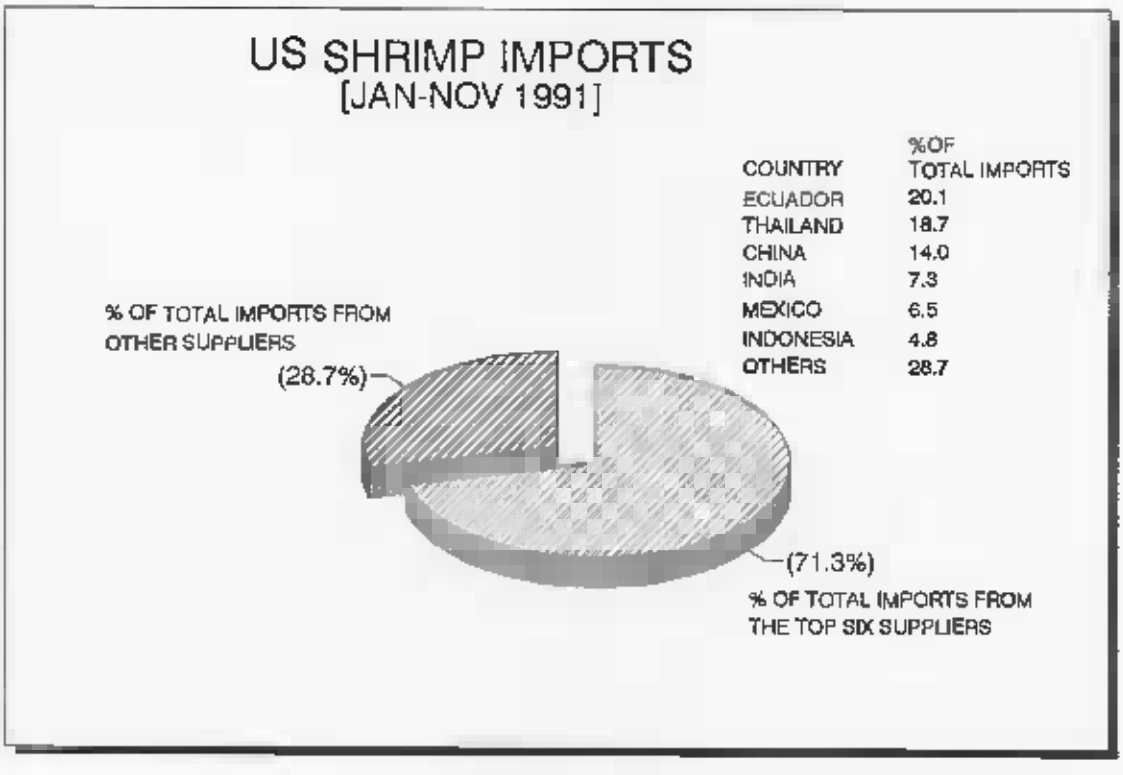


Figure 1c Japanese Shrimp Imports (January to November 1987)

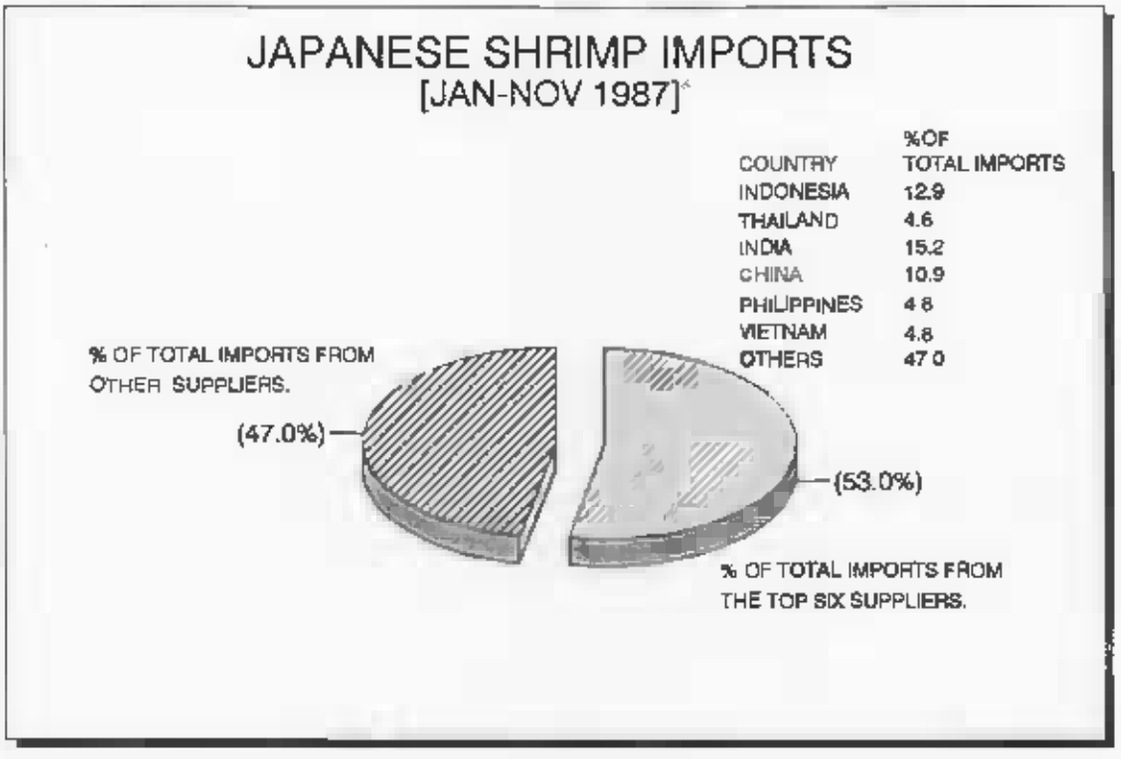
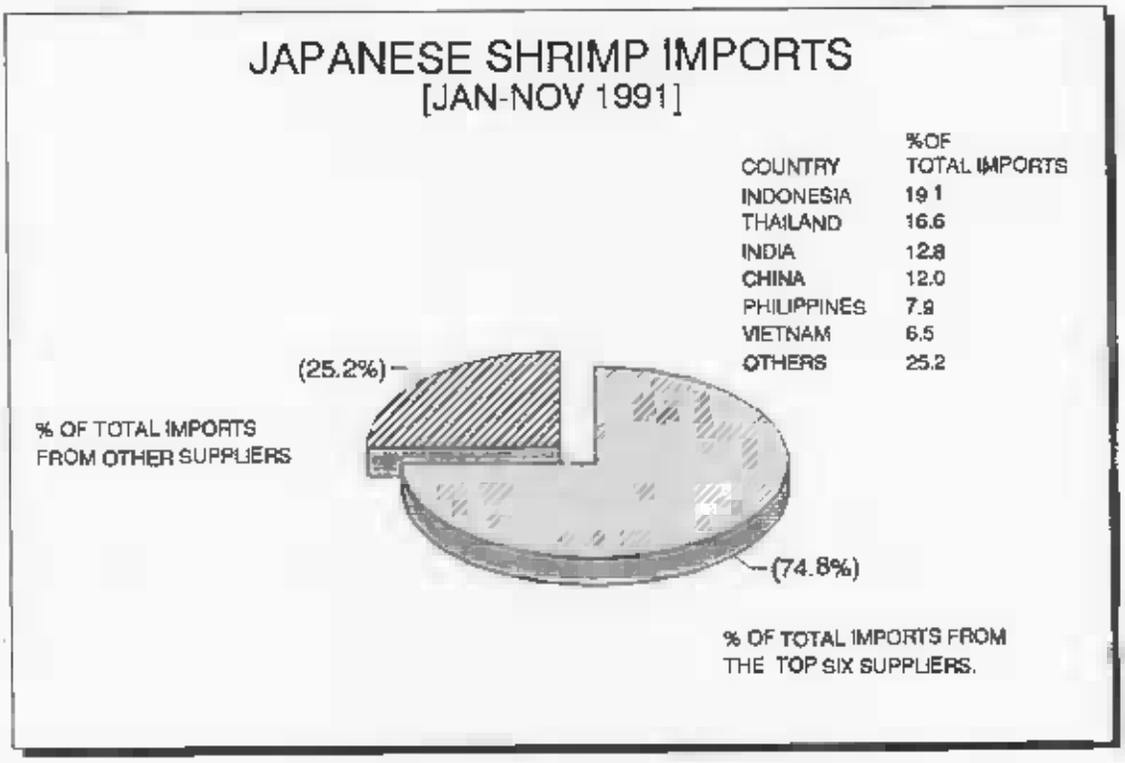


Figure 1d Japanese Shrimp Imports (January to November 1991)

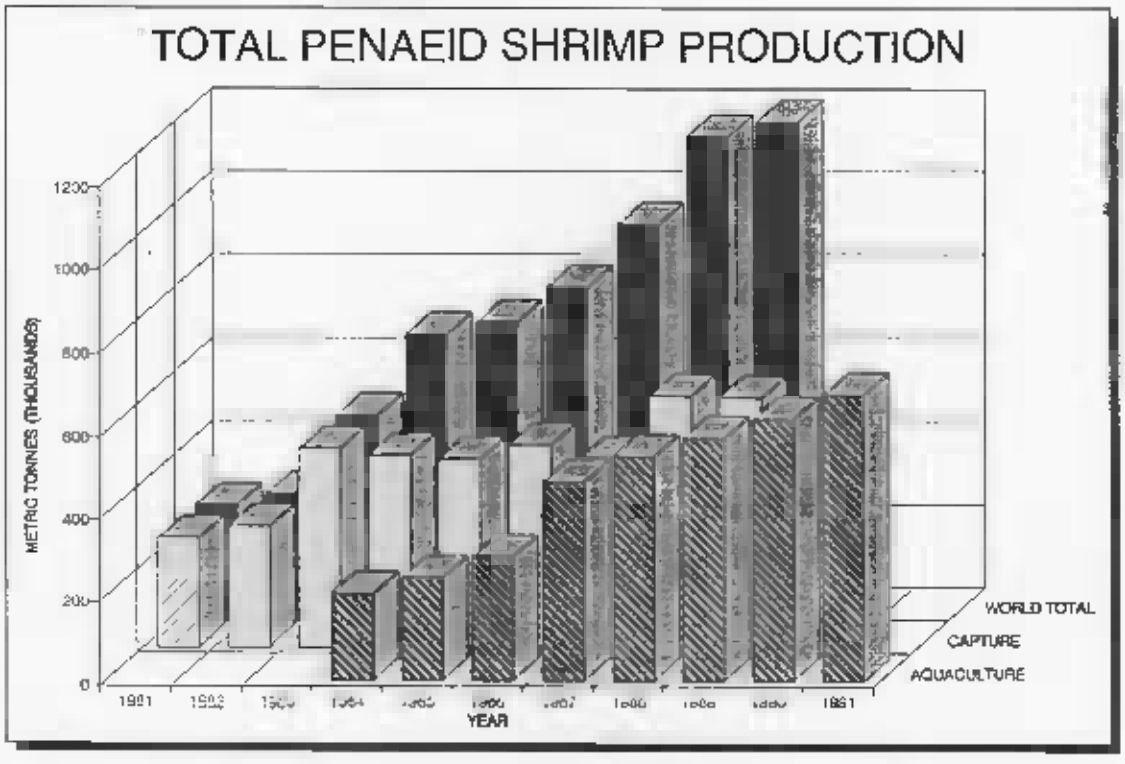


2.2.2 Historical Review of Major Sources

This chapter presents a review of the major sources of tropical shrimp with a view to determining the probable status of each source.

On the supply side there are two main sources from which the supply of tropical shrimp species is obtained. The first is the capture fishery which developed as the initial basis of commercial exploitation of Penaeid species. The 1989 annual production from this source was in the order of 608,000 metric tonnes. The second is aquaculture production, which developed rapidly during the 1980's, now contributes over 50 per cent of total production of Penaeid shrimp species and 30% of total world shrimp production, with an annual level of production close to 700,000 metric tonnes. Over 80% of production from aquaculture enters the international shrimp market. Figure 2 indicates the total world production trends for Penaeid and Metapenaeid shrimp species. No data on capture fishery landings were available for 1990 and 1991 and for this reason only aquaculture production is presented for these years.

Figure 2 Total Penaeid Shrimp Production



Between 1981 and 1988 capture production rose from 264,000 metric tonnes to 608,000, an increase of approximately 130 per cent. The 1989 capture fishery production estimate of 604,000 metric tonnes (FAO, Fishery Statistics, 1989) indicate the beginning of a stabilisation of output from this source. Aquaculture production also increased by approximately 130 percent between 1986 and 1991, with output rising from 300,000 metric tonnes to over 690,000 metric tonnes.

Of interest is the nature of the production function in each of the above cases where the level of output depends on the quantities of inputs used, the proportions in which they are combined and the technology of production. In the case of aquaculture both the inputs and outputs can be controlled by the producer in much the same way as most other production processes. In the case of a capture fishery one of the inputs is the capital stock or shrimp population available for

exploitation. Output will be affected positively by increasing capital and labour, but negatively by depleting the natural resource. Therefore in capture fisheries the changes in one set of inputs (capital and labour) will be systematically related to the other (capital stock).

Table 2 : Main Penaeid Species of Commercial Interest (1991).

SPECIES	% TOTAL CULTURED	% TOTAL CAPTURED	COMMENTS
P. monodon	45 %	10 %	Fastest growing farm raised shrimp, dominating production in S.E. Asia.
P. chunensis	18 %	35 %	China dominates production.
P. merguensis	see 'Others'	14 %	
P. vannamei	17 %	see 'Others'	Dominant species cultured in North and Latin America.
P.japonicus	see 'Others'	4 %	
Others	20 %	37 %	'Others' includes other Penaeus or Metapenaeus species whether mentioned or not.

Source: FAO Aquaculture Production (1991); World Shrimp Farming (1991).

Table 3 : Total World Shrimp Production : All Species (1000 Metric Tonnes).

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CAPTURE	(Source: [1] FAO catch statistics 1981-89, [2] Globefish - Fishdab - 19902131)										
[1] Total Penaeid spp	283.8	295	463.6	468.3	457.2	489.4	457.4	606.4	604.4		
Total others	1347.6	1440.8	1362.2	1441	1663.5	1728.7	1826.9	1939.7	1838.9		
[2] Total Capture	1631.4	1735.8	1825.8	1907.3	2120.7	2218.1	2284.3	2518.1	2443.3		
AQUACULTURE	(Source: FAO aquaculture production statistics 1986/87/88; Globefish - 19910331; World Shrimp Farming 1989/90/91)										
[3] Total Penaeid Culture				208	248.1	296.8	482.8	543.6	585.5	632.9	660.1
Total Penaeid Production [1]+[3]	283.8	295	463.6	675.3	705.3	786	940.2	1152	1189.9	632.9	660.1

Source : FAO Catch Statistics (1981/89); FAO Aquaculture Production (1986/87/88); Globefish-Fishdab (1989); World Shrimp Farming (1989/90/91)

2.2.2.1 Capture Fisheries: Status of Stocks

Figures 3a-3h represent the trends in landings of different species in eight fishing areas, as defined by the FAO in their fisheries statistics publications (FAO Nominal catches by species, fishing areas and countries or areas). The relevant areas together with the major commercial Penaeid species fished are identified in Table 4, and an associated map identifying fishing areas is reproduced in Annex I. The discussions below focus on the status of Penaeid shrimp stocks in the various fisheries. It must be noted that the data are often misleading in that increases in landings are sometimes a result of the inclusion of additional data sets.

The general trends in landings revealed by the quantitative and qualitative data presented below suggest that there is little potential for large increases in output from capture fisheries as a whole, with some degree of over-exploitation in Penaeid shrimp fisheries found in nearly all of the regions.

Atlantic West Central Area [31]. See Figure 3a.

After peaking at around 178,000 metric tonnes in 1985, landings dropped sharply to 129,000 in 1987 before recovering to around 162,000 metric tonnes in 1989. The shrimp fisheries in this region have been described as being overexploited in both biological and economic terms (Houston 1989).

Atlantic Central [34]. See Figure 3b.

Landings in this area have been fluctuating between 8,500 and 15,500 metric tonnes. A report on the shrimp fishery of Sierra Leone (Willmann 1989) suggests that the fishery for Penaeus notialis and Penaeus kerathurus may remain under exploited, however this is not represented by the available data.

Atlantic Southwest [41]. See Figure 3c.

Since 1985 landings have fallen steadily from over 68,500 metric tonnes to around 50,000 metric tonnes in 1989. This is corroborated by a study of Guinean shrimp fisheries for *Penaeus subtilis* and *Penaeus notalis* (Villegas and Dragovich 1984), suggested that falling catch rates and reduction in fleet size in the area was indicative of a decline in abundance of the two species. Fabres (1988), study on *Peneaus subtilis* fisheries ranging from Venezuela to Northern Brazil, also indicated that the stocks harvested by the offshore fishery had declined during the 1980's.

Indian Ocean, Western [51]. See Figure 3d

The data indicate a fairly stable catch rate between 1983 and 1987, at around 30,000 metric tonnes. Between 1987 and 1988 the landings increased to around 112,000 metric tonnes before falling slightly to 104,000 metric tonnes in 1989. The dramatic increase in nominal landings during 1987 was due to the inclusion, for the first time, of Indian catch statistics which amounted to 78,500 metric tonnes in 1987. The fall in landings between 1988 and 1989 may be more indicative of the general trend in the status of the shrimp stocks in this region. Results of various studies on *Penaeus indicus* stocks (Devi 1986, Agasen and Del Mundo 1988) in Manappad and Punnaikkayal fisheries (South India) show relatively high values of total mortality and exploitation rates, indicating the overexploited status of these stocks.

There seems to be a wide range of exploitation levels of stocks found within this area, a study by FAO (1989) indicated that the exploitation levels of the *Penaeus semisulcatus* stock off the coast of Madagascar were relatively modest. A 9.5 percent increase in annual landings from 2100 metric tonnes to 2300 metric tonnes was recommend to achieve an exploitation level close to the estimated MSY.

Indian Ocean, Eastern [57]. See Figure 3e.

Landings have increased steadily from 14,700 metric tonnes in 1985 to over 100,000 metric tonnes in 1989. The other species caught in this region have experienced a reduction in landings from 95,000 metric tonnes in 1987 to 75,500 metric tonnes in 1989.

Pacific Western Central [71]. See Figure 3f

The data indicates a dramatic fall in landings from 239,000 metric tonnes in 1983 to 179,000 metric tonnes in 1987. Between 1987 and 1989, landings increased to over 273,000 metric tonnes, a increase of approximately 52 percent from the 1987 landings. These data are not validated by case studies which have been carried out in this region.

Agasen and Del Mundo (1988) report an overexploited status for the Penaeus stocks in Manila Bay (Philippines). Sumiono (1988), studying *Penaeus merguiensis* in Indonesia, indicated a peak in

landings over 5200 metric tonnes in 1979 followed by a decrease to around 1000 metric tonnes in 1980. It must be noted that this fall was due mainly to a total ban on all trawl fishing in that year, a policy implemented to address political rather than biological issues associated with the fishery

Pacific Eastern Central [77]. See Figure 3g

Data for this area indicate a steady decline in landings from 110,000 metric tonnes in 1983 to 52,000 metric tonnes in 1989.

Pacific Southwest [87] See Figure 3h.

After a drop from 10,000 metric tonnes to 2,500 metric tonnes in 1984, the data indicates a steady increase in landings to a level of 8,600 metric tonnes in 1989.

Figure 3a Atlantic West Central 31

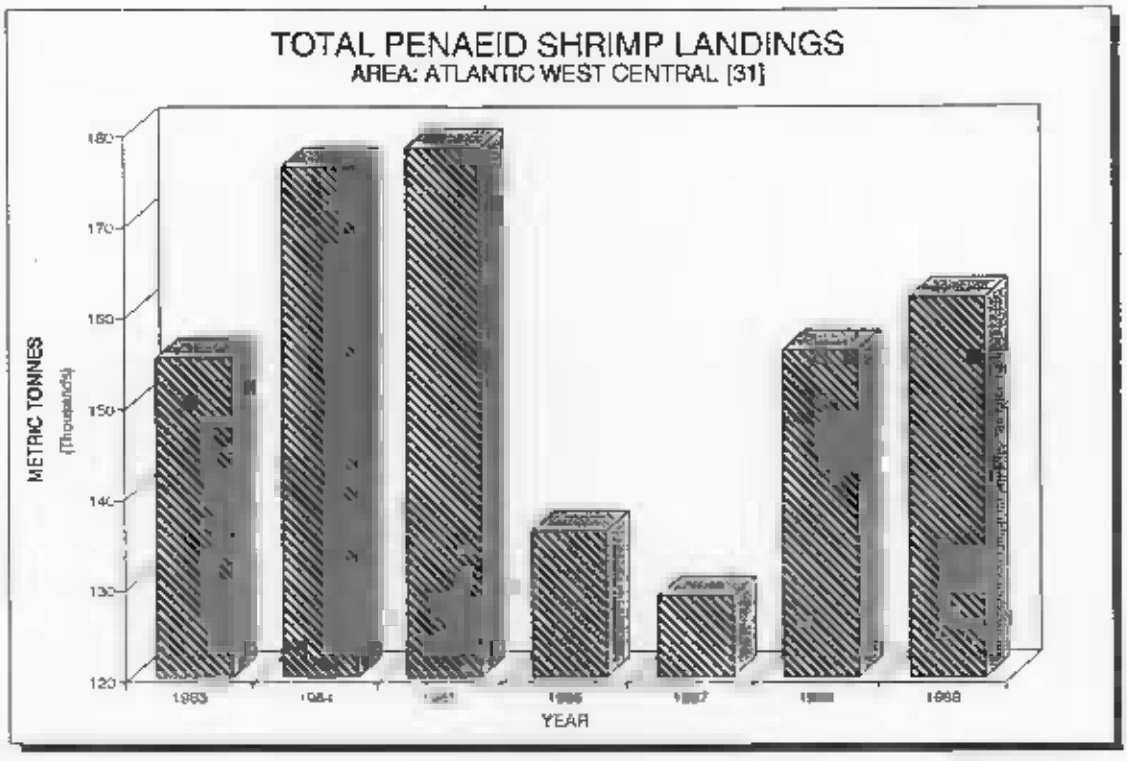


Figure 3b Atlantic Central 34

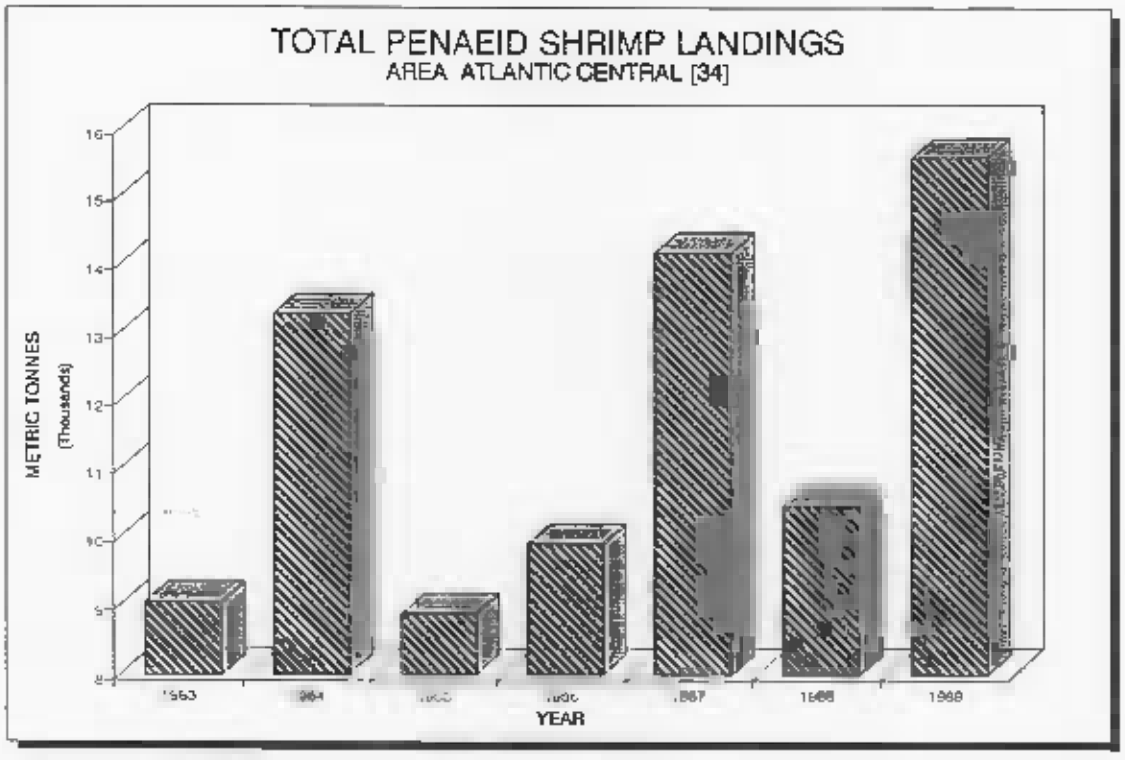


Figure 3c Atlantic South West 41

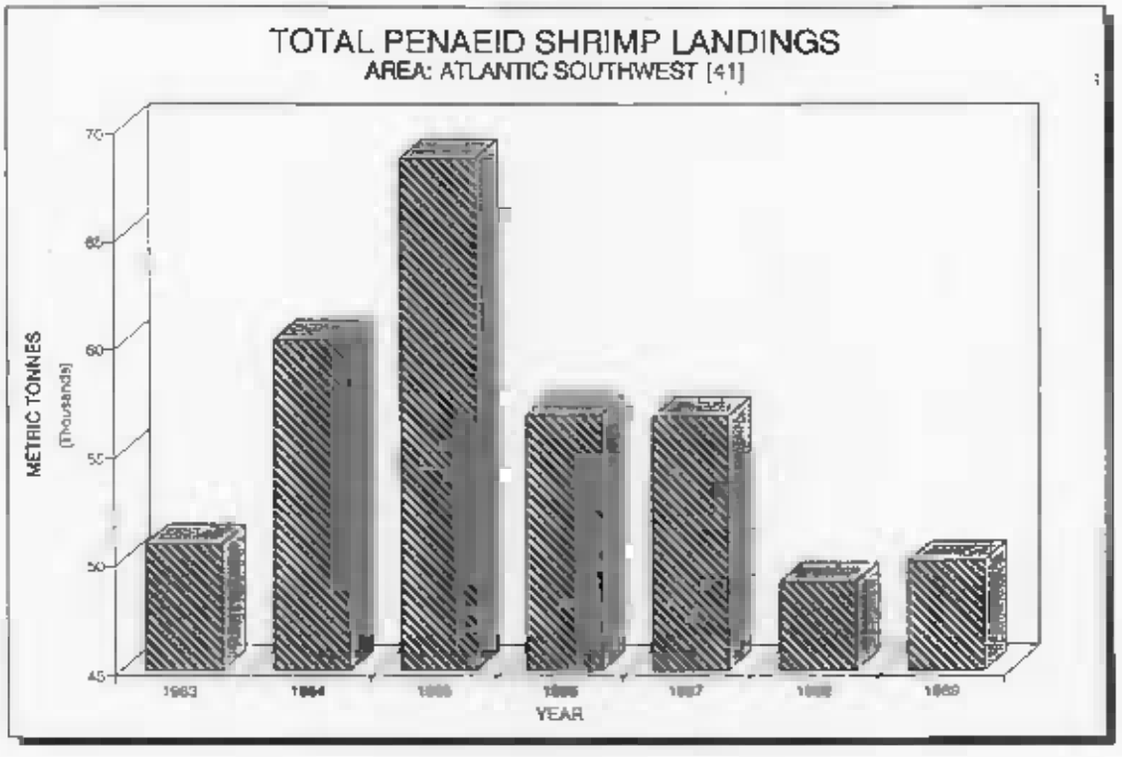


Figure 3d Indian Ocean Western 51

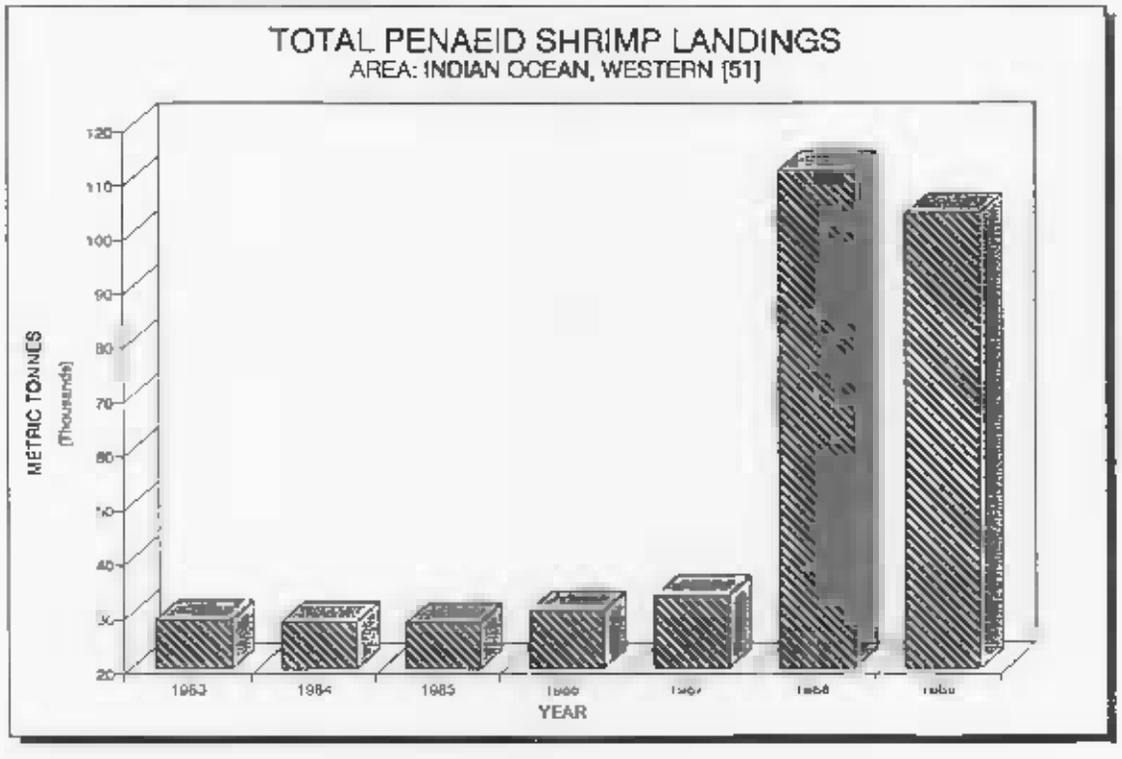


Figure 3e Indian Ocean Eastern 57

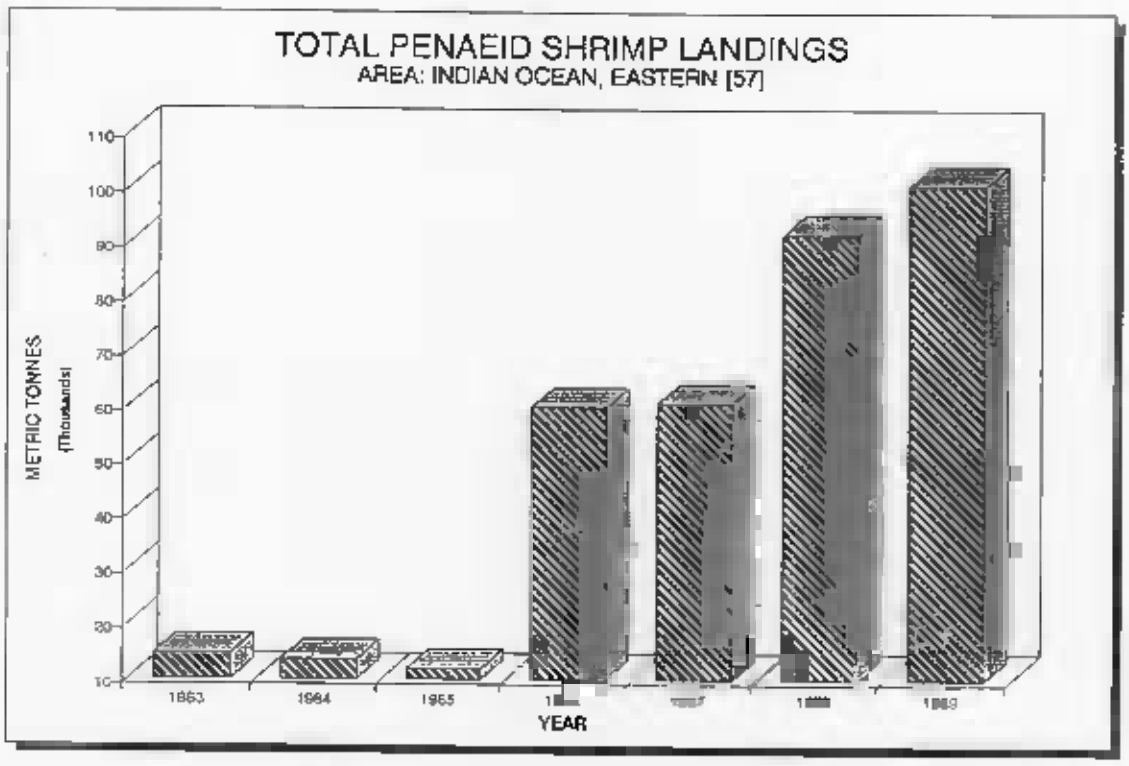


Figure 3f Pacific Western Central 71

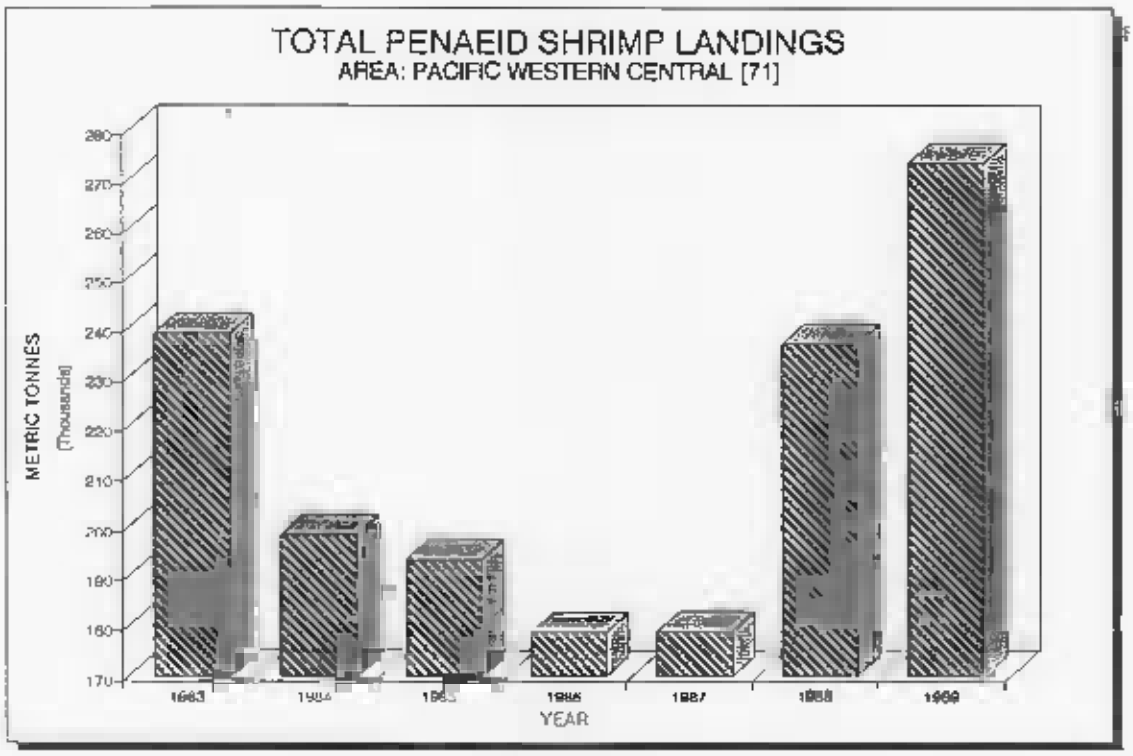


Figure 3g Pacific Eastern Central 77

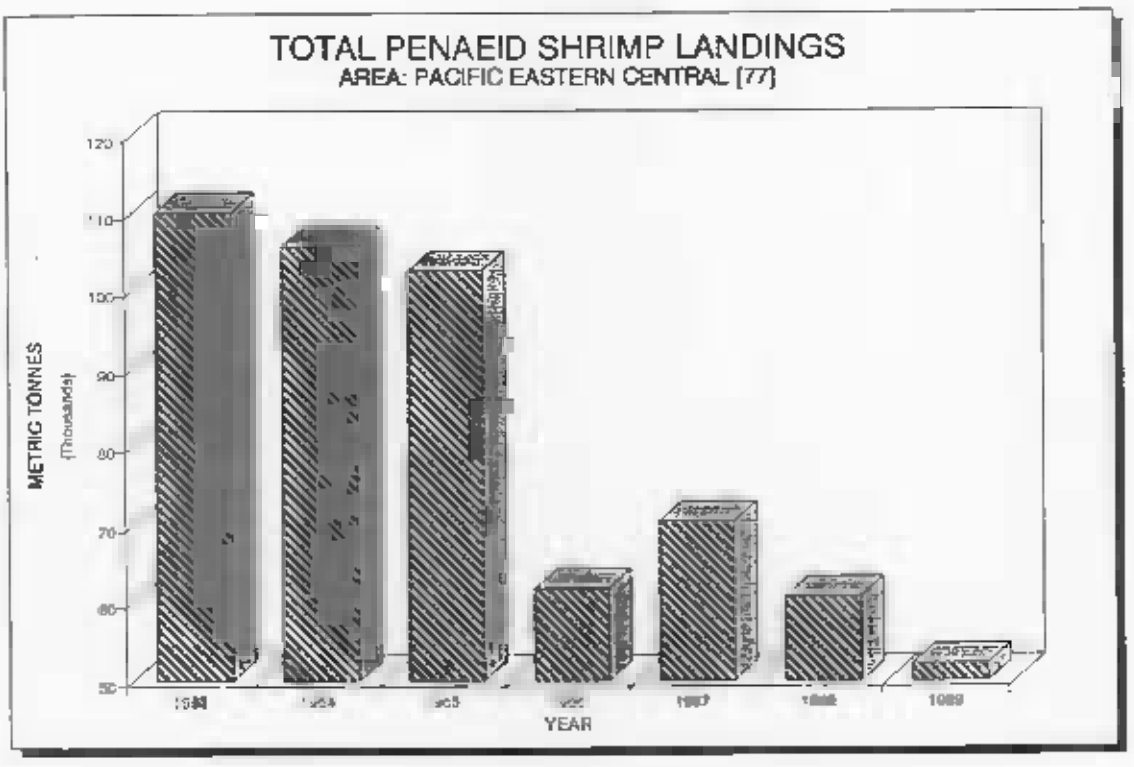


Figure 3h Pacific Southwest 87

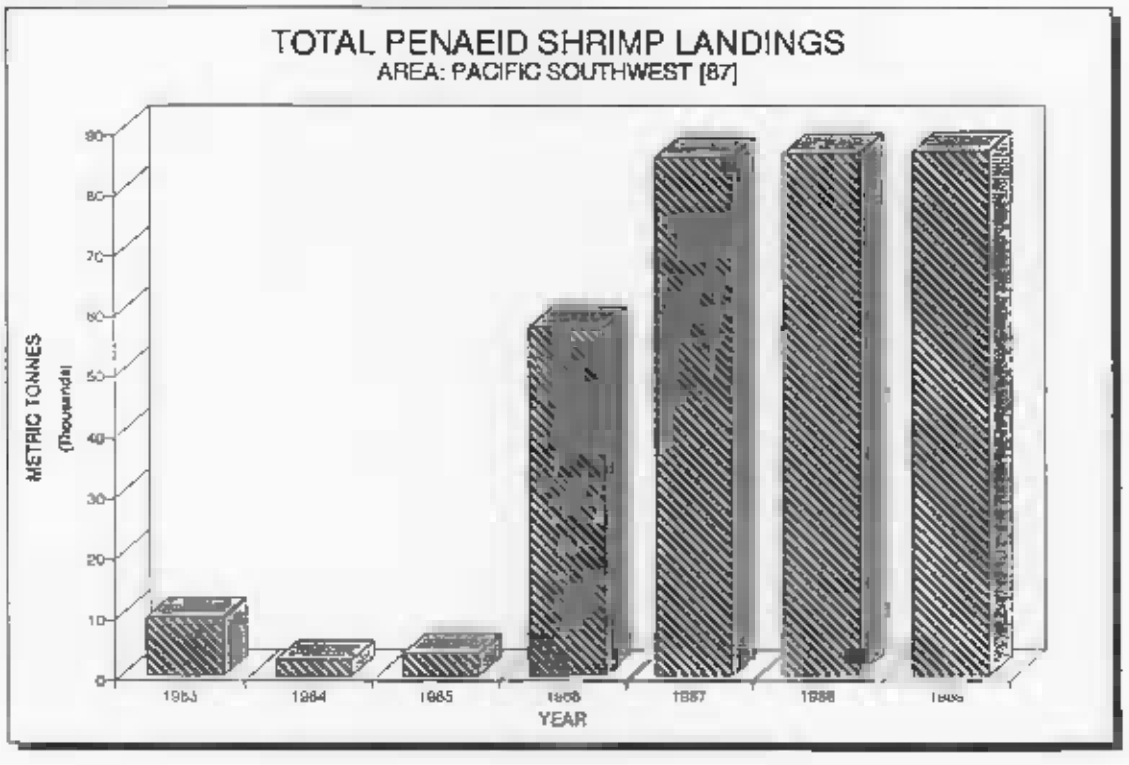


Table 4 : Penaeid Shrimp Landings by Area (Metric Tonnes)

SPECIES	AREA	1983	1984	1985	1986	1987	1988	1989
Penaeid	31	155135	176137	178283	136076	128987	156068	161826
Penaeid	34	9058	13294	8888	9919	14196	10456	15599
Penaeid	41	50823	60256	68650	56838	56752	49086	50037
Penaeid	51	29094	26752	28505	30881	33509	111948	104125
Penaeid	57	14702	13572	11941	59887	60636	91751	100603
Penaeid	71	239001	198553	193348	178865	178992	236873	273448
Penaeid	77	110313	105811	102707	61895	70610	60893	52216
Penaeid	87	9690	2531	3673	57510	85618	88212	86607
Total		617816	598906	595995	591871	629300	803289	844461

AREA	SPECIES
AREA 31 = ATLANTIC WEST CENTRAL	Penaeus aztecus, P. duorarum; P. brasiliensis; P. setiferus
AREA 34 = ATLANTIC CENTRAL	Penaeus kerathrus; P. notialis
AREA 41 = ATLANTIC SOUTHWEST	Penaeus subtilis; P. notialis
AREA 51 = INDIAN OCEAN, WESTERN	Penaeus indicus; P. semisulcatus; P. monodon
AREA 57 = INDIAN OCEAN, EASTERN	Penaeus merguiensis, P. monodon; P. semisulcatus, P. latisulcatus
AREA 71 = PACIFIC WESTERN CENTRAL	Penaeus merguiensis; P. japonicus; P. monodon; P. semisulcatus
AREA 77 = PACIFIC EASTERN CENTRAL	Penaeus californiensis, P. stylirostris; P. vannamei; P. brevirostris
AREA 87 = PACIFIC SOUTHWEST	Penaeus occidentalis

Source : FAO Catch Statistics (1983-1989)