ICLARM STUDIES AND REVIEWS 14

The Economics and Management of Thai Marine Fisheries

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INTERNATIONAL CENTER FOR
LIVING AQUATIC RESOURCES MANAGEMENT

WINROCK INTERNATIONAL INSTITUTE
FOR AGRICULTURAL DEVELOPMENT

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1987

WINROCK INTERNATIONAL INSTITUTE FOR AGRICULTURAL DEVELOPMENT
ARKANSAS, USA
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MANILA, PHILIPPINES

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Published by the International Center for Living Aquatic Resources Management, MC P.O. Box 1501, Makati, Metro Manila, Philippines and Winrock International Institute for Agricultural Development, Route 3, Petit Jean Mtn., Morrilton, Arkansas 72110-9537, USA

Printed in Manila, Philippines

Panayotou, T. and Songpol Jetanavanich. 1987. The economics and management of Thai fisheries. ICLARM Studies and Reviews 14, 82 p. International Center for Living Aquatic Resources Management, Manila, Philippines and Winrock International Institute for Agricultural Development, Arkansas, USA.

ISSN 0115-4389
ISBN 971-1022-25-7

Cover: Thai trawlers in dock, Sri Racha, Cholburi, Inner Gulf of Thailand. Photo by R.S.V. Pullin.

ICLARM Contribution No. 384.

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ACKNOWLEDGEMENTS

ICLARM gratefully acknowledges receipt of a special grant from the United States Agency for International Development (Bangkok, Thailand) which has made publication of this report possible.

During the time when initial work on this manuscript began, both authors were affiliated with Kasetsart University in Bangkok. The first author was there as Research Associate of the Agricultural Development Council (A/D/C) and was a member of the Faculty of Economics and Business Administration. The second author was a Research Associate at the Asian Institute of Technology and a graduate student of Dr. Panayotou who conducted his thesis research on Thai fisheries.

Both authors and publishers are indebted to several anonymous colleagues, including several in Thailand, who kindly reviewed the manuscript and made a number of constructive suggestions, many of which have been incorporated in the final text. Final responsibility for contents of the publication remains with the authors.

ABSTRACT

While still an economically developing country, Thailand possesses a commercial fishery comparable to those of the economically developed nations. The Thai fishing industry, one of the world's ten largest, with a fleet of over 20,000 modern vessels and a catch of about 2 million tonnes annually, supplies 20 kg of fish per capita to a population of 50 million and earns the country half a billion dollars in foreign exchange annually. However, Thailand's fishery management capabilities continue to be those of a developing country, lagging far behind the industry's exploitation capabilities. Moreover, the rapid development of the Thai trawl fishery and the stagnation of the small-scale coastal fishery have resulted in a dualistic structure with small-scale fisheries employing over 70% of the total number of fishermen, but landing less than 30% of the total catch.

Though somewhat unique, Thailand's experience is of particular relevance to developing countries that are trying to develop large-scale fisheries capable of exploiting fully their extended fisheries jurisdictions, often without paying attention to developing commensurate management capabilities. Several lessons can be learned from studying Thailand's overextended and refractory trawl fishery, depleted demersal resources and depressed coastal fishing communities.

The study documents the profitability of the trawl fishing, the poverty of small-scale fishermen, the heavy overfishing of the Gulf of Thailand, and the discrepancy between the catching power of the Thai fishing industry and the management and enforcement capabilities of Thailand and its neighbors. The study concludes that an effective strategy for the solution of Thailand's fisheries-related problems would involve the immediate halt to the construction of new trawlers, the licensing and control of the activities of existing vessels, assistance to small- and large-scale fishermen through fisheries enhancement projects, such as artificial reefs, community fishing rights, conclusion of more joint fishing ventures and development of alternative sources of animal protein, income and employment.

CHAPTER 1

INTRODUCTION

Thailand, a developing country in Southeast Asia, with a population of fifty million and a per capita income of roughly US$700, boasts one of the ten largest fishing industries in the world and the fifth largest in Asia, a distinction accomplished with little, if any, government assistance. The local fishing grounds along a coastline of 2,670 km are heavily exploited and a distant-water fleet employing highly sophisticated vessels and gear is deployed throughout the South China Sea and the Indian Ocean. In addition to annually supplying about 20 kg per head to a population of fifty million, the Thai fishery is one of the country's largest foreign exchange earners (US$440 million or 6% of the total value of exports in 1982). Thus, while still an economically developing country, Thailand possesses a commercial fishery comparable to those of the economically developed nations, a unique accomplishment within the Third World.

However, this disparity in development between the fishing industry and the rest of the economy is not without consequence. First, the capital intensity of the fishing industry is out of line with the country's relative factor endowments of abundant labor and scarce capital, a sheer misallocation of resources. Second, the development of the fishing industry has not been balanced but lopsided towards the trawl fishery creating a dualistic structure. Side by side with the heavily mechanized and highly profitable trawl fishery which accounts for over 70% of the catch but employs under 30% of the fishermen, operates a crowded coastal fishery using some of the most primitive gear and resembling the artisanal fisheries of the least developed countries. Third, Thailand's fisheries exploitation capabilities, being those of a long-distance fishing nation, far exceed its resource management capabilities which are still those of a developing country. As a corollary, because of its technological sophistication, financial strength and mobility, the large-scale fishery is virtually immune to regulation and government control.

Though unique, Thailand's experience is of particular relevance to developing countries that are trying to develop large-scale fisheries capable of exploiting fully their extended fisheries jurisdictions, often without paying attention to developing commensurate management capabilities. Several lessons can be learned from studying Thailand's overextended and refractory trawl fishery, depleted demersal resources and depressed coastal fishing communities.

Yet, a study of the development, economics and management of the Thai fisheries is also of interest in its own right. The literature on the subject is very limited and scattered and leaves unanswered many important questions concerning the spectacular rise and near fall of one of the world's largest fishing industries. What led to the transformation of Thailand from a developing country of subsistence rice farmers and coastal artisanal fishermen to a long-distance fishing nation in less than two decades? What accounts for the persisting dualism in Thai fisheries? Why did coastal fishermen neither extend their fishing range by upgrading their technology nor find better employment opportunities in the rapidly growing trawl fishery or elsewhere in the economy? How profitable is the trawl fishery today after 20 years of relentless expansion? What is the state of the Thai fishery resource? Is it overfished and how severely? How has the fishing industry adjusted to the two unprecedented external shocks of the 1980s, the precipitous rise in the oil prices and the loss of some 300,000 km^2 of traditional fishing grounds as a result of the declaration of extended fisheries jurisdictions by neighboring countries? Is the Thai fishing industry overcapitalized as a result, and how much relief does the opportunity for joint fishing ventures with other countries offer to Thailand? What are the prospects and policy alternatives?

These are some of the questions we will attempt to answer or at least to illuminate. They are not easy questions and the database is not solid enough for a firm stand on every issue. Yet, the success of any policy initiative or management scheme will depend squarely on understanding past developments, the current situation and future prospects of the Thai fisheries within both the national and the regional contexts.

Inevitably, the study is not without limitations. First, the scope is limited; it does not deal, for instance, with some economic aspects such as infrastructure, marketing, processing and exports or sociocultural and human factors such as values and attitudes or group behavior and community organization, except to the extent that they have a pronounced and direct effect on the economics, the state of the resource or the prospects for successful management. This is not to say that they are less important but to admit that we cannot do justice to them in a study of this length.

Second, the issues covered will not be investigated as deeply as one would have liked because a study of this length and scope is inevitably a compromise between breadth of coverage and depth of analysis. Ultimately, our information base is limited to the amount and quality of the available data. Some time series are too short to afford reasonable degrees of freedom for statistically valid inferences while others have gaps or inconsistencies. Still, these are the best fishery data we have, not only in Thailand but possibly throughout the developing world. Whenever the database is weak, warnings will be given to view the findings with caution.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

There are literally hundreds of studies on technical and biological aspects of the Thai fisheries, particularly of the demersal resources and the trawl industry. Very few studies, however, investigate the economics and management of the industry and even fewer attempt to integrate the economic and biological aspects of the fishery and determine the optimality of the prevailing allocation of resources. Here, we will review, chronologically and selectively, only the latter group of studies since the former are too numerous and too specialized to be reviewed. Since, however, we built on the findings of these (technical and biological) studies we will have cause to refer to some of them in later sections of the study.

One of the first economic studies of the Thai fisheries is by Huvanandana (1973) who estimated production functions for the Indo-Pacific chub mackerel *(Rastrelliger)* fishing industry. He also estimated and compared the costs and earnings of Thai and Chinese purse seines and encircling nets and concluded that the latter was the more profitable gear for exploiting the Indo-Pacific chub mackerel.

The Department of Fisheries (DOF) has conducted three cost-and-earnings studies for the trawl fishery, the first in 1969 (unpublished), the second in 1974 (DOF 1974) and the third in 1977 (Rientrairut 1979). The 1969 survey found profits across the board while the 1974 survey reported that all sizes of vessels suffered losses except for the large otter and pair trawlers (> 18 m long). In contrast, the 1977 survey found that all sizes of vessels earned substantial profits except for small otter trawlers (< 14 m). A more recent survey by the Office of Agricultural Economics (OAE 1983) found that large trawlers continue to enjoy high profits. Chapter 5 analyzes and interprets the results of these surveys.

Marr et al. (1976) made a detailed review of the fisheries sector in Thailand, including profitability analysis (based on the 1969 and 1974 DOF surveys), determination of maximum sustainable yield, investment requirements and institutional arrangements. It is one of the first studies to recognize the dualistic structure of the sector, to draw attention to the misallocation of resources and the encroachment of foreign fishing grounds and to recommend remedial policies. While the study did not receive the attention it deserves, it has drawn attention to economic and other factors beyond the conventional biological and technical aspects of the fishery and has stimulated further studies. The findings of this rather dated study will be compared with ours in the relevant sections.

Vattanavengpanit (1979) estimated the supply and demand functions for marine shrimp. The price coefficients of both the supply and domestic demand were found to be statistically insignificant. In contrast, the coefficients on both price and income were statistically significant in the case of export demand.

Panayotou (1980) in recent study reviewed the development of the Thai fisheries, analyzed the 1969, 1974 and 1977 DOF survey results and the state of the Thai fishery resources and discussed the sector's prospects and some policy options. Among the findings of the study were the profitability and resilience of the large-scale fishery, the depressed socioeconomic conditions of small-scale fishermen, the overexploited state of fishery resources in the Gulf of Thailand and the bleak prospects for joint ventures without effective management and enforcement capability by both

Thailand and its neighbors. The present study is an extensive revision, update and extension of that earlier study in the light of the findings of Jetanavanich (1981) and more recent information.

Jetanavanich (1981) reviewed extensively the Thai fishing industry and made the first attempt to determine the levels of catch and effort that will give rise to the maximum economic yield (MEY). He did this by estimating econometrically demand and supply functions for demersal and pelagic fish and equating price to the marginal cost of fishing. His main finding is that the catch in recent years has surpassed both the MEY and MSY (maximum sustainable yield) and that to obtain the maximum net benefit from fishing in the long run fishing effort for both demersal and pelagic fish must be reduced by about 70%. He concluded that economic management of the fishery would give rise to an annual surplus value or social benefit of US$112 million.

Rientrairut (1983), after a detailed review of the fisheries sector (both marine and inland) including marketing and utilization, focuses on the fisheries development planning process and fisheries legislation, and concludes with a review of current issues and policies. It is the most up-to-date review of the sector across the board in the same league as the Marr et al. (1976) review. It is also the first complete account of: (a) the numerous departments and agencies involved in fisheries planning and their respective roles; (b) existing and proposed fisheries legislations; and (c) government policies and projects. Though non-analytical, the study contains very useful information, not available elsewhere.

Of the numerous technical and biological studies, two relatively recent reviews summarize earlier findings as well as present very useful information for this study. Pauly (1979), after a brief review of earlier studies dealing with the decline of catch rates in the Gulf of Thailand, focuses on stock interaction as reflected in the changes of the composition of the catch over time. Using Gulf of Thailand data, he finds that at high levels of effort the small prey fishes disappear leaving no food for their predators, which also decline, while opportunistic species such as flat fishes and invertebrates increase their biomass both in absolute and relative terms in the multispecies stock despite the heavy fishing pressure. He concludes that because of the species interaction "there is no single optimum level of effort which will simultaneously produce the MSY for all . . . stocks" and therefore the simple total biomass/total effort estimates of MSY in the Gulf of Thailand are unreliable. He calls for models accounting for stock interactions, for example by dividing the stock into different trophic levels, determining the trophic level at which economic returns are maximized and selecting the appropriate fishing techniques (mesh size and gear selectivity).

Boonyubol and Pramokchutima (1982) estimate an MSY of 750,000 t for demersal fishery resources in the Gulf of Thailand to the depth of 50 m and infer that the Gulf has been overfished since 1973 with the number of trawlers growing from 5,000 during that year to 10,000 in 1982 (estimations of MSY by other studies will be reviewed in Chapter 8). They also present evidence showing that despite the manyfold increase in total catch, the catch of food fish increased only slightly since 1963, most increases being of trash fish (63% in 1980). Even more alarming is the evidence that trash fish is comprised of a high and rising proportion of juvenile food fish (37% in 1981). The small-scale or artisanal fishery is reported to account for 13% of fishing effort and 37% of the catch of edible fish from the Gulf. The authors conclude that the most cost-effective measure for protecting the demersal resources of the Gulf is to control the number of trawlers.

There are several studies of small-scale fisheries—Cole and Anand (1974), DOF (1978, 1979), Panayotou (1980), Kumpa (1981), Panayotou et al. (1982 and 1985) and Panayotou and Panayotou (1985). Cole and Anand (1974) estimate annual income to be 7,500 baht (US$ = 20 baht in 1974) for a Buddhist family and 4,200 baht for a Muslim one. These estimates compared unfavorably with both the income of crewmen of large trawlers (over 12,000 baht) and the national average for all occupations that year (over 30,000 baht).

The DOF (1978) on the other hand, found a wide spectrum of annual earnings (8,000 to over 20,000 baht) among small-scale fishermen in Ban Ta Sao fishing village in Songkhla Province depending on type of gear. Bamboo screens and set bags occupying premium locations were far more profitable than either cast nets or gill nets. The DOF (1979) found that a "typical" household in a fishing village in Pathalung Province operated a gill net and earned an annual income of 11,900 baht (compared to a national average over 30,000 baht in 1979), with location again appearing to be a crucial determinant of earnings.

Panayotou (1980) reviews the socioeconomic conditions of small-scale fishermen and their conflicts with larger scale fishermen, evaluates their benefits from government policies and examines their prospects. Emphasis is placed on the need for non-fishing activities to raise the small-scale fishermen's opportunity cost so that their incomes might be improved and fishery resources allowed to recover.

Kumpa (1981) analyzed the productivity, cost structure and profitability of small-scale fishing operations in Chumphon Province. She found that the most important determinants of catch and earnings were experience, size of boat and fishing time, and that fishermen were efficient in their use of inputs but their earnings varied according to the type and size of gear. The pelagic gear, purse seines and (drift) gill nets in particular, were found to be considerably more profitable than the demersal gear (trawls and push nets). The author infers that this is due to the overexploitation of demersal resources and recommends government assistance for the conversion of trawlers into pelagic gear and for creation of supplementary sources of income such as brackishwater fish culture for coastal fishermen.

Panayotou et al. (1985) compared and analyzed income levels and other indicators of well-being among four coastal provinces in Thailand—Chumphon, Nakhon Si Thammarat, Phangnga and Trat (Fig. 2.1). It was found that the average coastal fishing household with an annual income of about US$2,500 (1978) was at least as well off as the average Thai household. However, there was

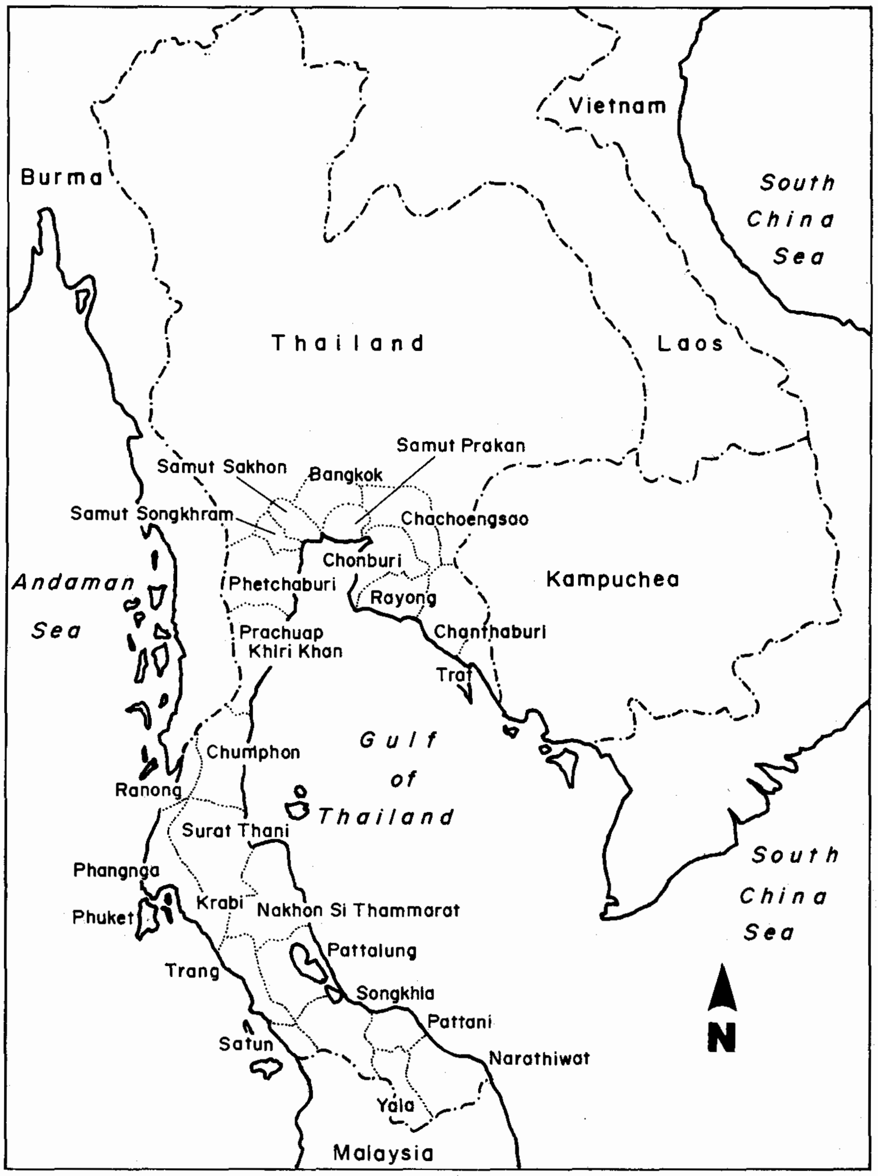

Fig. 2.1. Coastal provinces of Thailand and bordering countries and seas.

considerable variation among locations (and types of gear); Trat and Chumphon households earned incomes that were two to three times higher than those of the other two provinces. Nakhon Si Thammarat, in particular, suffering from both an unprofitable fishery and lack of alternative employment opportunities, was identified as a priority area for government assistance.

Tokrisna et al. (1985) estimated fishing production functions by type of gear and by location as well as for combined gears and locations. They found that technical efficiency varied among gears operating in the same location and for the same type of gear operating in different locations. Overall, the most productive gears were shell rakes in Trat, purse seines in Chumphon, push nets in Nakhon Si Thammarat and set bag nets in Phangnga. In terms of price efficiency, it was profitable for fishermen with less traditional gear to increase the size and engine power of their vessel, and for more traditional types to increase the use of labor. In terms of social profitability, however, virtually all types of gear should be given incentives to employ more labor.

Panayotou et al. (1982) compared indebtedness, cost structure and profitability between small- and medium-scale gear groups (according to fishing assets) in the same four provinces as in the previous two studies. Isolation rather than scale of operation was found to be responsible for high interest rates. The cost share of fuel, the main cash cost item, was lower for small-scale units which were more labor intensive although very little labor was hired outside the family. Therefore, cheap fuel and cheap labor policies tend to favor the medium- and large-scale fishermen who use relatively more of both these inputs. While limited capital is usually the binding constraint for small-scale operations, subsidized credit would not necessarily solve the problem because of fishery-resource constraints. Economic overfishing was found to exist in relation to certain combinations of gears and fishing grounds (e.g., trawls in Chumphon, wing set bag in Nakhon Si Thammarat, push net in Phangnga and fish gill net in Trat). For the small-scale fishery as a whole, there were still some, but not substantial, rents (net profits above all fishing costs).

Panayotou and Panayotou (1985) have studied geographical and occupational mobility among small-scale fishermen in Chumphon and Phangnga based on two extensive surveys carried out five years apart. They found that fishermen are responsive to economic incentives and move between occupations and locations to take advantage of earning differentials. Yet, this mobility is far from perfect. Labor is quite mobile between occupations but less so between locations. Capital tends to be less mobile than labor at least in the short run. Fishermen expressed a certain attachment to their occupation and place of residence but they were prepared to change both if a better paying occupation could be found having some of the most valued features of their current occupation and location, such as the freedom and independence of "being one's own boss" and the rural setting of their communities. Religion and distance were also found to constrain mobility. In general, mobility of labor out of fishing was greater than mobility into fishing; outmigration was rather temporary and in response to economic incentives while inmigration was more permanent but less significant, and socially rather than economically motivated. This is to be expected in the light of the finding of the study that rents from fishing have been dissipated, especially in Chumphon.

CHAPTER 3

HISTORICAL DEVELOPMENTS

Unlike the great maritime nations of Japan, Norway and the Soviet Union, which have had a long history of fisheries development, Thailand's large-scale fishery is of a very recent origin. Prior to the early 1960s, the Thai marine fisheries were concentrated along the coast and employed mostly small-scale gear, such as bamboo traps, which remained unchanged for centuries. Following the successful introduction of trawl fishing in 1960 with assistance from West Germany, the structure of the Thai fisheries underwent radical changes (Tiews 1965, 1973). In 1959 the entire marine fishery of Thailand consisted of 1,490 bamboo traps, 192 Chinese purse seines and 187 Thai purse seines and landed a total catch of less than 150,000 t. Four years later, in 1963, the same fishery employed over 2,000 trawlers and 500 encircling gill nets while the number of bamboo traps dropped to 662, purse seines to 211; the catch more than doubled (see Table 3.1).

While the cost of the new technology, about half a million baht per unit in the early 1960s[1], was far beyond the meagre resources of bamboo trap fishermen, its profitability attracted financially powerful investors from the urban centers (especially Bangkok) in what for centuries used to be a poor man's occupation. The trawling fleet expanded rapidly from less than 100 trawlers in 1960 to about 6,000 by 1973 while less than 200 bamboo traps remained in operation (Table 3.2). The annual catch increased more than tenfold during the period compared with less than twofold during the preceding period of equal span (Table 3.3), while the catch per unit of effort declined by 83% between 1961 and 1973 (see Fig. 8.1).

Not only was the new technology more costly and at the same time more profitable, but it also opened up new more abundant offshore resources which required a longer fishing range and faster and larger vessels. The new technology was clearly neither scale-neutral nor obtainable through gradual capital accumulation and progressive upgrading of existing technology. Not only was the required investment large and the departure from the traditional technology radical, but also the open-access status of the offshore resources underlined the importance of speed of investment and technological change. Only those with substantial venture capital of their own or ready access to inexpensive institutional credit, up-to-date information and entrepreneurial experience had a competitive advantage in joining the race for the open-access resources, a race which called for increasingly longer fishing trips to deeper and rougher seas.

Soon enough (early 1970s) the race was carried out to the fishing grounds of other nearby countries and the deep seas, necessitating not only larger vessels, but also more sophisticated navigation equipment, echo sounders for locating fishing grounds and radars for detecting pirates and the patrol vessels of neighboring countries, as well as armaments for self-defense. The capital cost of a fishing unit rose virtually overnight from few hundred baht (mostly in terms of local material and labor) to several hundred thousand baht. The total capital stock of the industry rose from less than a billion baht in 1963 to over 11 billion baht in 1982, both measured in constant 1976 prices.[1]

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[1] From figures estimated by the Fishing Vessel Development Section, Marine Fisheries Division, Department of Fisheries, Bangkok, Thailand.

Table 3.1. Number of selected types of gear (fishing units) registered, and marine fish caught (t) in Thailand during 1949-1966.

Year	Marine gear	Pelagic			Demersal	Marine catch (t x 10^3)		
	BST	CPS	TPS	EGN	trawlers	Demersal	Pelagic	Total
1949	1,160	52	99	—	—	33.0	75.8	108.8
1950	1,047	59	122	—	—	30.0	95.6	115.6
1951	1,122	71	93	—	—	30.0	111.0	141.0
1952	1,254	126	127	—	—	29.0	109.5	138.5
1953	1,334	121	138	—	—	32.2	116.0	148.2
1954	1,460	170	176	—	—	37.9	128.5	166.4
1955	1,462	139	175	—	—	34.4	117.1	151.4
1956	1,579	185	196	—	—	34.7	117.5	152.2
1957	1,287	208	116	—	—	37.2	133.7	170.9
1958	1,344	214	178	—	—	50.1	94.9	145.0
1959	1,470	192	187	—	—	58.4	89.4	147.8
1960	1,409	152	171	48	99	63.7	82.8	146.5
1961	918	110	141	233	201	123.1	110.2	233.3
1962	792	101	127	386	976	151.4	118.3	269.7
1963	662	116	95	537	2,026	227.5	95.9	323.4
1964	602	88	54	890	2,360	371.6	128.1	499.7[a]
1965	697	122	93	634	2,393	392.7	148.3	541.0[a]
1966	663	127	84	409	2,695	445.0	202.5	647.5[a]

— Not in use.

[a]Slightly lower figures, 494.2, 529.5, 635.2 and 762.2, respectively, are given in Department of Fisheries, Fisheries Record of Thailand, various issues.

Notation : BST = bamboo stake traps; CPS = Chinese purse seine; TPS = Thai purse seine; and EGN = Encircling gill net.

Source : Phasuk (1978) and Department of Fisheries, Thai Fisheries Vessel Statistics, various issues.

The small-scale coastal fishermen had clearly no competitive advantage in large-scale offshore fishing. They had special skills in constructing small boats, repairing nets, locating fish in shallow coastal waters and operating traditional gear, useful skills for a crewman on a large trawler but neither necessary nor sufficient for joining the race for offshore resources. The latter calls for access to venture capital, entrepreneurial skills and up-to-date information on technology, fishing grounds and markets, all of which are more readily available to the investors of Bangkok and of large coastal towns than to the coastal fishermen in remote fishing communities. Moreover, the necessary infrastructure, such as ports, landing facilities, roads and markets was made available only to Bangkok and large coastal towns.

Economic theory predicts that, in the presence of exchange, factor (i.e., labor and capital) mobility and growth, dualism cannot be but a short-run disequilibrium phenomenon. This, however, presupposes well-functioning product and factor markets, and this can hardly be said of markets in Thailand. Markets are said not to be well-functioning when they are either uncompetitive, fragmented or distorted. Of particular importance are the imperfections and distortions of the capital market. In theory, all producers, small and large, should have access to the same capital markets at the same rate of interest without the need of collateral.

The market may be said to be imperfect if it provides lower-cost credit to those who already have substantial amounts of capital of their own than to those who do not, thereby exacerbating rather than mitigating initial disparities in factor endowments. Factor markets are said to be distorted when government interventions in the market result in prices which do not reflect the true scarcities of resources. For example, in Thailand, investment privileges, interest rate ceilings, trade policies, public expenditures and minimum wage policies favor the use of scarce capital and penalize the use of abundant labor; at the same time they make subsidized credit available to large-scale operations through investment privileges and dry up rural credit to small-scale operations through interest rate ceilings.

Table 3.2. Number of fishing boats registered by type of fishing method, Thailand, 1967-1982.

Type of gear	1967	1968	1969	1970	1971	1972	1973	1974
Otterboard trawl	1,380	2,258	1,939	2,210	2,472	3,185	4,480	4,074
Pair trawl	176	244	243	442	522	702	824	854
Beam trawl	316	424	420	430	614	599	533	343
Subtotal trawl	1,572	2,926	2,607	3,032	3,608	4,486	5,837	5,271
Thai purse seine	n.a.	n.a.	n.a.	583	389	371	415	401
Chinese purse seine	n.a.	n.a.	n.a.	53	41	66	53	39
Anchovy purse seine	n.a.	n.a.	n.a.	80	44	68	103	82
Luring purse seine	n.a.	n.a.	n.a.	21	35	—	109	153
Subtotal seine	574	n.a.	520	737	509	505	680	675
Spanish mackerel gill net	n.a.	n.a.	n.a.	235	151	138	231	148
Pomfret gill net	n.a.	n.a.	n.a.	43	43	22	5	3
Encircling gill net	n.a.	n.a.	n.a.	269	244	254	228	188
Shrimp gill net	n.a.	n.a.	n.a.	—	—	—	—	53
Other gill nets	n.a.	n.a.	n.a.	291	369	422	1,155	900
Subtotal gill net	791	n.a.	n.a.	838	807	836	1,619	1,292
Push net	n.a.	n.a.	n.a.	354	610	1,327	1,628	1,213
Luring liftnet	46	n.a.	n.a.	21	35	—	—	16
Long line	n.a.	n.a.	n.a.	—	—	—	—	6
Other nets	n.a.	n.a.	n.a.	—	—	81	49	40
Squid cast net	n.a.	n.a.	n.a.	—	—	—	—	—
Total	n.a.	n.a.	n.a.	5,002	5,602	7,235	9,813	8,513

Type of gear	1975	1976	1977	1978	1979	1980	1981	1982
Otterboard trawl	3,816	4,088	4,962	5,110	7,038	8,131	6,021	9,358
Pair trawl	852	832	906	854	1,172	1,230	1,008	1,406
Beam trawl	294	284	420	489	537	1,060	496	711
Subtotal trawl	4,962	5,204	6,288	6,453	8,747	10,421	7,525	11,475
Thai purse seine	374	351	160	129	68	115	57	43
Chinese purse seine	18	17	22	15	15	12	14	13
Anchovy purse seine	40	58	19	31	51	34	32	56
Luring purse seine	193	300	505	578	547	620	730	728
Subtotal seine	625	726	706	753	681	781	833	840
Spanish mackerel gill net	177	157	244	151	227	296	327	281
Pomfret gill net	5	16	2	8	24	21	20	11
Encircling gill net	187	226	314	359	356	307	258	238
Shrimp gill net	21	527	1,196	1,770	2,529	3,067	2,759	2,856
Other gill nets	847	1,498	1,169	1,352	1,224	1,857	1,424	1,612
Subtotal gill net	1,237	2,424	2,925	3,640	4,360	5,548	4,788	4,998
Push net	1,075	844	1,177	1,426	1,923	2,262	1,216	1,899
Luring liftnet	2	1	1	—	—	—	—	—
Long line	16	47	71	33	216	222	47	34
Other nets	46	98	239	190	213	162	79	111
Squid cast net	—	44	—	34	6	115	235	637
Total	7,963	9,388	11,407	12,529	16,146	19,551	14,723	19,756

— : Nil or negligible.
n.a. : Not available.
Sources : Data for 1967-1982 obtained from Marr et al. (1976); others from Department of Fisheries Thai Fishing Vessels Statistics, Bangkok, various issues.

Table 3.3. Annual catch (t) by fishing ground, Thailand, 1957-1982.

Year	The Gulf of Thailand	The Indian Ocean	Total
1957	159,435	11,965	170,900
1958	137,215	7,784	145,000
1959	139,338	8,431	147,770
1960	135,740	10,731	146,471
1961	227,746	5,529	233,275
1962	256,649	13,060	269,709
1963	314,962	8,411	323,373
1964	472,226	21,970	494,196
1965	513,096	16,387	529,483
1966	605,020	30,145	135,165
1967	647,664	114,524	762,188
1968	841,810	162,248	1,004,058
1969	909,423	270,172	1,179,595
1970	1,098,562	237,128	1,335,690
1971	1,232,721	237,368	1,470,289
1972	1,318,060	230,097	1,548,157
1973	1,246,822	291,194	1,538,016
1974	1,107,098	244,492	1,351,590
1975	1,172,420	222,188	1,394,608
1976	1,295,742	256,050	1,551,792
1977	1,724,818	342,718	2,067,533
1978	1,633,173	324,612	1,957,785
1979	1,493,943	319,215	1,813,158
1980	1,306,893	341,060	1,647,953
1981	1,465,480	358,964	1,824,444
1982	1,561,039	425,532	1,986,571

Source : Department of Fisheries, Ministry of Agriculture and Co-operatives, Fisheries Record of Thailand, various issues.

Unfavorable initial factor endowments and lack of access to capital markets suffice to explain the inability of many coastal fishermen to upgrade their technology and extend their fishing range to other, potentially more abundant coastal resources. With few exceptions of wealthy small-scale fishermen, it was the fish traders and other nonfishermen with access to capital who acquired the new technology. Unlike the large-scale fishermen who, in addition to their own high profits, have access to low-interest, often government-subsidized loans, the small-scale fishermen borrow from informal credit markets (e.g., fish traders and middlemen) at rates which, though only implicit in marketing arrangements, are a multiple of those charged by banks. The high profits from offshore fishing, supplemented by easy access to subsidized capital and government-provided landing facilities, enabled the trawling industry to increase its fishing range and expand to fishing grounds outside the Thai waters as the harvest in Thai waters declined due to heavy fishing.

Having failed to expand their fishing range by upgrading their technology and joining the race for the offshore resources, the small-scale fishermen could only lose from the advent of the new technology. The biological interdependence between coastal and offshore resources became increasingly evident. The coastal resources became gradually depleted as trawlers enroached on coastal fishing grounds for high-value species (e.g., shrimp). At the same time, coastal fishermen's stationary or relatively immobile fishing gear suffered damage from the hit-and-run operations of trawlers in coastal fishing grounds. Last but not least, the massive landings of trawlers depressed the price of fish and hence the incomes of coastal fishermen whose catch remained at best stagnant. For example, the price of fish fell in real terms during most of the 1970s (see Table 3.4).

Under these circumstances, one would expect that small-scale fishermen would seek and obtain employment as crewmen in the rapidly expanding trawl fishery or abandon fishing for other more lucrative employment opportunities. Though up-to-date reliable figures are not available, it is apparent from interviews with fishermen (see Panayotou and Panayotou 1985) that some did take employment in the offshore fishery and others abandoned fishing altogether, but clearly most small-scale fishermen stayed on. According to Table 3.5, fishing households with two or fewer employees declined by 29% between 1967 and 1976 and fishing laborer households declined by 34% during the same period.

Table 3.4. Fish prices (baht/kg) in Thailand, 1971-1982.

Year	Demersal fish	Pelagic fish	Cephalopod[a]	Crustacean[b]	Weighted average price[c]	Real average price[d]
1971	1.63	3.93	5.42	11.04	2.79	4.60
1972	1.62	4.47	5.11	10.05	2.77	4.36
1973	1.65	4.47	4.56	11.90	2.74	3.73
1974	1.60	4.09	5.51	10.89	2.84	3.11
1975	1.69	5.47	6.59	12.94	3.27	3.40
1976	1.81	4.48	8.76	15.82	3.80	3.80
1977	2.03	4.31	8.72	18.98	4.03	3.75
1978	2.42	5.91	12.65	26.65	5.44	4.87
1979	2.20	5.35	15.57	32.86	6.01	4.71
1980	2.72	7.04	13.84	24.20	5.89	3.86
1981	2.86	7.47	15.74	31.21	6.57	3.81
1982	2.82	7.58	17.47	27.26	6.81	3.75

[a]Squid and cuttlefish.
[b]Shrimp and crab.
[c]Weighted average price = $\sum_{i=1}^{n} P_i S_i$ where S_i = proportion of species i to total amount of demersal resources caught by a research vessel (Pramong II), i.e., 0.70, 0.07, 0.20 and 0.03 for demersal fish, pelagic fish, cephalopod and crustacean, respectively.
[d]Deflated by the consumer price index (1976 = 100).

Source : Computed from Appendix Table A.3.

Table 3.5. Recorded number of fishing households, fishermen and vessels in the marine fishery of Thailand for selected years.

	1967	1969	1970	1973	1976
1. Fishing households	50,968	43,660	43,520	38,702	40,536
Fishing operator households	38,292	33,631	34,903	31,587	32,207
with 3 or more employees ('enterprise')	2,352	3,268	2,660	5,524	6,311
with 2 or fewer employees ('subsistence')	35,940	30,423	32,243	26,063	25,558
Fishing laborer households	12,676	9,969	8,617	7,115	8,329
2. Fishing population and fishermen					
Fishing population	315,897	269,009	271,132	249,618	257,254
Fishermen	75,676	77,886	74,086	64,277	69,927
Occupied solely in fishing	—	—	56,708	48,519	51,198
Occupied mainly in fishing	—	—	11,985	12,027	13,754
Occupied partly in fishing	—	—	5,393	3,731	4,999
3. Fishing vessels	35,631	—	27,521	26,439	26,135
Non-powered vessels	16,584	—	8,313	6,918	5,367
Powered vessels	19,047	—	19,208	19,521	20,768
Inboard engine	—	—	8,760	10,550	10,435
Outboard engine	—	—	10,448	8,971	10,333

— Data not available.

Source : DOF 1967; Marine Fisheries Inventory Survey 1970, 1973 and 1976; and Marr et al. (1976).

Why do not more coastal fishermen find employment in the trawl fishery or move to other sectors of the economy? The combination of four reasons appears responsible.

First, the trawl technology is intrinsically capital intensive. It has been more so in Thailand than in some other countries because of the distorted relative factor prices which favor capital and penalize labor; capital of large-scale investments is subsidized through tax privileges; large borrowers with collateral have access to subsidized low-interest institutional credit; the government tacitly encouraged investment in large capital-intensive vessels to increase Thailand's share of distant-water resources; fishing vessels have access to duty-free capital equipment from neighboring countries such as Singapore; and government provided landing facilities and exploration research. At the same time the use of additional labor is hindered by minimum wage legislation, labor union activities and the customary arrangement of providing crewmen with food and a share of the catch in addition to wage.

Second, the large-scale fishery has had easy access to inexpensive labor from labor surplus areas such as the northeast; impoverished and adventurous youth travel around the major coastal towns in search of employment and adventure often found on the offshore and distant-water fishing fleet. Small-scale fishermen with families living in remote fishing communities are less willing to join long and arduous fishing trips for a comparatively unattractive wage.

Third, alternative employment opportunities have not been easily forthcoming to remote fishing communities.

Fourth, fishermen are not particularly known for their mobility although given a sufficiently attractive alternative many if not most would have made a move (see Panayotou and Panayotou 1985). Attractive employment opportunities are scarce in a country with surplus labor, especially when one takes into account the costs of retraining and relocation and the psychological and other non-quantifiable costs involved.

Thus, a combination of distorted factor prices, easy access to a pool of inexpensive non-fishing labor, limited occupational and geographic mobility among small-scale fishermen and scarcity of alternative employment opportunities can explain why they continue operating in the traditional fishing grounds with the traditional technologies. They still manage to earn incomes which, however meagre, are higher than what they can earn from their next best alternative, net of the costs of change and the perceived risk.

As a result, a dualistic structure has emerged and persists with a mobile and rapidly growing trawling industry alongside an immobile and stagnating coastal fishery. The income earning positions of the two fishing subsectors differ greatly reflecting disparities in opportunity costs, which in turn result from varied factor endowments, differential access to capital markets and disproportionate shares in government benefits, as well as differential mobility.

A second not unrelated factor contributing to a wide divergence in incomes is the differential ability of the two subsectors to maintain their profits in the face of the open-access nature of the resources and recurring economic shocks. Profits (or rents), defined here as revenues above all costs of fishing, are expected to be competed away by new entrants or unfavorable changes in economic circumstances. However, despite the open-access status of the Thai resources and the steep rises in fuel costs that ought to have hastened the dissipation of profits, the resilient trawl fishery appears to be as profitable as ever while the relatively immobile coastal fishermen are literally fishing for subsistence.

CHAPTER 4

THEORETICAL FRAMEWORK

Cost and Earnings

An economic activity, to be worthwhile and viable in the long run, must earn sufficient revenues to cover both variable and fixed costs. These include the cost of not only purchased inputs but also imputed costs for own labor, as well as depreciation and interest on capital. In other words, the revenues must be high enough to cover the opportunity costs (foregone earnings from alternative uses) of all inputs including own and borrowed capital and family and hired labor. If there are no barriers to entry and exit and no recurring external shocks, an economic activity would tend, in the long run, to an equilibrium characterized by equality between revenues and costs (and hence zero excess profits) and a more or less stable number (and size) of economic units engaged in the activity. Such a state of affairs is usually characteristic of a mature industry operating in a competitive market. From both the individual firm and the society's point of view it is rational to expand the activity to the point of zero marginal profit (assuming no side effects) as this will maximize both the individual and the social returns from the activity.

Fishing, however similar to exploitation of other renewable resources such as forests, is an economic activity with a difference. One of the inputs into this activity, the fish stock, though a scarce resource (often more scarce than labor and capital), is available to the individual fisherman free of charge. While scarce to the society the fish stock is a free good to the individual fisherman. It is in the society's interest to economize the use of the fish stock, in the same way that the use of other scarce resources is economized, but the individual fisherman has no incentive to economize a resource to which he has essentially open and free access. To the society the fish resource is scarce and its use involves a social cost (user cost); to the individual fisherman the fish resource is abundant and its use involves no cost.

Thus, the total costs of fishing are lower for the individual than for the society and hence the fishing activity (i.e., levels of fishing effort) is carried beyond the level that is socially worthwhile. The individual fisherman may still be adding to his profits while the society is incurring increasing losses as the fishing activity expands (and hence total costs increase) beyond a certain point. Eventually, if there are no barriers to entry, the equilibrium of zero excess profits for the fishing industry would be reached. Fishermen would still cover *all* their costs, including opportunity costs, but the society would not. The latter suffers a net loss by not covering the user cost of the fish stock, a resource at least as scarce and valuable as labor and capital.

These ideas are shown diagrammatically in Fig. 4.1, which depicts the relationships between costs and fishing effort and revenues and fishing effort. The cost-effort relationship (TC) is linear because unit costs are assumed constant and, therefore, total costs (which do not include the user cost of the resource) are proportional to effort. The revenue-effort relationship (TR) is dome-shaped because as effort expands revenues rise less than proportionately reflecting the progressive depletion of the fish stock. Eventually, a point (M) is reached beyond which further expansion of effort produces a decline rather than a rise in revenues. Point M corresponds to what is known as the maximum sustainable yield (MSY), i.e., the maximum catch which can be sustained over the long run with a stable fish stock and a constant level of effort.

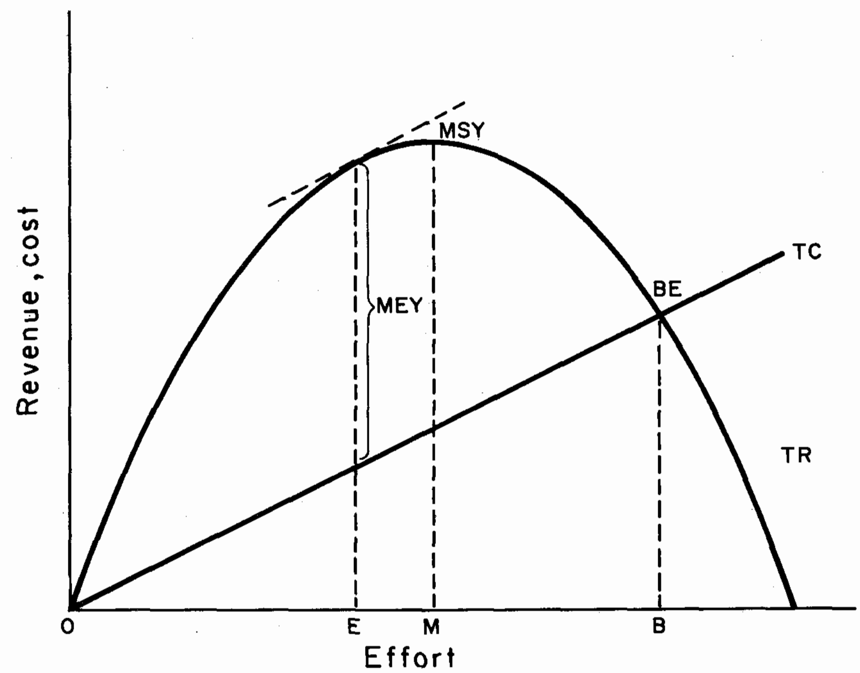

Fig. 4.1. A fixed price model of a fishery indicating the maximum economic yield (MEY), maximum sustainable yield (MSY) and bionomic equilibrium (BE) under open access. TR = total revenue; TC = total cost.

If the fishery is worth exploiting at all, revenues at low levels of effort exceed costs, that is, excess profits do exist. Profits attract additional fishing effort and while the profit per unit of effort falls steadily the total profit of the fishery as a whole rises up to a point, E, beyond which additional effort reduces both the individual fisherman's and the industry's profit. Point E corresponds to what is known as the maximum economic yield (MEY), i.e., the maximum economic return or profit that can be sustained over the long run with a stable fish stock and constant effort.

Under conditions of open access, however, effort will continue to expand until all profit is dissipated and a level of effort, B, is reached where total revenues equal total costs, known as bionomic equilibrium at which both effort and fish stock stabilize. At B there is no incentive for expansion of effort and if, for some reason, effort expands beyond B there would be losses inducing exit and return to B. Open-access fisheries operating in a stable economic and physical environment without barriers to entry are expected to gravitate towards a bionomic equilibrium (see Gordon 1953; Scott 1955). If they do not, there must be either barriers to entry/exit or recurring external shocks such as changes in economic and environmental parameters that prevent the system from completing the adjustment process.

At the bionomic equilibrium fishermen continue to earn the opportunity costs of their inputs but the society does not. The dissipated profit represents precisely the user cost which ought to have been paid by the users of the resource (fishermen) and received by the owner (the society). Seen from another angle, the society as owner of the fish resource, like the owner of land or other resources, is entitled to a rent for its use. Since the rent reflects the scarcity value of the resource, the more scarce the resource the higher the rent to which the society (or any other owner) is entitled. It is precisely this increase in rent with scarcity that helps rationalize the use of the resource and conserve it at its "optimal" level. At the bionomic equilibrium, however, the society earns no rent as if the fish resource were ubiquitous or useless.

Were the society to charge fishermen a rent or user cost for the resource, the total costs of fishing, which now include only labor and capital costs, would rise substantially above current levels. The higher fishing costs would make part of current fishing unprofitable thereby reducing fishing effort and conserving the resource at the level which maximizes the net benefit to the society from its scarce fishery and non-fishery resources. Fishermen would still cover all their (opportunity) costs but there will be less fishing effort, i.e., fewer fishing trips, fewer boats and fewer fishermen.

What about the loss of employment? If the fishing industry is small relative to the national economy, there would be no significant effect on employment since the released fishermen (and capital) would find employment in the rest of the economy at their opportunity cost which, in equilibrium, is not below their current fishing income. There would be a negative employment effect if the fishing industry is relatively large and the opportunity cost of labor (and capital) are not independent of the level of employment in the fishing industry (see Anderson 1977). In most cases, however, including Thailand, the fishing industry is small relative to the rest of the economy especially in terms of employment.

A second case in which the incomes of fishermen might be affected by the reduction of effort is when the fishery is in short-term disequilibrium either on its way towards a long-run equilibrium or following external shocks. Under these circumstances fishermen may be earning short-term excess profits, that is rent due to but not appropriated by the society. Taxation of total incomes so that these rents accrue to the government or other taxing authority (acting on behalf of the society) would cut the (short-term) incomes of both the remaining and departing fishermen down to their true opportunity costs (or long-term incomes).

It is, therefore, of both analytical significance and policy relevance to determine the private and social profitability of the industry by calculating and comparing costs and earnings. This may be done for a number of years to establish the trend in profits or rents, which is indicative not only of the profitability but also the maturity and stability and openness of the industry. A number of possibilities are shown in Fig. 4.2 and discussed briefly here. Steadily rising (excess) profits are reflections of either an immature fishery (I in Fig. 4.2) or of favorable changes in economic, technological or biological parameters (I'), e.g., rise in prices, fall in costs or improved productivity of the stock. Persisting stable profits (II) may reflect underlying barriers to entry which prevent their dissipation by new entrants. Steadily declining profits (III) under stable economic and biological conditions is an indication of movement towards a long-term bionomic equilibrium; otherwise they may reflect unfavorable changes in bioeconomic parameters. Persisting zero or near zero profits (IV) are evidence of the attainment of a bionomic equilibrium. Persisting losses (V) suggest the presence of barriers to exit which prevent unprofitable units from leaving the industry. Finally, widely fluctuating profits (anywhere between I and V) reflect unstable economic and/or biological environment, or an unstable response to external shocks, such as the EEZs or the enactment of fisheries

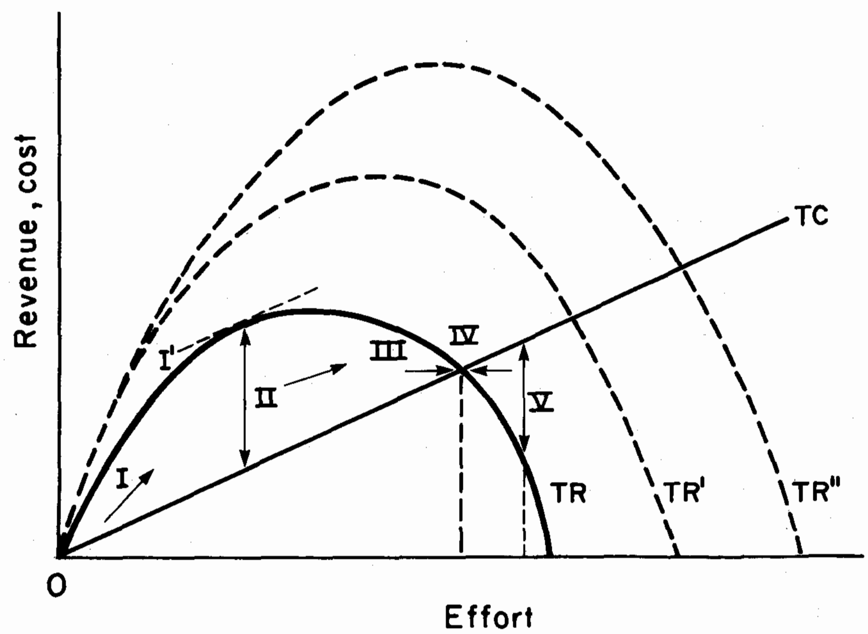

Fig. 4.2. A fixed price model of a fishery indicating rising profits (I and I′), persisting profits (II), declining profits (III), zero profits (IV) and persisting losses (V). TR = total revenue; TC = total costs. See text for further explanation.

regulations. The horizontal arrows indicate the tendency of an unregulated fishery towards dissipation of rents and open-access bionomic equilibrium. The vertical arrows show the magnitude of profits (rents) or losses at the corresponding level of fishing effort. TR′ and TR″ are total revenue curves corresponding to higher fish prices and/or increased productivity of the stocks. Such changes may generate profits where previously there were zero profits as losses. The reverse changes are also possible and can be depicted as downward shifts of the TR curve.

Correspondingly, the policy implications would differ depending on the profit picture of the fishery. Rising profits call for controlled expansion of the fishery while falling profits call for interventions to limit entry; zero profits suggest the need for reduction of effort while negative profits call for promotion of mobility and assistance for resettlement of surplus fishermen; finally, widely fluctuating profits call for stabilization policies to enable a planned expansion or contraction of the industry and improved information flow to induce more stable responses to external shocks.

Optimal Resource Use

If fishing effort must be controlled to prevent dissipation of economic rents or be reduced to reverse it once it has taken place, the question arises as to what constitutes an optimal level of effort at which the fishery should operate. From the economic point of view, the optimal level of effort is the level at which economic rents are maximized, that is, the level of effort which generates the maximum economic yield (MEY), which is the return to the scarcest factor of production, the fish stock. Of course, a managing authority may define as optimum yield that which maximizes other benefits such as "employment, equity or stability" but for the purpose of the present paper we will assume that the managing authority's objective is to maximize the economic return from the fishery (MEY).

How is MEY and the corresponding level of effort determined? By maximizing the spread between total fishing revenues and costs which is accomplished by equating the marginal revenue (MR) of effort to the marginal cost (MC) of effort as shown in Fig. 4.3. This in turn requires estimation of revenue and cost functions. Assuming constant cost per unit of effort (c), the cost function (TC) presents no difficulty. The total marginal and average costs may be written, respectively, as:

$$TC = cE \qquad \ldots (1)$$

$$MC = AC = c \qquad \ldots (2)$$

However, estimation of the revenue function involves estimation of the underlying sustainable yield function which is a relationship between sustainable catch (Y) and effort (E). In the case of single-species fisheries a sustainable function could be easily estimated by fitting a logistic growth curve to catch and effort data, or, equivalently, a linear function between catch per unit effort (Y/E) and effort:

$$Y = aE - bE^2, \text{ or} \qquad \ldots (3)$$

$$Y/E = a - bE \qquad \ldots (4)$$

where a and b are estimated parameters.

The level of effort generating the maximum sustainable yield (MSY) can be easily obtained from (3) through simple differentiation as:

$$E_{MSY} = a/2b \qquad \ldots (5)$$

MSY itself is obtained by combining equations (3) and (5):

$$MSY = a^2/4b \qquad \ldots (6)$$

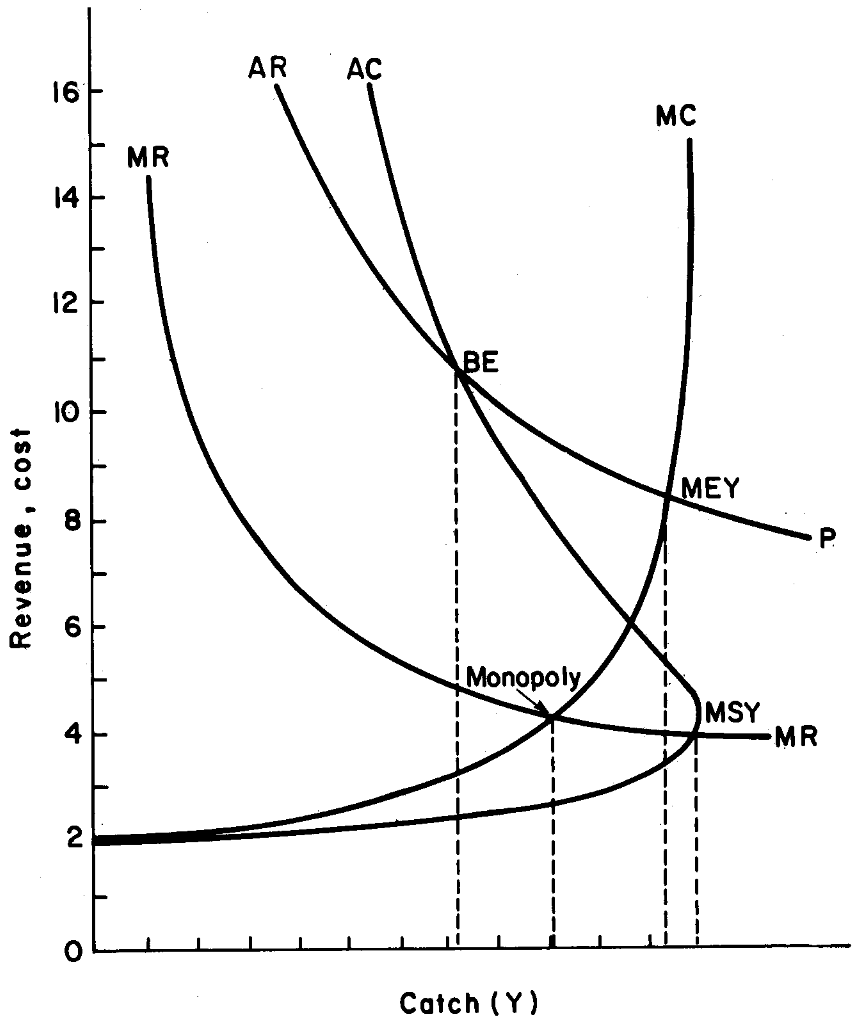

Fig. 4.3. A variable price model indicating the maximum economic yield (MEY), the maximum sustainable yield (MSY), the monopoly position and the bionomic equilibrium (BE) under open access. MR = marginal revenue; AR = average revenue; MC = marginal cost; AC = average cost; P = price. (Source: Copes 1970)

Then the total, marginal and average revenue functions may be written, respectively, as:

$$TR = p\ \{aE - bE^2\}, \qquad \ldots (7)$$

$$MR = p\ \{a - 2\,bE\}, \text{ and} \qquad \ldots (8)$$

$$AR = p\ \{a - bE\} \qquad \ldots (8)$$

As stated earlier the optimum, or MEY, level of effort is obtained by equating MR and MC of effort, i.e.,

$$p\ \{a - 2bE_{MEY}\} = c, \text{ and} \qquad \ldots (9)$$

$$E_{MEY} = \frac{pa - c}{2bp} = \frac{a}{2b} - \frac{c}{2bp} \qquad \ldots (10)$$

By comparing equations (5) and (10) we obtain:

$$E_{MEY} = E_{MSY} - \frac{c}{2\,bp}$$

and since c, b, p > 0 we conclude that $E_{MEY} < E_{MSY}$, that is, economic yields are maximized at a lower level of effort (and larger stock) than physical yields.

MEY itself may be obtained by combining equations (1), (7) and (10):

$$MEY = TR_{MEY} - TC_{MEY} = p\ \{aE_{MEY} - bE^2_{MEY}\} - cE_{MEY}$$

$$= (pa - c - b\ \frac{pa - c}{2bp})\ \frac{pa - c}{2bp} \qquad \ldots (11)$$

By combining equations (1), (5) and (7) and comparing the result with (11), it can be shown that excess profits or economic rents (TR—TC) are lower at E_{MSY} than at E_{MEY}. Profits are clearly maximized at E_{MEY} level of effort. This is the level an exclusive and secure owner of the resource will select in order to make the most of his/her resource.

Under open access too, fishermen attempt to maximize their profits but because of lack of exclusive property rights over the resource they have no incentive to take into account the effect of their fishing effort on other fishermen's catch. The guiding variable for expansion of effort is the expected average revenue of effort rather than the marginal revenue. That is, under open access the profit-maximizing rule for the individual fisherman (but not society as a whole) is to expand effort as long as the average revenue (AR) of effort exceeds the average cost (AC) of effort, no matter what this might do to other fishermen's revenues and to his own future revenues. Thus, the effort. for the fishery as a whole expands to the point where AR = AC, or

$$p\ \{a - bE\} = c \qquad \ldots (12)$$

Solving equation (12) for E we obtain the open-access or bioeconomic equilibrium level of effort (E_{BE}):

$$E_{BE} = \frac{pa - c}{pb} \qquad \ldots (13)$$

By comparing equations (13) and (10) we establish that the bionomic equilibrium is obtained at substantially higher level of effort than MEY but not necessarily at higher level than MSY (it depends on the price-cost relationship). Moreover, by combining equations (1), (7) and (12) we see that at E_{BE} level of effort profits are totally dissipated:

$$TR_{BE} - TC_{BE} = 0 \qquad \ldots (14)$$

At E_{BE} level of effort neither the fishermen earn excess profits nor the society earns economic rents for its scarce fishery resource. All potential surplus of revenues over costs has been totally dissipated in excessive effort. Reduction of effort from E_{BE} down to E_{MEY} would generate substantial profits to the remaining fishermen (or rents to the society), and at the same time increase the size of the fish stock (it might even increase if at E_{BE} the stock is severely depleted).

The preceding analysis assumes that the fishery under consideration is sufficiently small relative to the market in which it sells for changes in catch not to affect the price of fish. It is a fixed price model which is appropriate in the case of a local fishery selling in a national market, or a national fishery selling in the international market. For species such as prawns and squid which are exported from Thailand this model is applicable. However, for other species such as the Indo-Pacific mackerel which are consumed domestically, a more appropriate framework is a variable price model.

Such a model is best described in terms of revenues and costs per unit of catch rather than per unit of effort. This is done by solving equation (3) for E to obtain:

$$E = \{a \pm (a^2 - 4bY)^{1/2}\}/2b \qquad \ldots (15)$$

The AC and MC in terms of catch are obtained as:

$$AC = \frac{TC}{Y} = \frac{cE}{Y} = \frac{c}{a - bE} = \frac{2c}{a \pm (a^2 - 4bY)^{1/2}} \qquad \ldots (16)$$

and

$$MC = \frac{d(TC)}{dY} = \frac{c}{(a^2 - 4bY)^{1/2}} \qquad \ldots (17)$$

In order to derive the AR and MR functions it is necessary to estimate the relationship between catch and price or the demand function for fish since the TR curve is now written as:

$$TR = p(Y) \cdot Y \text{ where } dp/dY < 0 \qquad \ldots (18)$$

that is, the price of fish is not independent (but a declining function) of the catch.

The demand function for fish may be specified as:

$$p = \alpha - \beta Y \qquad \ldots (19)$$

where α is a constant embodying all variables other than catch that might have an influence on price such as incomes, prices of substitute products, population growth and changes in tastes; β is the slope of the demand function reflecting the effect of changes in catch on price. Now (19) may be written as:

$$TR = \alpha Y - \beta Y^2 \qquad \ldots (20)$$

The AR and MR functions are then obtained as:

$$AR = \alpha - \beta Y \qquad \ldots (21)$$

$$MR = \alpha - 2\beta Y \qquad \ldots (22)$$

Again we may determine the MEY and bionomic equilibrium levels of effort by setting, respectively, p = MC and p = AC. This is shown diagrammatically in Fig. 4.3 by superimposing the revenue and cost curves. Social benefits (profits plus consumer benefits) not just profits, are maximized at E_{MEY}. Profits, which include both resource and monopoly rents in this case, are maximized at a lower level of effort (where MR = MC) while they are completely dissipated at E_{BE} (AR = AC).

One limitation of the fixed and variable price models just described is in the estimation of the sustainable yield function which assumes a single-species fishery, in contrast with the multispecies composition of Thai (and other tropical) fisheries. In the absence of interspecies interactions it is still valid to estimate a total biomass yield curve. If, however, there are significant interdependencies among species, such estimates become unreliable because it is always possible to increase the stock and catch by depleting less prolific higher-value species and thereby stimulating the growth of their more prolific lower-value preys and competitors. Panayotou (1982) has suggested direct estimation of a sustainable value function as a way around the multispecies problem. The sustainable value curve of a multispecies fishery is constructed by multiplying the sustainable yield curve of each species by its price and summing up over all species. The maximum value is attained at a level of effort lower than that required for the maximum yield because of the depletion of high-value sizes and species as the fishing intensity increases. However, estimation of a sustainable value function is beyond the scope of the present study.

CHAPTER 5

COST AND EARNINGS I: THE LARGE-SCALE FISHERY

Ideally, we would like to have a long time-series on costs and earnings to calculate the profitability of fishing and its changes over time. Our methodology calls for establishing trends for profits (Fig. 4.2). Are profits rising, falling or persisting at a more or less fixed level over time, or have they been completely dissipated? Unfortunately, the existing cost and price data on Thailand's fisheries do not allow the construction of the necessary time-series for establishing reliable trends. At most, we were able to compute cost and earnings for the Thai trawl fishery for the years 1969, 1974, 1977 and 1982 drawing on three surveys by the Department of Fisheries (1969, 1974, 1977) and a more recent, though limited, 1982 survey by the Office of Agricultural Economics (OAE 1983). Because of the limited scope and unrepresentativeness of the 1982 survey most of the following discussion will focus on 1977 as the last year, except where more recent information is available.

The 1982 OAE survey used a limited sample of 40 vessels, which included only otter trawlers 14-25 m in length and pair trawlers 14-18 m in length to the exclusion of the numerous small trawlers (< 14 m) and the very large otter (> 25 m) and pair (> 18 m) trawlers. Even for the classes of trawlers that were included the capital costs and catch figures were apparently overestimated. To reduce the upward bias of the catch we combined the cost and price figures of the 1982 survey (which appear reasonable) with alternative catch figures from "The Marine Fishery Statistics Based on a Sample Survey 1982" (unpublished preliminary results of the Thai Department of Fisheries). The latter may err on the conservative side. Unfortunately, there are no alternative figures for capital costs. Thus, using the conservative DOF figures for catch and the overestimated OAE figures for capital cost we obtain very conservative profit figures (see Tables 5.1 and 5.2). If, on the other hand, we use only OAE figures we obtain grossly overestimated profits and unreasonable catch and effort figures for the fishery as a whole (see Appendix Tables A.9 and A.10). Therefore, the 1982 figures reported in this chapter should be regarded and interpreted with caution.

In the next chapter, we present two 'snapshots' of the costs and earnings situation of the small-scale fisheries based on two surveys (1978 and 1983) which we carried out as part of other projects.

The Trawl Fishery

The trawl fishery of Thailand grew from just over 2,600 registered vessels in 1969 to over 11,000 in 1982 (see Table 3.2). These figures are somewhat misleading since not all active trawlers are registered and those which are may not all be in operation. Moreover, of those which are in operation not all are operating in Thai territorial waters. Increasingly, over the years the fishing grounds for Thai vessels expanded from Thailand's shallow coastal waters to the high seas. As the number of vessels which are operating outside the Thai waters is unknown and varies according to circumstances, the resource base of the industry is not fixed and well defined. By implication catch and effort data are not as accurate and reliable as one would like to have for a cost and earnings study, but, by and large, they are indicative of the changing fortunes of the industry.

Table 5.1 presents a summary picture of the catch and effort and the cost and earnings situation of the trawl fishery as a whole. The total fishing effort, measured in standard research vessel (Pramong II) hours, has expanded almost sevenfold between 1969 and 1977 to attain a threefold increase in catch reflecting a precipitous fall (from 103 kg/hr to 47 kg/hr) in the catch per unit of effort (CPUE) as shown in Table 5.3. A further decline in CPUE from 47 to 39 kg/hr and, if the 1982 survey is to be believed, effort occurred between 1977 and 1982.

With a sevenfold increase in effort and only a threefold increase in catch, between 1969 and 1977, one would expect a larger rise in costs than revenues and hence erosion of the profit margin of the industry. In fact, the reverse has happened; revenues in 1977 were almost seven times larger than in 1969 while costs increased only six times over their 1969 level; again the spread in 1982 was in the same direction but larger (see Table 5.1).

Table 5.1. Catch, effort, revenues, costs and profits (in million baht) of the Thai trawl fishery for selected years.

Year	No. of vessels	Total catch (t x 10^3)	Total effort (St hr x 10^6)[a]	Total revenues	Total costs	Profits	Capital 1	Capital 2	Net profits[c]	Net profits[d]
1969	2,017	383	3.7	560	476	84	192	383	46	8
1974	4,868	969	16.7	2,074	2,122	–49	915	1,767	–234	–404
1977	5,868	1,209	25.7	3,673	2,852	822	1,966	3,621	428	100
1982[b]	4,528	679	17.4	4,211	3,242	969		5,062[e]		–45[f]

[a]Million standard hours.
[b]The 1982 figures include otter trawlers 14-18 m and 18-25 m and pair trawlers 14-18 m, while the 1969, 1974 and 1977 figures include also otter trawlers < 14 m and > 25 m and pair trawlers < 14 m and > 18 m. Not only are the 1982 figures not strictly comparable to the three earlier years but they should also be regarded with caution since they are derived from different sources. The 1982 profit figures in this and all other tables in this chapter are very conservative estimates, as we use the conservative catch per vessel figures of the Department of Fisheries. The catch figures of the Office of Agricultural Economics put profits at 2,920 million baht and net profit at 1,906 million baht (see Appendix Table A.10).
[c]Net profits 1 = profits minus opportunity cost of capital assumed to be 20% of capital 1 (= current value of fishing assets).
[d]Net profits 2 = profits minus opportunity cost of capital assumed to be 20% of capital 2 (= original purchase value of fishing assets).
[e]Clearly an overestimate but it is the only figure available.
[f]Clearly an underestimate because of reasons given in footnotes b and e (see also Appendix Table A.10).

Source : Computed from figures reported in Tables 5.2 and 5.3.

In both 1977 and 1982 the fishery earned substantial profits (gross of the return to capital), but suffered considerable losses in 1974 because of a sudden surge in fishing costs as a result of the steep rise in fuel prices during 1973-1974. Two different rates of return have been calculated; one based on the current value of fishing assets as appraised by the fishermen and the other on capital cost estimates; the first is thought to be more appropriate in explaining why existing vessels stay in or leave the industry while the second in explaining why new vessels enter (or refrain from entering) the industry. By 1977, the capital cost of the fleet had reached 3.6 billion baht in current prices (a ninefold increase from 1969). Fishermen's own estimates placed the current value of their fishing assets at 2 billion baht.

Both in 1969 and 1977 the industry earned a sufficiently high return, over 40% on the current value of assets or over 20% on capital cost (Table 5.2) to keep existing vessels in the fishery, and perhaps to attract a modest number of new entrants. In 1974, the trawl fishery suffered considerable losses that forced many vessels out of the industry. Each of these three years marks a new era in Thai fisheries.

Around 1968-1969, following a decade of relentless entry (1,000 trawlers entered in 1967 alone) under stable economic conditions, the trawl fishery, still confined to Thai waters was approaching a bionomic equilibrium (a situation of zero profits). In fact, in 1969 over 300 trawlers or 13% of the fleet left the industry in the first net exit since the introduction of trawling in Thailand (see Table 5.4 and Fig. 5.1). It was about this time that the Thai fishermen began in large numbers to encroach on the fishing grounds of neighboring countries, and the Department of Fisheries began to explore actively long-distance fishing grounds as an alternative to the depleting local stocks. The underexploited waters of neighboring countries and the success in locating new fishing grounds in the open seas have enlarged the resource base shifting upwards the sustainable yield and revenue curves and creating new economic rents. The industry was quick to recover its buoyancy: the number of trawlers more than doubled between 1969 and 1973 (Table 5.4) and the catching power per vessel, defined as the ratio between standard and nominal effort, almost tripled (Table 5.3).

Table 5.2. Revenues, costs and profits (in thousand baht) per vessel and average return to capital, Thai trawl fishery, selected years.

Year	Revenues	Costs	Profits	Capital 1	Capital 2	Return on capital 1[b] (%)	Return on capital 2[c] (%)	Net profits 1[d]	Net profits 2[e]
1969	266	226	40	91	182	44	22	22	4
1974	426	436	—10	188	363	—5	—3	—48	—83
1977	626	486	140	335	617	42	23	73	17
1982[a]	930	716	214[g]	1,118[f]		19[g]		—10[g]	

[a]The 1982 figures include otter trawlers 14-18 m and 18-25 m and pair trawlers 14-18 m, while the 1969, 1974 and 1977 figures include also otter trawlers < 14 m and > 25 m and pair trawlers < 14 m and > 18 m. Not only are the 1982 figures not strictly comparable to the three earlier years but they should also be regarded with caution since they are derived from different sources. The 1982 profit figures in this and all other tables in this chapter are very conservative estimates, as we use the conservative catch per vessel figures of the Department of Fisheries. The catch figures of the Office of Agricultural Economics put profits (per vessel) at 645,000 baht and net profits at 373,000 baht (see Appendix Table A.10).

[b]Profits divided by capital 1 (= current value of fishing assets).

[c]Profits divided by capital 2 (= current purchase price of fishing assets).

[d]Profits minus opportunity cost of capital assumed equal to 20% of capital 1.

[e]Profits minus opportunity cost of capital assumed equal to 20% of capital 2.

[f]Clearly an overestimate but it is the only recent figure available.

[g]Clearly underestimates because of reasons given in footnotes a and f above (see also Appendix Table A.10).

Source : Computed from Tables 5.3 and 5.6.

Table 5.3. Average catch and effort per vessel, catch and cost per unit of effort and price, cost and profit per unit of catch, Thai trawl fishery, selected years.

Year	Catch per vessel (t)	(% trash)	Effort per vessel (hr)	(St hr)[a]	Cost per unit of effort (฿/st hr)	CPUE[b] (kg/hr)	(kg/st hr)	Catching power index	Price (฿/kg)	Cost (฿/kg)	Profit (฿/kg)
1969	182	67	4,436	1,767	186	41	103	0.40	1.46	1.24	0.22
1974	199	68	3,171	3,430	155	63	58	1.09	2.14	2.19	—0.05
1977	206	63	3,225	4,380	124	64	47	1.45	3.04	2.36	0.68
1982[c]	150	70	1,956	3,837	183	76	39	1.95	6.20	4.77	1.43

[a]Standard hours.

[b]CPUE (catch per unit of effort) here is not necessarily equal to the CPUE of the research vessel given in Table 8.2 because of the smaller mesh size used by the commercial fleet.

[c]The 1982 figures include otter trawlers 14-18 m and 18-25 m and pair trawlers 14-18 m, while the 1969, 1974 and 1977 figures include also otter trawlers < 14 m and > 25 m and pair trawlers < 14 m and > 18 m. Not only are the 1982 figures not strictly comparable to the three earlier years but they should also be regarded with caution since they are derived from different sources (see sources to Table 5.5 from which this table is derived).

It was about this time that the oil crisis shocked the industry. The price of fuel rose by 138% between 1972 and 1974. More damagingly, there had been no warning. The sudden and successive price rises took the industry by surprise following its heavy investment in a fuel-intensive distant-water fleet with engines, gear and nets designed for an era of low fuel prices. With fuel accounting for over 50% of fishing costs, the more than doubling of fuel prices meant at least a 50% increase in fishing costs. Between 1969 and 1974, the cost per unit of catch rose by 77% or 13% above the rate of inflation. By comparison, the price of fish rose by only 47% or 17% below the rate of inflation. Not only were all profits dissipated but also the industry is estimated to have suffered losses between 230 and 400 million baht (Table 5.1) despite the exit of about 500 trawlers (Table 5.4). Exit continued into 1975 and the industry did not return to its 1973 size of fleet until 1977.

By 1977 the necessary adjustments to the new realities of depleted local stocks and high fuel prices were made and the industry had recovered sufficiently to turn in a profit and attract 3,000 additional trawlers into the fishery over the following three years. In fact, 1977 is a sort of landmark in the history of the Thai fishery because of its all-time record catch of over 2 x 10^6 t (Table 3.3). No doubt, much of this catch, 40-60% according to some estimates (Rientrairut 1983), came from outside the Thai territorial waters despite the high fuel prices which discriminate against distant-water fishing.

But the cost of distant-water fishing was to be raised again soon. Country after country, Thailand's neighbors began to declare and enforce 200-mile exclusive economic zones: Vietnam in 1977, Kampuchea and Bangladesh in 1978, the Philippines in 1979 and Indonesia and Malaysia in 1980. And then came the second oil price shock of 1979-1980. These events combined to raise the cost of fishing, especially in distant waters and to reduce the fish stocks at home. The declaration and

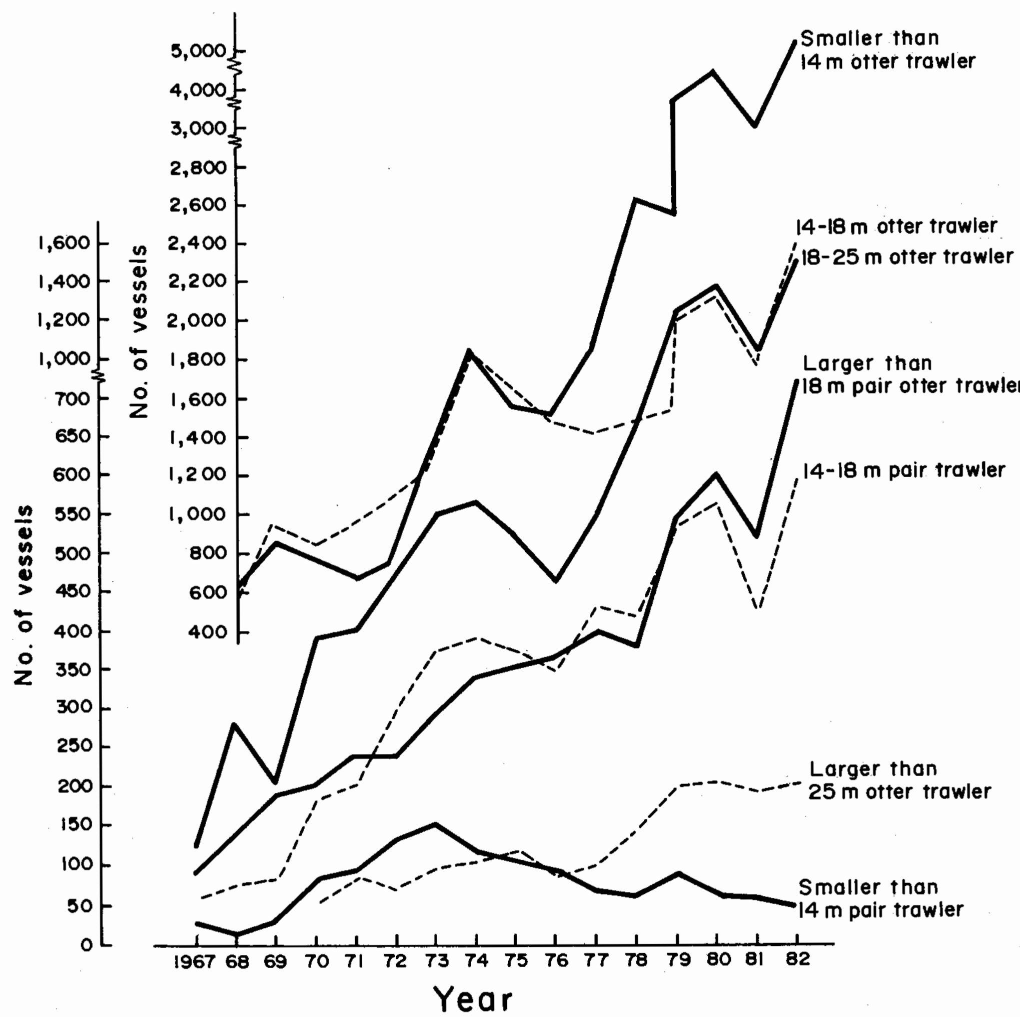

Fig. 5.1. Time trends in the numbers of Thai trawl vessels, 1967-1982.

Table 5.4. Registered trawling vessels of various sizes, Thailand, 1967-1983.

Year	Otter trawlers < 14 m	14-18 m	18-25 m	> 25 m	Pair trawlers < 14 m	14-18 m	> 18 m
1967	661	589	130[a]	—	26	56	94
1968	945	1,030	283[a]	—	19	79	146
1969	826	906	207[a]	—	22	80	146
1970	732	1,011	400	57	71	189	182
1971	816	1,157	414	85	73	202	247
1972	1,323	1,321	463	78	124	303	245
1973	1,941	1,941	553	92	153	381	290
1974	1,663	1,731	506	114	117	395	342
1975	1,597	1,571	528	119	112	379	361
1976	1,986	1,523	469	90	104	358	370
1977	2,715	1,569	575	103	70	432	404
1978	2,705	1,594	671	140	68	417	367
1979	3,602	1,998	1,238	200	92	533	547
1980	4,409	2,132	1,384	206	65	565	600
1981	3,000	1,788	1,036	197	60	425	523
1982	5,219	2,406	1,529	204	51	593	762

[a]Figure includes other trawlers 18-25 m and over 25 m in length.

Source : Department of Fisheries, Thai Fishing Vessels Statistics, various issues.

— Zero or negligible.

enforcement of EEZs by neighboring countries increased the risk of loss of life, capital and catch and made necessary investment in faster vessels and more sophisticated detection equipment to avoid arrest. At the same time it must have forced others to retreat into the Thai territorial waters to avoid the extra cost.

While data on these developments are not available, the 1982 survey provides some indication of what may have happened. First, as shown in Table 5.3 the cost per kilogram of fish caught doubled from 2.36 baht in 1977 to 4.77 baht in 1982, the catch per unit of effort dropped from 47 to 39 kg/hr, and the cost per unit of standard effort increased by at least 40% over the same period. The losses that must have occurred in 1980 and early 1981 forced almost 2,000 trawlers to leave the fishery (Table 5.4 and Fig. 5.1). As a result, the completion of adjustments to the new realities and the rise in fish prices during 1981-1982, substantial profits gross of the opportunity cost of capital were earned in 1982 attracting almost 3,000 additional trawlers into the fishery during that year alone. According to our conservative estimates based on the costs and prices given in the latest survey by the Office of Agricultural Economics (OAE 1983) and the catch and effort statistics of the Department of Fisheries, the trawl fishery (excluding otter trawlers below 14 m and above 25 m and pair trawlers below 14 m and above 18 m) earned a profit of almost a billion baht or a return of 20% on its capital (Table 5.1) despite the entry of 5,000 new vessels since 1977. (When only OAE figures were used, the estimated 1982 profits reached 3 billion baht or 58% on assets as shown in Appendix Table A.10.).

However, this aggregate picture may be somewhat misleading. The 1982 survey focused on trawlers above 14 m in length which have access to distant-water fishing grounds, and ignored the numerous small (< 14 m) trawlers with little or no access beyond the heavily exploited local fishing grounds. The difference in profitability between trawlers of different scale can be dramatic. In 1974, for example, the only vessels that registered substantial profits were large otter trawlers over 18 m in length; smaller trawlers suffered catastrophic losses. It is, therefore, important to disaggregate the industry by type of vessel. This is done in Tables 5.5 and 5.6. A number of observations can be made from these tables.

First, small trawlers have been generally less profitable than larger ones and less able to adjust to changing circumstances partly because of their limited access to offshore resources. Even with the most conservative estimate of capital costs, the otter trawlers less than 14 m had reached a bionomic equilibrium around 1969. In 1974 they suffered losses from which they were not able to recover even in 1977 which was a generally good year for the industry as a whole. In fact, in 1977 they incurred losses at least twice as large as in 1974, failing even to cover their variable costs. Yet, despite a limited temporary exit (in 1970, 1975 and 1978) following these losses the fleet of small trawlers continued to grow and reached 5,200 vessels by 1982 (see Table 5.4). This paradoxical behavior can be explained by the low mobility of existing trawlers out of the fishery in response to losses and the high mobility into the fishery of new trawlers in response to large profits from operating in underexploited coastal waters of neighboring countries, especially Kampuchea and Burma. Evidence for the validity of this explanation is provided by the relative stability of the fleet in depressed fishing areas and the rapid expansion of the fleet in provinces neighboring Kampuchea and Burma such as Trat and Ranong, respectively.

The next size (14-18 m) otter trawlers with a longer fishing range performed somewhat better than the smaller trawlers. While they also were around bionomic equilibrium in 1969 and suffered heavy losses in 1974 they returned to bionomic equilibrium around 1977 and enjoyed substantial profits in 1982. Their fleet grew at a slower but more steady pace from 900 vessels in 1969 to 2,400 vessels in 1982 with entry and exit following profits and losses closely (see Tables 5.4 and 5.6). The most resilient of the otter trawlers turned out to be the larger sizes, 18-25 m and over 25 m in

Table 5.5. Catch and effort per vessel, catch and cost per unit of effort, and price, cost and profit per unit of catch, by type and size of trawler, Thailand, selected years.

Year	No. of vessels	Catch per vessel (t)	(% trash)	Effort per vessel (hr)	(st hr)[a]	Cost per unit of effort (฿/st hr)	CPUE (kg/hr)	(kg/st hr)	Catching power index	Price (฿/kg)	Cost (฿/kg)	Profit (฿/kg)
						<14 m otter trawler						
1969	826	52	53	3,059	505	276	17	103	0.17	2.98	2.67	0.31
1974	1,663	74	59	2,690	1,276	114	28	58	0.48	2.02	1.95	0.07
1977	2,715	77	58	2,894	1,638	87	27	47	0.57	1.74	1.86	–0.12
						14-18 m otter trawler						
1969	906	218	66	5,590	2,117	119	39	103	0.38	1.40	1.17	0.23
1974	1,731	201	72	4,277	3,416	122	47	58	0.81	1.85	2.12	–0.27
1977	1,569	231	72	3,983	4,915	113	58	47	1.23	2.89	2.55	0.34
1982[b]	2,406	143	68	2,461	3,667	174	58	39	1.49	5.93	4.46	1.47
						18-25 m otter trawler						
1969	207	381	66	6,145	3,700	121	86	103	0.83	1.20	1.17	0.03
1974	506	425	70	3,972	7,328	129	107	58	1.84	2.42	2.22	0.20
1977	575	510	60	4,345	10,851	84	115	47	2.45	2.29	1.77	0.52
1982[b]	1,529	170	74	1,593	4,359	194	107	39	2.74	6.27	4.97	1.30
						> 25 m otter trawler						
1974	114	1,059	71	3,170	18,258	117	334	58	5.76	2.42	2.02	0.20
1977	103	1,174	60	5,486	24,979	175	214	47	4.55	5.41	2.50	2.91
						<14 m pair trawler						
1969	22	163	79	2,629	1,583	188	62	103	0.60	1.30	0.90	0.40
1974	117	31	56	924	1,534	669	33	58	0.57	3.84	5.85	–2.01
1977	70	155	87	1,267	3,298	242	122	47	2.60	2.72	1.85	0.87
						14-18 m pair trawler						
1974	395	175	56	1,786	3,017	271	98	58	1.69	2.19	2.35	–0.16
1977	432	162	55	1,928	3,447	329	84	47	1.79	4.45	3.63	0.82
1982[b]	593	124	67	846	3,179	214	147	39	3.77	6.35	5.49	0.86
						> 18 m pair trawler						
1969	146	414	66	2,916	4,019	188	142	103	1.38	1.20	0.91	0.29
1974	342	260	61	1,093	4,483	269	238	58	4.10	2.35	2.33	0.02
1977	404	350	63	2,071	7,447	222	169	47	3.60	2.64	2.37	0.27

[a] Standard hours.
[b] The 1982 figures should be regarded with caution, since they have been calculated based on figures from different sources (see sources below).

Source : Number of vessels and CPUE (per standard hour) from Tables 5.4 and 8.2, respectively. All other figures for 1969, 1974 and 1977 from Appendix Tables A.2 and A.3. The 1982 figures are from Appendix Tables A.6 (costs per standard hour and price per kg of catch), A.7 and A.8 (catch per vessel and nominal fishing effort).

length, presumably because of their longer fishing range and, hence, access to less heavily exploited fishing grounds. Larger trawlers managed to earn profits even in 1974, the worst year in the history of the Thai fisheries. It is apparently easier to adjust to higher fuel prices than depleted fishing grounds. Large vessels, despite their large fixed costs, manage to adjust to changing circumstances because they have more degrees of freedom, more options to choose from. When one fishing ground

Table 5.6. Revenues, costs and profits per vessel and rates of return to capital by type and size of trawler, Thailand, selected years.

Year	Revenues (฿ x 10^3)	Costs (฿ x 10^3)	Profits (฿ x 10^3)	Capital 1 (฿ x 10^3)	Capital 2 (฿ x 10^3)	Return on capital 1 (%)	Return on capital 2 (%)	Net profits 1 (฿ x 10^3)	Net profits 2 (฿ x 10^3)
				< 14 m otter trawlers					
1969	154	138	16	40	87	40	18	8	–1
1974	149	144	5	55	120	9	4	–6	–19
1977	135	144	–9	59	180	–15	–7	–21	–27
				14-18 m otter trawlers					
1969	174	149	25	84	164	30	15	8	–8
1974	373	428	–55	173	339	–32	–16	–90	–123
1977	667	589	78	353	692	22	11	7	–60
1982[a]	848	638	210	728		29		64	
				18-25 m otter trawlers					
1969	462	444	18	245	530	7	3	–31	–88
1974	1,030	946	85	410	886	21	10	3	–92
1977	1,168	903	265	599	1,297	44	21	145	6
1982[a]	1,066	845	221	2,005		11		–180	
				> 25 m otter trawlers					
1974	2,566	2,141	425	1,409	1,863	30	23	143	52
1977	6,357	4,352	2,004	4,227	5,589	47	36	1,159	886
				< 14 m pair trawlers					
1969	254	148	56	33	94	171	60	50	38
1974	117	178	–62	48	137	–78	–29	–71	–89
1977	421	286	135	66	189	204	71	122	97
				14-18 m pair trawlers					
1974	383	412	–29	133	n.a.	–22	(–8)[b]	–56	n.a.
1977	719	587	132	461	n.a.	29	(14)[b]	40	n.a.
1982[a]	787	681	107	415		26		24	
				> 18 m pair trawlers					
1969	502	378	124	210	350	59	35	82	54
1974	610	606	4	285	475	2	1	–53	–91
1977	927	830	88	657	1,096	13	8	–44	–132

n.a. = Data not available.

[a]The 1982 figures should be regarded with caution since they are derived from different sources (see sources to Table 5.5 from which this table is derived).

[b]Assuming the two rates of return for intermediate size trawlers bare the average relationship of the two rates of return for smaller and larger pair trawlers, i.e., $R_2 = R_1$ (0.615 + 0.348)/2 = (29) (0.481) = 14.

Source : Revenues and costs from Table 5.5; capital from Table 8.4.

becomes depleted they can move to another; when fuel prices in Thailand increase they refuel elsewhere and land their catches in nearby ports to minimize fuel cost, to take advantage of higher fish prices and/or to avoid taxes. They also enjoy lower risk from rough seas, pirates and neighboring countries' patrol vessels because of their sheer size, powerful engines and sophisticated detection and defense armory. The higher profitability of large vessels accounts for their high growth rate. In 1969 there were only 200 vessels over 18 m in length; in 1982 there were over 1,700 of them. In the late 1960s there were only a score of vessels larger than 25 m; in 1982 there were as many as 103 (Table 5.4). It is also of interest to note that these giant trawlers enjoyed a reduction in the proportion of trash fish in their catch from 71% in 1974 to 60% 1977 because of the ability to explore and exploit new fishing grounds (Table 5.5). An alternative explanation is that giant trawlers continued to catch similar amounts of fresh fish in their catches, the only difference being the proportion discarded at sea.

The superiority of larger vessels, however, does not apply to pair trawlers. Pair trawlers over 18 m long, while very costly in terms of capital and fuel consumption, are too cumbersome and inflexible for the modern day 'open-sea' fishing which takes the form of a 'hit-and-run' operation. Thus, large pair trawlers have not been able to recover from their 1974 slump as rapidly as the medium (14-18 m) trawlers have. Yet, in 1982 both size groups were earning substantial profits as reflected in the 26% return on capital for medium trawlers (Table 5.6) and the massive entry of new vessels in both groups (Table 5.4).

A second observation from Tables 5.5 and 5.6 is the changed fortunes of the small (< 14 m) pair trawlers, once the most profitable gear. In 1969 small pair trawlers enjoyed at least a 60% return on capital, by far the largest in the industry and saw their fleet grow from 19 vessels in 1968 to 153 in 1973. In 1974, they suffered such catastrophic losses, by far the largest in the industry, that their fleet dwindled to 70 vessels in 1977 and 50 vessels by 1982, despite a temporary recovery in 1979. One reason behind this dramatic change has been the rise in fuel prices that affected disproportionately the small pair trawlers which use two vessels usually fitted with inefficient second-hand automobile engines. Between 1969 and 1974 the cost per unit of effort rose by 250% and the cost per kilogram of fish caught by 550%.

In conclusion, resource rents appear to have been dissipated over time for small trawlers and to have risen for all other groups, which have been able to adjust to the changing circumstances of high fuel prices, depleted local stocks and the declaration of EEZs by neighboring countries. In general, it could be said that profitability and size tend to be correlated because of the greater mobility and wider range of options for adjustment to changing circumstances that larger size can afford. Of course, it is not just vessel length but also engine power, speed, tonnage, technology and financial capital which are correlated with size that account for the greater resilience of the large-scale trawl fishery. In the following chapter, we turn to the other end of the spectrum, the traditional small-scale fishery, which lacks not only size but also modern technology and capital, and is confined to the coastal fishing grounds around isolated fishing communities.

A Note on the Pelagic Fishery

While the focus of this study is on the dualism between the small-scale coastal fishery and the large-scale offshore trawl fishery and their interactions and conflicts, another subsector, of an intermediate scale, deserves some attention: the pelagic or purse-seine fishery. The two terms are not synonymous since trawlers, though primarily a demersal gear, also catch some pelagic fish and seiners, though primarily a pelagic gear, also catch some demersal fish (see Table 5.7). In this note, we briefly discuss the pelagic fleet and catch. An indication of the profitability of the pelagic fishery (purse seines and gill nets) is given in Chapter 6 where the small- and medium-scale fisheries are compared (see Table 6.3). A more in-depth economic analysis of the pelagic fishery is not intended. The state of pelagic resources is discussed in Chapter 8.

The pelagic catch accounts for roughly 20% of the total catch and 35% of the edible catch. Seines, the main pelagic gear, land nearly 20% of the total catch and 90% of the pelagic catch (see Table 5.7). In 1981 seine nets caught 337,000 t of fish, which represents a 35% increase over 1980 and a 25% decline from 1977. One feature of the purse seine fishery is its volatility, both in terms

Table 5.7. Annual production by fishing gear type[a], 1974-1981 (t x 10^3).

Gear type	Variety	1974	1975	1977	1978	1979	1980	1981
Otter trawl	Pelagic	16.6	18.5	13.2	16.2	20.0	18.3	17.5
	Demersal	139.4	174.5	149.7	140.0	121.4	143.9	122.3
	Crustacea	69.4	66.1	103.8	105.8	92.2	78.7	82.1
	Cephalopods	32.7	33.8	54.7	62.8	52.5	—	48.0
	Trash	574.9	500.1	665.3	688.9	620.2	638.7	626.8
	Total	833.0	793.0	986.7	1,013.7	906.3	879.6	896.7
Pair and beam trawl	Pelagic	8.6	13.0	12.0	13.2	12.0	10.5	9.8
	Demersal	28.0	28.1	48.0	31.9	25.2	22.3	21.9
	Crustacea	4.2	4.4	6.5	4.1	2.6	8.0	12.2
	Cephalopods	28.6	27.4	35.3	26.4	22.1	17.7	18.1
	Trash	94.7	112.9	140.4	126.7	113.7	97.6	99.2
	Total	164.1	185.8	242.2	202.3	175.6	156.10	161.2
Seine nets	Pelagic	80.2	99.1	413.5	335.5	255.0	193.7	263.9
	Demersal	1.5	—	15.1	47.4	12.1	24.5	32.3
	Crustacea	—	—	1.5	—	—	—	1.0
	Trash	—	2.7	6.2	3.7	23.5	22.7	40.0
	Total	81.7	101.8	436.3	386.6	290.6	241.9	337.2
Luring lift nets	Pelagic	63.9	65.1	—	—	—	—	—
	Demersal	5.3	8.9	—	—	—	—	—
	Total	69.2	74.0					
Gill nets	Finfish	38.2	53.3	46.3	39.0	76.6	111.0	54.3
	Crustacea	11.6	13.7	—	—	—	10.4	—
	Total	49.8	67.0	46.3	39.0	76.6	121.4	54.3
Push nets	Fish	4.0	2.3	3.9	3.4	5.8	3.3	2.6
	Crustacea	8.0	8.6	6.9	8.4	8.1	18.9	15.1
	Cephalopods	0.4	0.6	1.1	1.0	1.0	14.5	1.0
	Trash	9.0	8.9	10.3	12.5	14.2	1.0	16.5
	Total	21.4	20.4	22.2	25.3	29.1	36.7	35.2
Other small-scale gear		84.6	61.8	200.5	182.9	346.4	146.6	159.2
Total		1,303.8	1,303.8	1,934.2	1,849.8	1,824.6	1,582.3	1,643.8

[a]1976 data unavailable.

Source : ADB 1985.

of the stocks and effort, which is translated into large fluctuations in the catch. For example, the seine catch jumped from 102,000 t in 1975 to 436,000 t in 1977 to decline to 291,000 t in 1979.

The variations in the purse seine catch and, therefore, in the pelagic catch partly reflect the historical development of the fishing industry in Thailand. Before the introduction of the trawlers, the Thai and Chinese purse seines and gill nets were the most prevalent marine fishing gears. With the introduction of trawling, many purse seiners were converted for trawling with consequent decline of the pelagic catch. Since the mid-1970s, the introduction of modified "luring purse seining" techniques, the declining catch rates of trawlers and the location of new pelagic fish grounds in the Central Gulf gave new impetus to the pelagic fishery which has since become again a significant subsector of the Thai fisheries (ADB 1985).

The main pelagic gears in the past have been the traditional Thai and Chinese purse seines and the anchovy purse seines. These gears are now increasingly replaced by the luring purse seine which is becoming the predominant pelagic gear of the Thai fishery. Other important pelagic gears are encircling gill nets and drift nets. In 1982, the licensed pelagic fleet consisted of 840 seine net vessels (15% under 14 m in length) and 4,760 gill net vessels (over 90% under 14 m in length). The changes over time in the numbers and types of registered pelagic gear units in the Gulf of Thailand are given in Table 5.8, side by side with the pelagic catch attributable to these units. It is worth noting that while the number of fishing units remained constant between 1977 and 1981 and effective effort increased as a result of the replacement of Thai purse seine by luring purse seine, the pelagic catch has declined steadily.

Table 5.8. Pelagic catch in the Gulf of Thailand, and changes in the numbers of fishing gear units for small pelagic species.

	Pelagic catch (t)	Registered fishing gear units				
		Thai purse seine	Luring purse seine	Anchovy purse seine	Encircling gill net	Total gear units
1971	62,853	44	1	42	244	615
1972	80,171	317	1	48	254	620
1973	140,783	347	109	66	227	749
1974	170,430	289	152	46	183	670
1975	196,282	289	193	30	187	699
1976	308,967	262	300	45	226	833
1977	476,058	138	410	14	314	967
1978	393,147	82	510	28	358	978
1979	345,315	64	478	43	353	938
1980	285,594	103	507	28	304	942

Source : ADB 1985.

The most important pelagic species caught in the Gulf of Thailand are sardines, round and hardtail scads and Indian and Indo-Pacific mackerels which account for 39%, 31% and 10% of the pelagic catch of luring purse seines, respectively. Encircling gill nets and drift nets catch mainly Spanish mackerels. On the Andaman Sea the most important pelagic species are the Indian and Indo-Pacific mackerels (ADB 1985).

CHAPTER 6

COST AND EARNINGS II: THE SMALL-SCALE FISHERY

Until recently, there was only fragmentary information on the costs and earnings from small-scale fishing by some 300,000 small-scale fishermen in Thailand scattered along a coastline of 2,600 km. The spectacular development of the trawl fishery during the past 25 years has overshadowed the small-scale coastal fishery, which has managed to survive despite the keen competition from trawlers and the relative neglect by the government. Chapter 2 reviewed some of the earlier fragmentary information on the socioeconomic conditions of small-scale fishermen.

This chapter discusses the results of two more recent and more systematic surveys of the cost and earnings situation of small-scale fisheries. The two surveys conducted in 1978 and 1983 are comparable (though the second is not as extensive as the first) in the strict sense of having surveyed precisely the same sample (or a subsample) for the purpose of identifying the changes that have occurred between 1978 and 1983. In what follows is a discussion, first, of the 1978 findings in some detail (by province and type of gear) and then a presentation of a community by community comparison of incomes and rents between 1978 and 1983. A more detailed account of the results of the 1978 survey is given in Panayotou (1982) and of the 1983 survey in Panayotou and Panayotou (1985).

Analysis by Scale of Operation

The 1978 survey was conducted by Kasetsart University staff members (including the authors) for a study on the "Socioeconomic Conditions of Coastal Fishermen", which was supported financially by the International Development Research Centre of Canada. Four coastal provinces, Chumphon, Nakhon Si Thammarat, Trat and Phangnga were then selected as a cross-section representation of coastal fisheries in Thailand. Geographically, the four project sites were so selected that two, Chumphon and Nakhon Si Thammarat, are located on the west coast of the Gulf of Thailand; Trat, on the east coast and Phangnga on the Andaman Sea coast. Religion was also a factor in selecting the four provinces: Chumphon and Trat consist of purely Buddhist communities, Phangnga is predominantly Muslim and Nakhon is mixed. In terms of level of development the fisheries of Nakhon and Phangnga are smaller in scale and more primitive in technology than the other two. A total sample of 891 households was drawn randomly from predominantly fishing villages. Data were collected on catch and effort, costs and prices, fishing and non-fishing employment and assets, incomes and expenditures and several sociodemographic variables including occupational and geographic mobility.

Scale is defined in terms of current value of fishing assets: fishing units with fishing assets valued at less than 20,000 baht in 1978 were classified as small scale while those with more than 20,000 baht were classified as medium scale and those with assets worth over 100,000 baht as large scale. The Department of Fisheries uses length of vessel as a criterion of scale: vessels under 14 m in length but excluding trawls, purse nets, purse seines are classified as small scale, the rest large scale. The two definitions, of course, may give rise to different results regarding the numbers and economic conditions of small-scale fishermen. While the surveys and background studies to this chapter were based on the "asset" definition of scale and the results presented here in that format, it would be useful to translate the results, to the extent possible, into the DOF definition of scale. This is done later in this section.

Table 6.1 presents the cost structure of the coastal fishery by province and scale of operation Unlike the large-scale fishery (assets above 100,000 baht) where fixed costs (depreciation and interest on capital) often dominate, in the coastal fishery, which includes both small and medium scale (including otter trawlers under 14 m), fixed costs rarely exceed 15% of total costs. Labor costs are relatively more important, especially in the small-scale fishery where they range between 29 and 41% of total costs reflecting the labor intensity of the coastal fishery. It should be noted, however, that these labor costs are not actually paid expenses for hired labor but imputed opportunity costs for family labor, unlike the labor costs of the medium- and large-scale fisheries. Labor is most important in the small-scale fishery of Phangnga where capital accounts for only 8% of total cost. Fuel is an important cost item accounting for 14 to 42% but not as important as in the large-scale trawl fishery where it accounts for over 50% of total costs. Least fuel-intensive are the small-scale fishing vessels in Chumphon, Trat and Phangnga, some of which are non-mechanized, while most fuel intensive are the medium-scale trawlers of Trat which venture into Kampuchean waters.

Most striking are differences in the cost of borrowed capital (see Table 6.1). In Phangnga which is predominantly Muslim and in Trat which has well-developed institutional credit by virtue of its proximity to Bangkok, the interest rates paid by fishermen, small and medium scale alike, were in line with the institutional rates of interest paid by the large-scale trawl fishery. In Chumphon and Nakhon the coastal fishermen borrowed mainly from informal sources which charged them interest rates three to five times as high as those charged by banks. The interest rate ceiling of 12% imposed on bank loans by the government, ostensibly to help poor farmers and fishermen, dries up rural credit which is generally more costly and forces fishermen to borrow from fish traders and middlemen at high interest rates often hidden in preemptive marketing arrangements. This is a

Table 6.1. Cost structure, debt and current capital cost by scale of operation, four coastal provinces, Thailand, 1978.

Location	Sample size	Current capital cost	Debt: Amount	Debt: Interest	Debt: % of capital cost	% of total cost: Fixed cost	% of total cost: Labor cost	% of total cost: Fuel cost	% of total cost: Other costs
Chumphon									
Small scale	87	8,232	3,904	33	47.42	17.58	37.79	15.94	28.69
Medium scale	89	38,534	17,724	36	46.00	11.27	39.02	17.16	32.55
Average	176	23,555	10,893	34	46.24	12.05	38.86	17.01	32.08
Nakhon									
Small scale	235	8,825	3,671	52	41.82	15.62	28.76	30.40	25.22
Medium scale	40	25,454	8,750	42	34.38	15.81	20.45	41.32	22.42
Average	275	11,244	4,410	51	39.22	15.93	26.34	33.40	24.33
Phangnga									
Small scale	229	4,600	911	10	19.80	7.62	40.58	21.74	30.06
Medium scale	—	—	—	—	—	—	—	—	—
Average	229	4,600	911	10	19.80	7.62	40.58	21.74	30.06
Trat									
Small scale	86	12,201	4,449	11	36.46	8.31	35.15	13.71	42.83
Medium scale	42	54,945	12,646	13	23.02	10.01	32.09	41.52	16.38
Average	128	26,226	7,139	12	27.22	9.48	33.05	32.82	24.65

Source : Panayotou et al. (1985) based on the 1978 survey.

particularly restrictive constraint for coastal fishermen who borrow up to 50% of their fishing capital which ranged between 4,600 baht for the small-scale fishery in Phangnga to 55,000 baht for the medium-scale fishery in Trat (see Table 6.1). The latter, however, borrows only 23% of its capital because it generates sufficient profits for reinvestment from its operation in the lightly exploited Kampuchean waters.

Table 6.2 reports the revenues, costs and returns for the coastal fishery, again by province and scale of operation. Revenues ranged between 35,000 baht in the small-scale fisheries of Chumphon, Nakhon and Phangnga to 250,000 baht in the medium-scale fishery of Chumphon and 360,000 baht in the medium-scale fishery of Trat. Costs were equally varied ranging between 17,000 baht in the small-scale fishery of Nakhon and 200,000 baht in the medium-scale fishery of Trat. Imputed costs (the part of the cost that is incurred but not paid out in cash because it involves the use of owned inputs such as family labor and capital) ranged between 36 and 48% of total costs for the small-scale fishery and 19 to 25% for the medium-scale fishery (see Table 6.2). As we would expect, the larger the scale of a fishing operation the less it relies on its own factors of production and more on hired labor and borrowed capital.

Gross family income defined as revenues minus cash costs, is the maximum income that the household can consume in the short run. It is not sustainable over the long run since no allowance for the depreciation of fishing assets is made. Gross family income ranged between 16,000 baht earned by small-scale fishermen in Nakhon to almost 200,000 earned by medium-scale fishermen in Trat. Net family income, which allows for depreciation and therefore is sustainable over the long run, was only marginally lower than gross income because of the low capital intensity of the coastal fishery. By comparison to a national average of 8,390 baht per capita (see NESDB 1977, 1981) and assuming no other source of income, the small- and medium-scale fishermen to Nakhon were worse off than the average Thai citizen. The small-scale fishermen in the other three provinces earned net incomes comparable to the national average. The medium-scale fishermen of Chumphon and Trat were substantially better off than the average Thai citizen.

Table 6.2. Annual revenues, costs and returns (฿ x 10^3) per coastal fishing unit by type of technology in four provinces, Thailand, 1978.

Location/ scale	Revenues	Costs: Cash	Costs: Imputed	Costs: Total	Income[a]: Gross	Income[a]: Net	Profit[b]: Gross	Profit[b]: Net	Resource rents	Return to capital %	Return to labor (฿/day)
Chumphon											
Small scale	36	11	10	21	25	24	19	17	11	183	37
Medium scale	251	113	38	151	138	124	117	99	94	65	100
Average	144	62	30	92	82	77	68	58	53	123	68
Nakhon											
Small scale	34	18	7	25	16	15	13	9	5	81	21
Medium scale	65	44	13	57	22	20	18	9	4	35	24
Average	38	21	8	29	17	16	14	9	5	74	22
Phangnga											
Small scale	35	10	7	17	25	25	19	18	11	417	47
Medium scale	—	—	—	—	—	—	—	—	—	—	—
Average	35	10	7	17	25	25	19	18	11	417	47
Trat											
Small scale	58	30	17	47	28	27	15	11	−2	50	40
Medium scale	362	163	39	202	199	192	181	161	147	311	66
Average	160	74	25	99	86	82	71	61	49	137	49

Source : Panayotou et al. (1985) based on the 1978 survey.

Gross profits, defined as the difference between revenues and variable (operating) costs, were positive for both small- and medium-scale vessels as groups, ensuring their continued operation over the short run since all operating costs were covered. Similarly net profits, defined as gross profit minus fixed costs, were positive, ensuring continued operation over the long run as well. Pure profits or resource rents, obtained as the difference between net profits and the opportunity cost of management (that is, what owner-operators could earn by hiring out their managerial skills approximated here by the average earnings of hired skippers), were positive for both groups in all locations except for small-scale fishermen in Trat. The opportunity cost of management as an imputed cost is relevant to all fishing units regardless of capital or management intensity, but admittedly operators of large and modern vessels and gear have more marketable management skills. Here, we assume that the opportunity costs of management vary only across locations but not across gear types. However, in most cases, these rents were not substantial enough to refute the hypothesis that the fishery had reached a bionomic equilibrium. The only exceptions were the medium-scale fishermen of Chumphon and Trat who earned 94,000 and 147,000 baht in rents, respectively.

The return to capital was highest in Phangnga where many vessels are non-powered and have very low capital cost and in Trat for medium-scale vessels which earned the highest resource rents because of their operation in the rich fishing grounds of neighboring Kampuchea. In the latter case, however, a very high return is necessary to compensate for the substantially higher risk of loss of life and vessel borne by encroaching fishermen. However, returns to capital are high for all gear groups in all locations, even for those with negative resource rents because of the very low capital cost involved in coastal fishing. For this reason, the concept of return to capital makes little sense in the case of small-scale fisheries.

More appropriate is the concept of return to labor, since coastal fishing is a labor-intensive activity. Fishermen and other members of their family engaged in coastal fishing earned daily wages of 21 to 100 baht. The minimum daily wage for unskilled labor in 1978 in southern Thailand was 35 baht. Since fishermen are not totally unskilled and also tend to face higher risk at sea than do unskilled laborers on land, they are expected to earn over 35 baht a day. Medium-scale fishermen in Chumphon and Trat and small-scale fishermen in Phangnga did, but the rest did not. Most unsatisfactory were the wages of fishermen in Nakhon, small and medium scale alike, which averaged 22 baht per day. This is a reflection of both the low profitability of fishing in Nakhon and the lack of alternative employment opportunities.

As in the case of the trawl fishery, averages may be misleading when variances are large. Table 6.3 breaks down these averages by type of gear. While on the average, coastal fishermen had positive incomes and profits, fish gill nets in Trat had negative income and both fish gill nets in Trat and push nets in Phangnga had negative gross profits and would have been better off not operating at all even in the short run since they did not cover their operating costs. In the long run, in addition to these two groups of gears, trawl nets in Chumphon were also unprofitable and hence economically non-viable since they failed to cover their fixed costs in addition to variable costs. When the opportunity cost of management was deducted from net profits three additional types of gear turned out to earn negative resource rents: crab gill net in Chumphon and Phangnga and winged set bag in Nakhon. In total, six gear groups, at least one in each location, had negative rents, which if they persist over the long run would imply geographic and/or occupational immobility.

It is of interest to examine how sensitive our results are to the particular definition of scale used by reassembling the 1978 survey data according to the definition of scale: small-scale fisheries are those which are carried out by small fishing gears operating on a subsistence basis from vessels less than 14 m in length with engines not greater than 30 hp deployed in the vicinity of the home base with mostly family labor on board; trawls, push nets, purse seines, mackerel gill nets and even bamboo traps are excluded regardless of size. This leaves only non-powered gear, cast nets, lift nets, winged set bags, crab traps, non-mackerel gill nets and other traditional fish catching devices, to be included in small-scale fisheries. The economies of these individual gear types are given in Table 6.3.

When the 1978 survey data were reassembled based on the DOF definition of scale and aggregated into a "small-scale" fishery group the results were not significantly different from those obtained earlier based on "our" definition of scale (and, thefore, they are not repeated here). This is hardly surprising. In Chumphon, the two definitions give rise to the same classification of fishing units and, therefore, no differences in the results should be expected. A small difference arises for

Table 6.3. Profitability per fishing unit by selected types of technology, four coastal provinces, Thailand, 1978.

Technology (Type of gear)	Fishing months	Gross revenues	Gross family income	Net family income	Operating profit	Net profit	Pure profit (economic rent)	Return to capital[a] (%)	Return to labor[b] (%)
Chumphon									
Cast net (S)	7.6	5,123	3,874	3,747	2,811	2,458	1,822	243	37.0
Shrimp gill net (S)	7.6	7,011	4,685	4,590	3,961	3,214	2,578	290	30.0
Crab gill net (S)	7.6	3,738	2,265	2,061	905	320	−316	18	43.5
Fish gill net (M)	7.9	22,610	10,563	10,197	7,956	6,165	5,529	143	122.0
Push net (M)	7.9	11,480	4,997	4,062	3,695	1,626	990	33	37.0
Purse seine (M)	7.9	121,830	78,950	78,067	71,038	67,449	66,813	109	198.0
Trawl net (M)	7.9	13,108	1,723	996	585	−1,857	−2,493	−26	43.0
Nakhon									
Lift net (S)	8.5	2,811	1,718	1,685	1,182	882	392	146	25.3
Winged set bag (S)	8.5	1,992	854	758	665	173	−317	15	11.5
Shrimp gill net (S)	8.5	4,719	2,451	2,365	1,863	1,462	972	106	39.8
Trawl net (S)	8.5	4,490	1,403	1,306	1,462	754	264	57	8.6
Push net (M)	8.5	7,701	2,538	2,364	2,081	1,026	536	35	24.0
Phangnga									
Non-powered (S)	9.9	1,885	1,335	1,332	862	845	135	1,400	68.3
Push net (S)	9.9	1,362	688	652	−187	−289	−999	−59	22.9
Winged set bag (S)	9.9	3,040	2,251	2,190	1,676	1,535	825	224	30.9
Crab gill net (S)	9.9	2,771	1,712	1,655	1,220	1,063	353	142	47.0
Shrimp gill net (S)	9.9	5,382	4,318	4,234	3,613	3,389	2,679	377	63.7
Trat									
Crab trap (S)	11.0	5,175	3,843	3,770	2,306	2,127	982	308	41.8
Fish gill net (S)	11.0	2,911	−926	−1,018	−1,388	−1,592	−2,737	−204	17.1
Shrimp gill net (S)	11.0	8,607	3,985	3,673	2,333	1,669	524	62	54.8
Crab gill net (S)	11.0	4,157	1,880	1,742	756	417	−728	35	47.5
Push net (M)	10.5	26,955	18,769	18,108	17,788	16,107	14,962	263	30.3
Trawl net (M)	10.5	56,844	40,182	38,963	38,365	35,846	34,697	359	72.1

S = small scale, M = medium scale.

[a]Original cost of capital.
[b]Family labor.

Source : Panayotou et al. (1985) based on the 1983 survey.

Nakhon, Phangnga and Trat where trawl nets, push nets and fish gill nets, respectively, were included under our definition of scale and are now excluded under the DOF definition. Since all these three types of gear were doing worse than the average gear in the group, in terms of return to both labor and capital, their exclusion from the group would raise rather than lower the average profitability of the small-scale fishery. Therefore, our results overestimate somewhat the plight and numbers of small-scale fishermen compared to the results on the official classification of scale. However, the difference is small because the sample (and population) size of push nets in Phangnga and fish gill nets in Trat is very small and the performance of trawl nets in Nakhon, which are more numerous, diverges only marginally from that of the group as a whole.

Thus, it matters little which definition of scale is adopted, at least for the sample and time frame of this study. What matters more is that any assistance towards the sector should not be indiscriminate for the entire coastal fishery but targeted to benefit those in need of assistance to improve their fishing performance or to move to other more profitable activities.

Analysis by Fishing Community: Changes Over Time

In order to investigate the persistence of rents (whether positive or negative) and the extent of mobility in and out of the fisheries, in 1983 we carried out a survey of a subsample of the 1978 survey.

Table 6.4 presents a comparative picture of fishing, non-fishing and total income per household in seven villages in Chumphon, during 1978 and 1983. The average fishing income per household in Chumphon dropped from 25,600 baht in 1978 to 23,600 in 1983, an 8% decline in nominal terms or a 45% decline in real terms (the consumer price index rose by over 40% during the period). This decline was not uniform across the seven villages; in fact, in three out of seven fishing incomes rose substantially, but the decline in the other four was sufficiently strong to average in an overall decline. In contrast, non-fishing incomes rose in all villages except one. On the average non-fishing incomes rose by 165% in nominal terms or by 59% in real terms.

The total household income averaged 32,000 baht in 1978 and 40,000 in 1983, a 25% increase in nominal terms or a 25% decline in real terms despite a 17.5% increase in effort (measured in man-days of work). Moreover, there has been a change in the composition of total household income; in 1983 only 60% was derived from fishing compared to 80% in 1978. Overall, the sampled fishing villages of Chumphon in 1983 were on the average poorer and less dependent on fishing than five years earlier. The cause behind this rise in poverty was clearly the decline in the profitability of fishing. As seen from Table 6.5 the fishing wage rate declined by 3.5% while the non-fishing wage rate (that is, the opportunity cost of fishing) rose by 54%, both in nominal terms. These developments amount to a 93% drop in fishery resource rents from 30 baht per man-day in 1978 to 2 baht per man-day in 1983; that is, by 1983 virtually all rents were dissipated. In only two villages did fishermen earn positive rents. In the other five they suffered considerable losses ranging from 4 to 36 baht per man-day.

How much shifting to other occupations took place in response to the diminished profitability of fishing vis-à-vis non-fishing occupations? Tables 6.5 and 6.6 show that a 3.5% reduction in the fishing wage rate is associated with a 4.3% reduction in the number of man-days devoted to fishing by the household. On the other hand, a 54% increase in the non-fishing wage rate corresponds to a 76% increase in the number of man-days devoted to non-fishing activities. These changes imply a mobility "elasticity" (percentage change in working hours over percentage change in wage) of 1.23 for fishing and 1.41 for non-fishing, that is, there was substantial, though not infinite, mobility out

Table 6.4. Changes in fishing, non-fishing and total incomes (average per household, in baht) between 1978 and 1983 in selected villages in the Muang District, Chumphon Province, Thailand.

Subdistrict/ village	Sample size	Fishing income[a] (baht) 1978	1983	% Δ	Non-fishing income[a] (baht) 1978	1983	% Δ	Total income 1978	1983	% Δ
Paknam										
Village 2	3	13,918 (15,435)[b]	20,280 (13,595)	45.7	7,800 (7,275)[b]	20,000 (18,330)	156.4	21,718	40,280	85.5
Village 3	2	22,324 (19,341)	17,064 (7,161)	−23.6	14,355 (6,852)	11,550 (3,818)	−19.5	36,679	28,614	−22.0
Village 4	8	19,813 (18,077)	17,825 (11,368)	−10.0	8,464 (12,815)	26,343 (38,461)	211.2	28,277	44,168	56.0
Village 5	7	18,230 (14,593)	35,511 (26,623)	9.48	3,193 (2,554)	23,916 (29,708)	649.0	21,423	58,707	174.8
Village 7	3	26,430 (28,289)	56,511 (44,768)	113.8	12,583 (2,184)	14,600 (22,491)	16.0	39,013	71,111	82.3
Natoong										
Village 3	14	34,205 (27,413)	16,702 (10,500)	−51.2	4,977 (6,156)	10,312 (11,729)	107.2	39,182	27,014	−31.1
Village 4	7	27,567 (22,026)	21,960 (23,612)	−20.3	2,490 (1,748)	8,135 (7,622)	229.3	30,037	30,095	0.2
Total	44	25,589	23,641	−7.6	6,066	16,054	164.6	31,655	39,695	25.4

[a]Net of depreciation and opportunity cost of capital.
[b]Figures in parentheses are standard deviations from the mean.

% Δ : Percentage change between 1978 and 1983.
Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

Table 6.5. Changes in fishing, non-fishing and total wage and resource rents (average per household) between 1978 and 1983, in selected villages in the Muang District, Chumphon Province, Thailand.

Subdistrict/ village	Sample size	Fishing wage (baht/man-day) 1978	1983	% Δ	Non-fishing[a] wage (baht/man-day) 1978	1983	% Δ	Average wage 1978	1983	% Δ	"Rents" 1978	1983	% Δ
Paknam													
Village 2	3	67	63	−6.0	48	67	28.4	59	77	30.5	19	−4	−121
		(68)	(98)		(25)	(81)							
Village 3	2	54	45	−16.7	75	58	−22.7	61	49	−19.7	−21	−13	38
		(26)	(5.6)		(9.3)	(23)							
Village 4	8	66	63	−7.8	75	70	−6.6	68	69	1.5	−9	−7	22
		(45)	(24)		(28)	(28)							
Village 5	7	80	88	10	53	114	115.1	75	93	24.2	27	−36	−233
		(45)	(56)		(56)	(57)							
Village 7	3	124	178	43.5	60	125	108.0	93	163	75.3	64	53	−17
		(66)	(102)		(68)	(71)							
Natoong													
Village 3	14	94	69	−26.7	44	74	68.1	82	71	−31.4	50	−5	−11
		(50)	(31)		(27)	(45)							
Village 4	7	102	96	−5.9	32	72	125.0	87	88	1.2	70	24	−63
		(49)	(41)		(13)	(25)							
Total	44	85	82	−3.5	52	80	53.8	77	82	6.5	30	2	−93

[a]Includes farming, hired labor, mining, retail trade, construction, etc.

Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

Table 6.6. Changes in fishing, non-fishing and total employment per household between 1978 and 1983 in selected villages in Chumphon Province, Thailand.

Subdistrict village	Sample size	Fishing employment (man-days) 1978	1983	% Δ	Non-fishing employment (man-days) 1978	1983	% Δ	Total employment (man-days) 1978	1983	% Δ
Paknam										
Village 2	3	207	320	54.5	160	299	25.0	367	520	417
		(211)[a]	(200)		(151)	(199)				
Village 3	2	410	380	−7.3	191	199	4.0	601	579	−3.7
		(438)	(198)		(69)	(46)				
Village 4	8	301	293	−2.7	113	351	231.9	414	644	56.0
		(213)	(80)		(130)	(415)				
Village 5	7	227	404	77.9	60	226	210.6	287	630	110.5
		(112)	(195)		(57)	(309)				
Village 7	3	213	318	49.3	208	117	−43.8	421	435	3.3
		(128)	(214)		(81)	(151)				
Natoong										
Village 3	14	362	241	−33.5	113	139	23.0	475	380	−20.0
		(184)	(144)		(127)	(153)				
Village 4	7	269	229	−14.9	78	113	−35.0	347	342	−1.4
		(100)	(244)		(50)	(101)				
Total	44	300	287	−4.3	112	197	75.8	412	484	17.5

[a]Figures in parentheses are standard deviations from the mean.

% Δ : Percentage change between 1978 and 1983.

Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

of the fishery and into other occupations. Geographic mobility, however, was considerably more limited except for temporary outmigration of hired fishing labor to other southern provinces with better employment opportunities (see Panayotou and Panayotou 1985).

Table 6.7 presents a comparative picture of income levels in 1978 and 1983 in another province, Phangnga on the Andaman Sea. The average fishing household income which was 26,500 baht/year in 1978 (compared to 25,600 in Chumphon) fell only slightly to 26,300 baht in 1983 which amounted to a decline of over 40% in real terms. Of the five sampled villages only one had experienced a rise in real fishing incomes while three villages suffered a decline in both real and nominal incomes. Non-fishing incomes have suffered a decline in all five villages averaging 53% in nominal terms or 72% in real terms. As a result, the percentage of total household income derived from fishing rose from 53 to 71%. Total annual household income declined from 50,000 baht in 1978 to 37,000 baht in 1983, a 25% decline in nominal terms or a 54% decline in real terms.

The decline of fishing income in Phangnga was strictly the result of a reduction in fishing employment rather than of the wage rate which rose 21% between 1978 and 1983 (Table 6.8). As shown in Table 6.9 the number of man-days devoted to fishing was reduced by 19% implying either a perverse response to the higher (nominal) fishing wages or the absence of money illusion since real fishing wage dropped by 27%. Non-fishing employment was reduced even more, by 33%, in response to a 32% decline in the nominal non-fishing wage rate. This decline in the non-fishing wage rate was largely due to the slump of the tin mining industry.

The average nominal wage rate from all activities of the sampled households remained unchanged between 1978 and 1983 but in real terms it fell by 40% "inducing" a 25% reduction in labor supply by the household (Table 6.9). As a result of the rise in nominal fishing wages and the steep decline of non-fishing wages, resource rents from fishing rose substantially, from 4 baht per man-day in 1978 to 50 baht in 1983, although in one village they continued to be negative and in another negligible. Again, labor mobility appears to be considerable but the response in Phangnga

Table 6.7. Changes in fishing, non-fishing and total incomes (average per household) between 1978 and 1983 in selected villages in the Muang District, Phangnga Province, Thailand.

	Sample size	Fishing income (baht)[a] 1978	1983	% Δ	Non-fishing (baht)[a] 1978	1983	% Δ	Total income (baht)[a] 1978	1983	% Δ
Punyee										
Village 1	5	13,422 (5,343)[b]	5,557 (6,867)	−58.6	41,536 (58,654)	25,470 (25,219)	−38.6	54,958	31,027	−43.5
Village 2	26	34,432 (29,046)	32,066 (26,652)	−6.9	14,603 (19,427)	12,265 (14,125)	−16.0	49,035	44,331	−9.5
Village 3	17	17,905 (11,965)	23,319 (15,120)	30.2	19,500 (30,666)	6,096 (9,859)	−68.7	37,405	29,415	−21.4
Bangtae										
Village 5	4	16,878 (13,863)	27,926 (17,969)	65.4	20,788 (17,904)	11,430 (22,860)	−45.0	37,666	39,356	4.5
Village 6	21	28,406 (25,348)	26,072 (16,307)	−8.2	34,177 (34,342)	9,767 (23,245)	−71.4	62,583	35,839	−43.0
Total	73	26,448	26,262	−0.7	23,557	10,968	−53.4	50,005	37,230	−25.0

[a]Net of depreciation and opportunity cost of capital.
[b]Figures in parentheses are standard deviations from the mean.

% Δ : Percentage change between 1978 and 1983.
Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

Table 6.8. Changes in fishing, non-fishing and total wage rate and resource rents (average per household) between 1978 and 1983, in selected villages in Muang District of Phangnga Province, Thailand.

	Sample size	Fishing 1978	Fishing 1983	% Δ	Non-fishing 1978	Non-fishing 1983	% Δ	Wage rate (baht/man-day) 1978	1983	% Δ	"Rents" (baht/man-day) 1978	1983	% Δ
Punyee													
Village 1	5	71	69	−2.8	70	64	−8.5	71	65	−8.5	1	5	400
		(27)	(33)		(56)	(29)							
Village 2	26	82	109	32.9	56	48	−14.3	72	81	12.5	26	61	188
		(57)	(71)		(130)	(138)							
Village 3	17	75	104	38.7	89	43	−51.7	82	61	−26.0	−14	61	536
		(37)	(45)		(97)	(84)							
Bangtae													
Village 5	4	71	107	50.7	150	119	−20.6	100	110	10.0	−79	−12	85
		(85)	(7.2)		(98)	(45)							
Village 6	21	117	110	−6.0	112	79	−29.5	114	100	−12.3	5	31	520
		(47)	(36)		(115)	(60)							
Total	73	88	107	21.6	84	57	−32.1	86	85	−1.2	4	50	4,900

Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

Table 6.9. Changes in fishing, non-fishing and total employment per household between 1978 and 1983, selected villages, Phangnga Province, Thailand.

Subdistrict/ village	Sample size	Fishing employment (man-days) 1978	1983	% Δ	Non-fishing employment (man-days) 1978	1983	% Δ	Total employment (man-days) 1978	1983	% Δ
Punyee										
Village 1	5	189	81	−57.1	590	399	−32.3	779	480	−38.4
		(57)[a]	(86)		(721)	(363)				
Village 2	26	418	295	−29.4	263	254	−3.5	681	549	−19.4
		(453)	(288)		(377)	(258)				
Village 3	17	239		−6.5	218	142	−35.0	457	485	6.1
		(150)	(116)		(318)	(335)				
Bangtae										
Village 5	4	239	261	+9.2	139	96	−30.9	378	357	−5.6
		(248)	(184)		(102)	(191)				
Village 6	21	243	236	−3.1	305	123	−59.8	548	359	−34.5
		(151)	(149)		(316)	(224)				
Total	73	301	245	−18.6	280	191	−33.2	581	436	−25.0

[a]Figures in parentheses are standard deviations from the mean.

% Δ : Percentage change between 1978 and 1983.
Source : Panayotou and Panayotou (1985) based on the 1978 and 1983 surveys.

appears to be more to changes in real rather than nominal incomes. It is also of interest to note that the large disparity of 18,400 baht between Chumphon and Phangnga in 1978 was reduced to 2,400 baht in 1983.

In conclusion, the rents from fishing were dissipated in Chumphon and regenerated in Phangnga not as much because of the change in the profitability of fishing (which in real terms declined in both locations) as from the change in the profitability of non-fishing alternatives. This contrasts with the large-scale trawl fishery where rents were dissipated mainly as a result of rising fuel costs and depleted resource stocks and were regenerated through technological adjustments and expansion to new fishing grounds farther offshore. As we have seen earlier, small-scale fishermen lack access to low-cost credit to upgrade their technology and, hence are confined to the relatively fixed coastal fishing grounds. As a result, their incomes depend on the competition over these grounds and the availability and profitability of non-fishing alternatives in the surrounding area. Unlike the large-scale fishermen whose incomes rise in direct proportion with the rents from fishing, small-scale fishermen's total income may decline with a rise in rents if the latter is more the result of a decline in the profitability of their non-fishing employment rather than of an increase in the profitability of fishing. Thus, rents and poverty are compatible, especially for small-scale fishermen whose opportunity costs are very low. A further decline may create rents from fishing but these are rents of poverty not wealth; what should matter is the total real income not nominal increases of one source "at the expense" of another.

CHAPTER 7

ECONOMIC ANALYSIS

To recapitulate, the calculation of revenues, cost and returns in Chapters 3 and 4 yielded the following results: (1) the returns to fishing vary widely, among both large- and small-scale fishermen, depending, in the first case, on size of vessel and type of gear and, in the second, on location and type of gear; (2) the large-scale fishery is, on the average, far more profitable because of its resilience to changing economic and biological conditions; (3) among the different vessel-classes the large otter trawlers and small pair trawlers, being the most resilient groups, continued to be profitable while the numerous small otter trawlers steadily lost ground to the point of negative returns in 1977; and (4) small-scale fishermen combine a variety of fishing and non-fishing occupations to earn, on the average, a subsistence income, somewhat lower than the average rural income in the country.

The economic theory of open-access resource exploitation (reviewed in Chapter 4) predicts that: (1) in the absence of barriers to entry, resource rents (revenues in excess of the opportunity cost of fishing inputs) would attract new entrants; and (2) entry, under static biological and economic conditions, tends to reduce and in the long run eliminate these rents allowing labor and capital to earn no more than their opportunity costs. As a corollary, fishermen operating in regulated fisheries are expected to earn some rents if the latter are not taxed by the government. To what extent is the described situation of the Thai fisheries in agreement with these predictions? Does either the absence of rents in the small-scale fishery (despite the regulation of access to coastal waters) or the long-term persistence of rents in the large-scale fishery (despite the open access status of the non-coastal resources) constitute a refutation of economic theory? Are not 20 years of rapid growth of the industry sufficient to deplete rents? Should not one at least observe a gradual decline in these rents over time as effort expands?

The first point to be made is that the available information of a few points in time, some under exceptional circumstances, does not suffice to answer these questions conclusively. Second, the tumultuous years under study (1960-1982) hardly fit the static world of unchanging economic and biological conditions. Environmental parameters have been altered by rising pollution levels in the Gulf of Thailand while fish resources expanded through a gradual shift to fishing grounds outside the Thai waters. Fuel prices and labor costs have been rising dramatically inducing discrete changes in technology. The catch per unit of effort may have been falling as a result of incessant entry but fish prices have been rising under domestic population pressures and strong foreign demand. These multiple shifts may have overshadowed any tendency towards dissipation of rents due to entry as new rents were created (or old ones dissipated) as a result of these developments.

For the trawl fishery, we have already, in Chapter 5, tested and failed to reject the first prediction of the theory that rents would induce entry and losses exit by comparing the time profile of registered vessels in each class given in Table 5.4 against that of the rent situation depicted in Table 5.6. Only in the case of small trawlers did we observe perverse behavior, entry following losses (e.g., otter trawlers during 1975-1977) and exit following rents (e.g., pair trawlers 1976-1979).

Unfortunately, there is no nationwide information on entry into and exit from the small-scale fishery. However, based on our survey in two provinces we have concluded that there was considerable mobility between fishing and non-fishing occupations in response to income differentials (profits and losses), as long as no change of location was involved. Geographic mobility was rather limited. There was considerable outmigration to other districts and provinces where seasonal fishing was more profitable but on a temporary basis (3-4 months/year). Permanent outmigration or immigration was more in response to social rather than economic factors, e.g., marriage and education.

The depletion of rents in the coastal fishery of Chumphon and their persistence under open-access exploitation are not at odds with the theory. While access to coastal resources is 'regulated' (for instance, trawling within 3 km from the shore is prohibited), rules and regulations have not been enforced and where they were, their effect was simply to create a new group of rent-claimants (the local enforcement officials) and hasten the dissipation of rents. Despite their mobility the trawlers did not abandon the coastal waters altogether for a number of reasons: (a) the coast is rich in shrimp and other high-value species; (b) coastal fishing by comparison with distant-water operations involves lower traveling and operating costs; and (c) the coast provides supplementary fishing grounds for utilization of excess fishing capacity during seasons when offshore fishing is highly risky or simply not possible. The escalation of fuel prices and shortages coupled with the increased abundance of certain coastal species, especially crustaceans, often induces increasing coastal activity by trawlers as is evidenced by the increasing frequency of conflicts with coastal fishermen (see Bangkok Post 1979a, 1979b).

One of the anonymous reviewers of the present study commented that it has been observed that while the *Penaeus* stocks have decreased in abundance in the Gulf of Thailand, *Metapenaeus* stocks have increased and that the baby trawlers and push nets have benefited to some extent.

Unable to extend their fishing range and expand 'seaward', and with their limited fishing grounds being encroached by trawlers, the coastal fishermen often seek supplementary sources of income 'landward' which, however, are hard to obtain without initial capital. Inability to convert fixed fishing assets to non-fishing capital, as well as educational or emotional attachment to the fishery often result in short-run deviations of incomes from opportunity costs. What appears as a continual drift of fishing incomes is a reflection of declining opportunity costs due to increasing unemployment and landlessness outside the fishery. Unlike the legendary open-access fishermen who regard resource rents as part of the remuneration for their productive services, it may be said that coastal fishermen in Thailand came to regard everything they might get out of the fishery as 'rent'.

In contrast, the large-scale fishery, because of its mobility, even to areas far outside Thai coastal waters, and ability to continuously upgrade its technology, managed to maintain and even expand its rent earning position despite the incessant entry into the fishery. The economic theory of rent dissipation in open-access resource exploitation holds over a well-defined, limited resource and under static conditions. In the case of the Thai large-scale fishery, technological progress and the opening of new fishing grounds proceeded fast enough to more than offset the effect of entry on resource rents. As coastal fishing grounds became increasingly crowded, catch declined, and cost rose, the large-scale fishery was able to upgrade its technology thus lowering the travel and operation cost of distant-water fishing so that new rents were created farther and farther away from the coast.

With ample rents for reinvestment (not to mention the easy credit) and with the government unwilling or unable to intervene, the Thai trawling fleet moved into both the open sea and the lightly fished and lightly guarded fishing grounds of neighboring countries establishing, in retrospect, historical fishing rights over much of the Bay of Bengal and the South China Sea. Given the extent of these new fishing grounds and the absence of competing large-scale fisheries (with the possible exception of Taiwan), the continuing entry on the part of Thailand alone is not likely to dissipate the rents in distant-water fishing as long as technological progress continues to keep costs down and growing demand maintains the upward trend of fish prices.

The vulnerability of these rents to general economic conditions, as well as the fishing industry's ability to make the necessary technological adjustments to cope with them, has been aptly demonstrated during the energy crisis of the early 1970s. While after a 138% rise in fuel prices between July 1973 and February 1974, virtually all vessel groups (except for the very large trawlers) incurred losses or just broke even, three years later, in 1977, virtually all (with the exception of small-scale trawlers) were making substantial profits despite a new fuel price increase of 13% in March 1977.

In conclusion, it could be said that the inshore fishery, as far as the small-scale fishermen and small and medium otter trawlers (less than 18 m) are concerned, is overexploited in the economic sense of rent dissipation even if temporary rents are occasionally recreated by the depression of non-fishing activities (e.g., tin mining) in remote fishing communities. This eventuality, however, is not yet in sight for larger vessels with an ever-expanding fishing range that already stretches from the Thai coast though the Andaman and South China Seas to the coasts of India, China and Indonesia. The large-scale fishery will continue to enjoy healthy rents regardless of the economic conditions in the rest of the economy as long as neighboring countries lack the capability to enforce respect of their Exclusive Economic Zones (EEZs). Fish and fuel price fluctuations may affect temporarily the profitability of the industry but not its long-term viability. What threatens the long-term viability of the fishing industry in Thailand, as we know it, is the increasing capability of neighboring countries to both police and exploit their EEZs and Thailand's growing concern over its relations with its neighbors who resent the encroachment on their fishing grounds and its international image. Unless Thailand succeeds in negotiating increasing numbers of joint ventures and other long-term arrangements with other countries, the Thai fleet sooner or later will have to retreat into Thai waters, and its long-term viability will be determined by the state of the Thai fishery resources.

CHAPTER 8

THE STATE OF THE RESOURCES

Before considering the prospects of the fishery (Chapter 9), it is necessary to examine the state of the Thai fishery resources on which the future of the industry inevitably depends. A given fish stock is said to be biologically overfished (underfished) if the annual catch exceeds (falls short of) the maximum sustainable yield (MSY) or maximum net natural growth. The latter depends on environmental conditions, such as food availability, temperature, salinity, currents, as well as the biological traits of and interaction among the species of which the stock is composed. While economic underexploitation (operation of a fishery below the level that maximizes rents) precludes biological overfishing, rent dissipation does not necessarily imply biological overfishing nor does the presence of rents preclude it (Fig. 5.1). It is, therefore, of interest to examine whether the fishery resources have been optimally exploited in both the biological and economic sense.

Earlier biological evidence (SCS 1973a) indicates that the inshore (< 50 m deep) zone of the Gulf of Thailand has been overfished since 1966-1967 with the 1970s catch being 605,000 t compared to an MSY of only 447,000 t. The reverse was true of the offshore zone (50-500 m deep) where only 49,000 t were caught out of an MSY of 164,000 t. The inshore catches of the early 1970s did not involve biological overfishing by comparison with the new estimates of MSY. However, by 1973 the inshore catch reached 803,000 t which is indicative of overfishing not only when compared to the MSY but also when the declining catches in subsequent years are considered (although economic factors such as the oil crisis are at least partly responsible for the fall in catches during 1974-1975). Further, it has been estimated that the 1972 level of 6.7×10^6 standard (research vessel) fishing hours would have sufficed to catch the MSY while actual fishing effort exceeded 8.5×10^6 hours in 1973 and continued to exceed 7.5×10^6 hours in 1975 (Table 8.1). The SCS (1978b) results have been corroborated by further re-estimations (Boonyubol and Hongskul 1976 and 1977; Pauly 1979; Boonyubol 1979) the most recent of which employed 1961-1977 data to arrive at an MSY of 685,684 t per annum and a corresponding optimal effort of 6.4×10^6 standard fishing hours. The demersal catch in 1977 reached 875,360 t with a fishing effort of 9.6×10^6 standard hours.

As for the offshore resources of the Gulf, the earlier (SCS 1973a) result that they are biologically underfished has been corroborated by the newer SCS (1978b) study as only 28,000 t were caught in 1972 and 61,000 t in 1975 compared to the estimated MSY of 127,000 t (Table 8.1) although the latter estimate is considerably below the 1973 estimate of 164,000 t. Finally, in the Straits of Malacca (including the relevant portions of the Andaman Sea), the combined catch of about 428,000 t was judged approximately equal to the estimated MSY of the area as a whole. A similar study (SCS 1973b) of the pelagic resources inferred from fragmentary evidence that some pelagic species such as the Indo-Pacific mackerel were underfished at the time.

Three subsequent studies (SCS 1976, 1978a, 1978b) based on longer time series of catch and effort by commercial and research vessels, with appropriate adjustments for catches outside the Thai waters, have produced a more complete and, hopefully, more accurate picture of the Thai fish resources. Their results, with some ramifications, are summarized in Table 8.1. The demersal fish resources of Thailand extending over an area of 350,000 km^2 are found to total a virgin biomass (in the absence of fishing) of 1,810,000 t with a mean density of 5.2 t/km^2. More than two-thirds of this biomass is contributed by the 179,000 km^2 of the inshore (< 50 m deep) zone of the

Table 8.1. The demersal and pelagic fish resources of Thailand.

	Demersal fish resources				Pelagic fish resources	
	Gulf of Thailand		Andaman		Gulf of	Andaman
	< 50 m deep	> 50 m deep	Sea	Total	Thailand	Sea
Area (km^2)	179,000	127,000	44,000	350,000	—	—
Mean density (t/km^2)	7.43	2.09	4.9	5.17	—	—
Virgin biomass, B_o, (t)	1,330,000	265,000[b]	415,000[b]	1,810,000	—	—
Maximum sustainable yield, MSY (t)	641,000	127,000	200,000	968,000	365,000	71,000
Effort for MSY (hr)[a]	6,667,000	1,320,000[c]	1,300,000	9,287,000	—	—
Peak catch						
— Year (up to 1975)	1973	1972	1969	1973	1977	1973
— Catch (t)	803,000	28,000	216,000	1,020,000	476,058	56,965
— Effort (hr)	8,563,000	204,000	1,134,000	—	—	—
Peak effort						
— Year	1973	—	1970	—	—	—
— Catch (t)	803,000	—	183,000	—	—	—
— Effort (hr)	8,563,000	—	1,887,000	—	—	—

[a]In standard research-vessel fishing hours unless otherwise stated.
[b]Calculated from the corresponding MSY by assuming the same relationship as in the Gulf of Thailand (50 m deep, i.e., MSY/B_o = 0.482).
[c]Calculated from the corresponding MSY by assuming the same relationship between MSY and needed effort as in the Gulf of Thailand (< 50 m deep, i.e., 96.2 kg/hr).

Sources: SCS (1976, 1978a); Menasveta et al. (1973) and Bahtia et al. (1983) for the pelagic resources of the Gulf of Thailand and the Andaman Sea, respectively.

Gulf which has mean density of 7.4 t of fish/km^2 compared to 2.1 t/km^2 of the offshore zone, and 4.9 t/km^2 of the Andaman Coast.

In terms of MSY, these studies estimated that 641,000 t could be caught on a sustained basis from the inshore zone of the Gulf, 127,000 t from the offshore zone and about 200,000 t from the Andaman Sea. Thus, earlier studies may have underestimated the potential catch from the inshore zone. The SCS (1978b) MSY estimate of 200,000 t for the demersal resources of the Thai portion of the Andaman Sea indicates that some overfishing incurred as early as 1969 when 216,000 t were landed. In contrast, the pelagic resources as appraised by SCS (1976) and SCS (1978a) continue to be underexploited especially those of the Gulf's East Coast and of the Andaman Sea (see Table 8.1).

Related indications of the advancing depletion of the demersal resources in the Gulf of Thailand have been the rapidity with which the catch per unit of effort (CPUE) fell and the composition of catch changed since the introduction of trawlers. Table 8.2 and Fig. 8.1 show that the catch per hour of the research vessel Pramong II, operating in the Gulf of Thailand fell steeply during the 1961-1966 period of massive entry of trawlers (interval B in the figure). It levelled off when entry was halted and fishing into international waters began during 1966-1969 (interval C) and declined sharply again during the rapid entry of 1969-1972 (interval D). The exit of vessels following the 1973-1974 oil crisis halted further declines in CPUE until 1977. The precipitous rise in the number of trawlers in 1976 and 1977 precipitated no more declines in CPUE as the fleet did not exceed its peak 1973 size until some time in mid-1977. Moreover, at least some of the new vessels, especially the larger ones, were directed towards distant-water fishing grounds. The catch per hour of the research vessel in 1977 was only 16% of its 1961 volume (obtained with the use of a commercial trawler), and in 1982 dropped to 13% (see Table 8.2).

A marked change in the composition of catch towards a greater percentage of trash fish and a smaller percentage of edible fish as well as larger percentage of cephalopods (squid, cuttlefish and octopus) among the latter may be indicative of past (and present) overfishing of the edible species if

Table 8.2. Demersal catch, catch per unit of effort and comparison of proportion of trash fish between commercial fleet and research vessel (Pramong II), Gulf of Thailand, 1960-1982.

Year	Commercial catch Total (t)	Commercial catch Trash fish (%)	Pramong II research vessel Average catch (kg/hr)	Pramong II research vessel Edible fish (%)	Pramong II research vessel Trash fish (%)
1960	63,700	—	n.a.	n.a.	n.a.
1961	123,100	14.1[a]	297.8	n.a.	n.a.
1963	198,190	27.6	231.6 (256.0)	38.34	61.66
1964	320,614	43.1	225.6	n.a.	n.a.
1965	343,140	35.0	179.2	n.a.	n.a.
1966	363,842	33.2	131.8	70.11	29.89
1967	437,424	30.7	115.1	79.76	20.24
1968	513,380	37.0	105.9	73.47	26.53
1969	518,650	47.2	102.7	85.69	14.31
1970	530,890	44.2	97.4	74.54	25.46
1971	608,580	57.0	66.3	76.92	23.08
1972	737,949	55.3	63.1	57.05	42.95
1973	830,873	53.6	51.9	65.90	34.10
1974	604,853	55.1	57.7	71.75	28.25
1975	752,107	51.3	47.0	70.43	29.57
1976	787,914	44.7	57.2	63.46	36.54
1977	848,103	47.0	47.3	70.61	29.39
1978	814,054	49.6	52.2	70.00	30.00
1979	832,392	49.7	51.6	66.47	33.53
1980	798,035	54.6	47.5	67.04	32.96
1981	895,092	51.1	39.8[b]	n.a.	n.a.
1982	1,000,127	48.3	39.0[b]	n.a.	n.a.

n.a. = not available.

[a]For 1962.

[b]Preliminary data.

Source : Boonyubol and Pramokchutima (1979) and Phasuk (1978). The proportion of trash fish in the commercial catch was obtained by dividing the commercial catch by the sum of quantities of fish used for fishmeal, fertilizer, fish sauce and 'other' as recorded in the Fisheries Record of Thailand, Table 2.

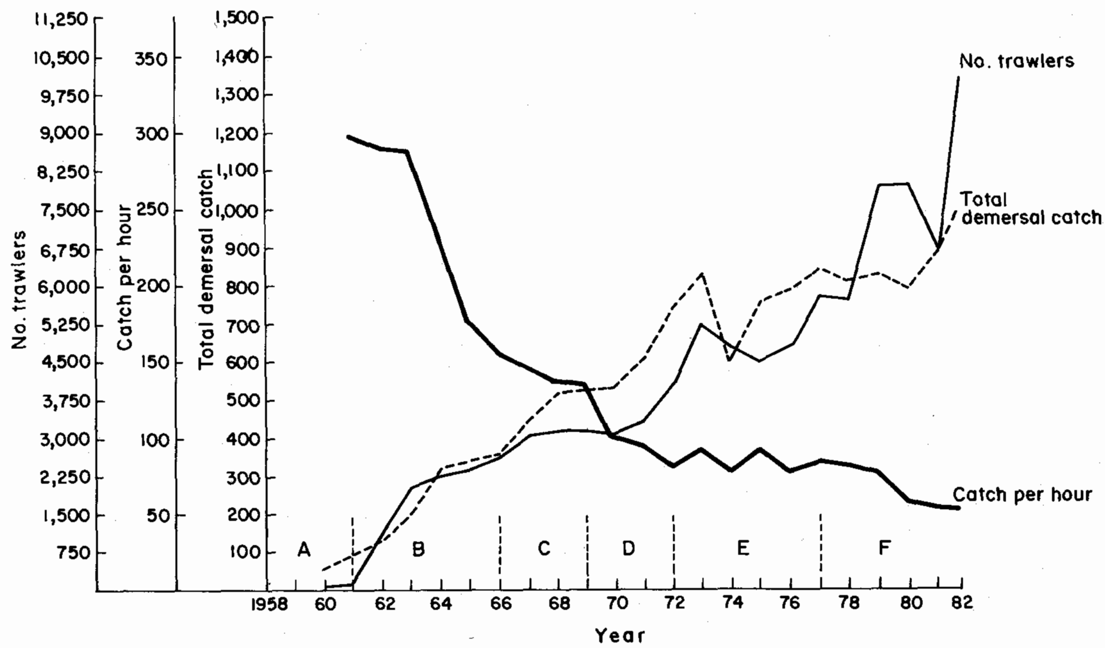

Fig. 8.1. Time trends in the number of trawlers, catch per hour and total demersal catch in the Gulf of Thailand, 1958-1982.

not of the total biomass as well. The results of the research vessel surveys underestimate the proportion of trash fish in the total catch and distort its time trend because of the larger and fixed (4 cm) cod-end mesh size of the trawler net used by the research vessel compared to the variable, less than 2.5 cm mesh size of the commercial trawlers. The latter is sensitive to economic parameters such as the prices of fish and fuel and hence the proportion of trash fish (consisting of the juveniles of edible fish and smaller non-edible species) may change independently of biological parameters and in turn effect a change in them. In 1977, the proportion of trash fish in the research vessel catch was only 29% compared to 47% for the commercial fleet as a whole (Table 8.2) and 63% for the commercial trawlers (see Table 5.3).

Table 8.2 presents conflicting time trends in the proportion of trash fish in the total catch from research and commercial vessels (due partly to different definitions of trash fish), but, on balance, the evidence suggests an increasing trend up to 1974 and a rather ambiguous trend thereafter. The most pronounced changes among vessel classes were the decrease in the proportion of trash fish among large otter board trawlers from 71% in 1974 to 60% in 1977 and the increase for the small pair trawlers from 56% in 1974 to 87% in 1977 (see Table 5.5 and DOF 1979a). Incidentally, these two classes fared best in terms of return during 1977 (see Table 5.6) for different but not dissimilar reasons. Both were exploiting a new resource: the former, new fishing grounds outside the Thai waters; the latter, the booming stocks of squid and cuttlefish. It is, however, difficult to ascertain to what extent the changes in the composition of the catch were the result of changes in the composition of the stocks due to overfishing and/or expansion into new fishing grounds and to what extent they were the result of a deliberate choice by fishermen to discard more (or less) trash fish at sea.

The latter development is part of an ongoing process of changing relative abundance of individual fish populations within the multispecies fisheries of the Gulf of Thailand under the ecological impact of small meshes and intense fishing effort. Marr et al. (1976) reported that striking changes occurred between 1963 and 1972 in the number and identity of the dominant species or groups of species in the catch from the Gulf of Thailand: catfish, rays and slipmouth fell from 9.21, 12.66 and 34.41% of the catch, respectively to 1.51, 0.94 and 6.60%, while jacks, lizard fish and threadfin bream rose from 2.60, 1.56 and 4.44%, respectively to 7.02, 7.14 and 7.86%. Even more spectacular was the increase in the percentage of squid from less than 1% in 1963 to over 27% in 1972 (Marr et al. 1976). An even more dramatic upsurge in the stocks of squid and other cephalopods has been observed which resulted in an almost doubling of their catch between 1976 and 1977 (DOF, 1977). Such developments not only are indicative of overfishing of the predators and/or competitors of the 'booming' species, but may also render overly optimistic the estimates of MSY based on 'overall biomass/overall effort' data which ignore the between-species interactions as Pauly (1979) convincingly argued on the basis of evidence from the Gulf of Thailand.

While estimates of MSY based on aggregate biomass are less than satisfactory in the case of multispecies tropical fisheries, a more appropriate model is lacking for estimating the potential and evaluating the current state of the resources. Pauly (1979) and Panayotou (1982) proposed some alternatives which are not yet sufficiently operational to be used in this study. We will instead, use the conventional approach of estimating MSY for the total biomass of the Gulf of Thailand. This approach admittedly ignores interspecies interaction. This is to update earlier estimates of MSY in the light of more recent observations.

A Schaefer-type sustainable yield function was used to obtain estimates of the MSY for two different mesh sizes, 2.5 cm and 4 cm, using 1963-1982 data. Two alternative mesh sizes are used to account for the difference in mesh size between the commercial fleet (2.5 cm) and the research vessel (4 cm), since the catch data come from the commercial fleet while the catch per unit of effort data come from the research vessel. The estimated equation is a parabolic function of the form:

$$Y = aE - bE^2 \qquad \ldots (1)$$

where Y is catch and E is standardized fishing effort, while a and b are parameters to be estimated.

Estimations for the two mesh sizes were derived by first dividing equation (1) by effort to obtain the catch per unit of effort (CPUE) as a function of effort and using the CPUE of the research vessel to standardize commercial vessel effort. We then regressed CPUE on standardized effort to obtain estimates of the parameters a and b. The following results were obtained for mesh sizes of 4 cm and 2.5 cm, respectively.

$$Y_{4\ cm} = \underset{(4.48)}{77.1\ E} - \underset{(-2.30)}{1.868\ E^2} \qquad \ldots (2)$$

$\bar{R}^2 = 0.95$, $F = 382$, $D.W. = 1.66$, $N = 20$

$$Y_{2.5\ cm} = \underset{(10.55)}{122.4\ E} - \underset{(-3.89)}{3.914\ E^2} \qquad \ldots (3)$$

$\bar{R}^2 = 0.96$, $F = 3.99$, $D.W. = 2.64$, $df = 20$

where $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom, F is the F-ratio, D.W. is the Durbin-Watson statistic for autocorrelation, and df are degrees of freedom. The figures in parentheses are t-ratios. Based on these statistics the fit of the model is very good: one variable, E, and its square explain over 95% of the annual variation in the catch. All coefficients are statistically significant at the 0.01 level and the D.W. statistic indicates absence of autocorrelation. Based on these estimates we have calculated the maximum sustainable yield and the corresponding level of effort using equations (6) and (5) of our theoretical framework (Chapter 4), i.e., $MSY = a^2/4b$ and $E_{MSY} = a/2b$, where a and b are the coefficients of the estimated sustainable yield function above. The results are reported and compared with the 1982 levels of catch and effort in Table 8.3.

The maximum sustainable yield of the demersal fishery of the Gulf of Thailand is found to range between 796,000 and 958,000 t depending on the mesh size used. The MSY level of effort ranges between 15.7 and 20.6 x 10^6 standard hours, depending on the mesh size used. The actual catch and effort in 1982 were, respectively, 1,000 t and between 19.2 and 25.6 x 10^6 hours (depending on mesh size). Therefore, the demersal fishery resources of the Gulf of Thailand do appear to be biologically overexploited in the sense of catch and/or effort exceeding significantly their MSY levels.

Table 8.3. The maximum sustainable yield (MSY) of the demersal fishery of the Gulf of Thailand and corresponding effort at different mesh sizes based on 1963-1982 data and compared to the 1982 situation.

Mesh size	Maximum sustainable yield Catch ($t \times 10^3$)	Maximum sustainable yield Effort ($St\ hr \times 10^6$)[a]	1982 situation Catch ($t \times 10^3$)	1982 situation Effort ($St\ hr \times 10^6$)[a]
2.5 cm	958	15.7	1,000	19.2
4.0 cm	796	20.6	1,000	25.6

[a]Million standard hours.

This result corroborates the findings of earlier studies which, as we have seen, have found that the Gulf of Thailand has been overexploited since 1972 when the catch was 738,000 t compared with the estimated MSY of 641,000 t. The catch today is 36% higher than in 1972 but also our estimate of MSY is almost 50% higher than earlier estimates. This upward revision of MSY which has been done repeatedly as new data became available, casts doubts on the reliability of MSY estimates and the usefulness of the concept of MSY for fisheries management. This is an area which calls for further research to arrive at a more suitable model for multispecies fisheries with interspecies interaction.

The discussion thus far has focused on the demersal resources. However, the pelagic resources, which contribute about 20% of the catch, suffer from more or less the same level of overexploitation, at least in the Gulf. The rapid increase of the pelagic catch during 1971-1977 and its steady decline thereafter (Table 5.8) despite the continued rise in effective effort suggests that the pelagic resources of the Gulf of Thailand are overexploited, and this could be due to a large extent to their vulnerability to fish attraction devices such as the luring purse seines. In contrast, the pelagic fishery resources of the Andaman Sea are believed to be underexploited (Bhatia et al. 1983) although the pelagic catch shows a downward trend as well as wide fluctuations. Menasveta et al. (1973) has estimated the maximum sustainable yield (MSY) of the pelagic resources of the Gulf of Thailand to be 365,000 t/year compared to a 1977 catch of 476,000 t and a 1980 catch of 286,000 t. Bhatia et al. (1983) estimated the MSY of pelagic fish and squid of the Andaman Sea at 71,000 t/year compared to a 1973 catch of 57,000 t and a 1981 catch of only 14,000 t (see Table 8.1).

Since the Thai trawl fishery is not confined to the Gulf of Thailand (and the Andaman Sea) but operates in the Bay of Bengal and the South China Sea, among other areas, it is of interest to present a brief account of the state of the resources in these areas. Tables 8.4, 8.5 and 8.6 present rough estimates of the density, standing stock and mid-1970s landings of both demand and pelagic stocks in the Bay of Bengal and the South China Sea by area including the Gulf of Thailand. Again, these figures are likely to be underestimates and should be regarded with caution. They give, however, a rough picture of the relative abundance of the fish stocks in the areas where much of the Thai fishing industry has been operating since the early 1970s and continues to operate today.

Table 8.4. Fish stocks off Burma and in the Bay of Bengal (above 20°N).

Subarea	Area (km^2 x 10^3)	Density (t/km^2)	Standing stock (t x 10^3)	Landing (t x 10^3) Potential	Present	Index of fishery expansion
Burma Coast	250					
Pelagic		2.22	555	222	120	1.85
Demersal		1.70	425	625	350	1.78
Bay of Bengal	105					
Pelagic		2.22	233	93	60	1.55
Demersal		1.70	178	260	150	1.73

Source : Hunting Technical Services Limited (1974).

Table 8.5. Demersal fish stocks in the South China Sea.

Subarea	Area[a] (km^2 x 10^3)	Density (t/km^2)	Standing stock (t x 10^3) Maximum	Optimum	Potential catch
Northern Sunda Shelf	87	1.75	152	76	114
Central Sunda Shelf	276	1.78	491	245	367
Gulf of Thailand	304	2.82	952	476	714
Southern Sunda Shelf	330	1.17	386	193	290
Eastern Sunda Shelf	232	2.54	589	295	442
Kalimantan Strait	151	0.89	134	77	115
Total potential catch					2,042
Present catch					1,308
Index of fishery expansion					1.56

[a]Waters < 200-m deep.

Source : Shindo (1973).

Table 8.6. Pelagic fish stocks in the South China Sea.

Subarea	Area ($km^2 \times 10^3$)	Density (t/km^2)	Standing stock ($t \times 10^3$)	Catch ($t \times 10^3$) Potential	Present	Index of fishery expansion
Off Mekong Delta	236	5.86	1.383	553	188	2.94
Gulf of Thailand	304	3.41	1.037	415	262	1.59
East coast of West Malaysia	100	3.26	327	130	32	4.06
West coast of West Malaysia	335	2.22	744	293	124	2.40
Sarawak Bay	288	4.56	1.313	525	295	3.22
Kalimantan Strait	258	3.26	841	336	295	3.22
East Sarawak and Sabah	98	2.28	223	89	295	3.22
Central Basin	1.418	0.50	709	284	—	—
Total potential catch				2,630		
Present catch					1,491	
Index of fishery expansion						1.76

Source : Huntings Technical Services Limited (1974).

CHAPTER 9

OPTIMAL RESOURCE USE

Having already described the economics of the Thai fishing industry (Chapters 5-7) and the state of Thai fishery resources (Chapter 8), it is appropriate now to combine the two within an optimizing framework to determine the optimum resource use which should be the objective of fisheries management. Such an optimizing framework was provided in Chapter 4. The optimal resource use was postulated to be attained at the level of catch and effort that maximize the (sustainable) economic yield (MEY) or rents from the fishery, that is, the excess of revenues over costs. Of course it is always possible to increase current economic rents (profits) beyond this level but, in the same way that catch above MSY cannot be sustained for long, profits above MEY cannot be sustained for long. Thus, abstracting from adjustment and enforcement costs which could be substantial, fisheries management should aim at the attainment of MEY level of effort as it can be shown to be superior to all other levels of effort, including MSY and open access, in terms of returns to a resource in limited supply. The purpose of this chapter is to determine MEY for the Gulf of Thailand and the corresponding levels of effort, catch, revenues, costs and profits and compare them to those prevailing under open access and MSY management. Following our theoretical framework we do this estimation both under fixed and variable price assumptions.

Fixed Price Model

Recall that the level of effort yielding the maximum economic yield, E_{MEY} was given in equation (10) of Chapter 4 as:

$$E_{MEY} = \frac{Pa - c}{2bP}$$

where p is the price of fish per kilogram, c is the cost per unit of effort and a and b are the parameters of the sustainable yield function. The 1982 values for p and c have been estimated in Chapter 5: p = 6.2 baht/kg or 6,200 baht per tonne and c = 183 baht per standard fishing hour (for mesh size of 4 cm). The values of the parameters a and b were estimated in Chapter 8: a = 77.1 and b = 1.868 (for mesh size of 4 cm). A note of caution is in order. The validity of the results which follow rest squarely on the robustness of these parameters and the validity of the surplus production model (on which they are based) for multispecies fisheries. Substituting these values into the equation above we obtain: $E_{MEY} = 12.8 \times 10^6$ standard hours with a mesh size of 4 cm. The corresponding catch is obtained by substituting the value of E_{MEY} in equation (3) of Chapter 4 to obtain:

$$Y_{MEY} = aE_{MEY} - bE^2_{MEY} = (77.1)\ (12.8) - (1.868)\ (12.8)^2 = 681{,}000\ \text{t} \qquad \ldots (1)$$

To obtain MEY itself, that is maximum total profit or rents, we apply equation (11) (Chapter 4) which gives MEY as a function of E_{MEY}:

$$MEY = aE_{MEY} - bE_{MEY}^2 - cE_{MEY} \qquad \ldots (2)$$

$$= 6{,}200\,(77.1)\,(12.8) - (1.868)\,(12.8)^2 - (183)\,(12.8)$$

$$= 1{,}880 \text{ baht x } 10^6$$

These results are compared in Table 9.1 with the corresponding actual 1982 figures, and the estimated MSY and open-access figures. The MEY level of effort is about one-half the actual 1982 level and 62% of the MSY level. The MEY catch is 68% of the actual catch and 86% of the MSY catch. Profits are, as expected, highest at MEY amounting to 1,880 million baht or 24% higher than actual and 61% higher than at MSY. According to these findings, MEY management will earn the industry and the country an additional 365 million baht in profits, gross of management costs. If the fishery is left unmanaged, it is expected to reach a bionomic equilibrium (i.e., zero profits) at 25.5 x 10^6 standard hours with a sustainable catch of 752,000 t, and society would lose 1,880 million baht in resource rents.

Table 9.1. Comparison of catch, revenues, costs and profits at different levels of effort based on a fixed price model, 4-cm mesh size and 1963-1982 data, Gulf of Thailand.

	Effort (St hr x 10^6)[a]	Catch (t x 10^3)	Revenues (฿ x 10^6)	Costs (฿ x 10^6)	Profits (฿ x 10^6)
Actual (1982)	25.6	1,000	6,200	4,685	1,515
MSY	20.6	796	4,935	3,770	1,165
MEY	12.8	681	4,222	2,342	1,880
Bionomic equilibrium	25.5	752	4,662	4,662	0

[a]Million standard hours.

Based on 1982 data, the industry appears to put forth the bionomic equilibrium (BE) level of effort but the catch is higher than the BE level of catch by 250,000 t and substantial profits are earned, which implies that the fishery is operating on a short-run production curve (Fig. 9.1); that is, the current catch and profits are derived from liquidation of part of the stock and, therefore, they are not sustainable over the long run. Whether this is actually the case remains to be seen and depends on: (a) the assumptions of 4 cm mesh size and fixed price and (b) the validity of the aggregate biomass model for multispecies fisheries.

Let us first investigate the sensitivity of our results to the specific mesh size we have assumed, which is the one used by the research vessel rather than the actual mesh size of the commercial fleet. We follow the same procedure to obtain E_{MEY}, Y_{MEY} and MEY for the commercial mesh size of 2.5 cm. The parameters used are: P = 6,200 baht per tonne, c = 244 baht per standard fishing hour (adjusted for 2.5 cm mesh size), a = 122.4 and b = 3.914 (for the latter two parameters see equation (3), Chapter 8). The values obtained are E_{MEY} = 10.4 x 10^6 standard hours, Y_{MEY} = 847,000 t and MEY = 2,713 million baht. The results are compared with the corresponding actual 1982 figures, and the estimated MSY and open access figures in Table 9.2. Again, the MEY level of effort is about 50% of the actual level of effort in 1982 which is only 10% lower than the open-access equilibrium level where all profits are dissipated. Catch at MEY is only 15% lower than the actual catch but profits are 80% higher. By comparison with the MSY, the MEY catch is 12% lower and the corresponding effort 34% lower, and profits 29% higher. If the fishery is left unmanaged, it is expected to reach a bionomic equilibrium at about the same sustainable catch as MEY but with

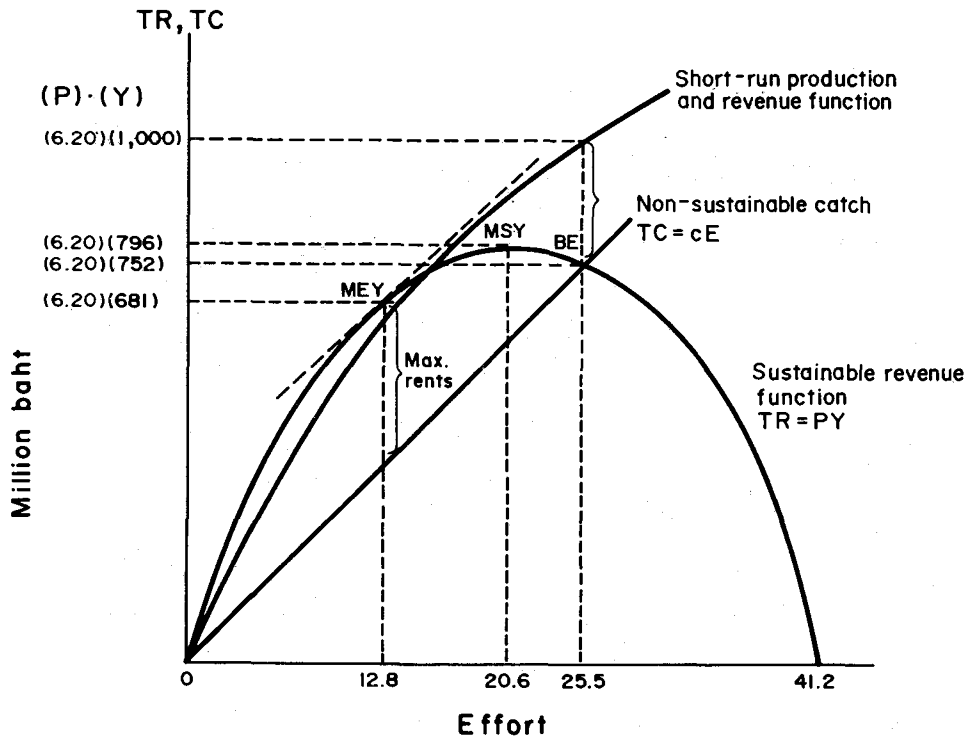

Fig. 9.1. Fixed price model applied to the Gulf of Thailand fishery (P_{1982} = ฿6.20/kg, mesh size = 4 cm). TC = total cost; c = average cost; E = effort; TR = total revenue; P = price of fish; Y = annual catch; MSY = maximum sustainable yield; MEY = maximum economic yield; BE = open access bionomic equilibrium.

Table 9.2. Comparison of catch, revenues, costs and profits at different levels of effort based on a fixed price model, 2.5-cm mesh size and 1963-1982 data, Gulf of Thailand.

	Effort (St hr x 10^6)[a]	Catch (t x 10^3)	Revenues (฿ x 10^6)	Costs (฿ x 10^6)	Profits (฿ x 10^6)
Actual (1982)	19.2	1,000	6,200	4,685	1,515
MSY	15.7	958	5,940	3,831	2,109
MEY	10.4	847	5,251	2,538	2,713
Bionomic equilibrium	21.2	836	5,183	5,183	0

[a]Million standard hours.

more than twice as much effort; the potential loss from this excessive effort would be about 2,713 million baht (Fig. 9.2).

A comparison between the results of the two mesh sizes indicates the following: (a) a larger resource becomes accessible with the smaller mesh size as indicated by the 20% higher MSY in the case of the commercial mesh size; (b) as a consequence, the unsustainable portion of current catch is reduced from 250,000 t to 93,000 t; and (c) the MEY level of catch with 2.5 cm mesh size is 24% higher than with 4 cm mesh size and profits are 44% higher. To the extent that these gains from the finer mesh size are sustainable, there is no reason why it should not be used. However, since our model ignores interspecies interactions there is always the danger that the implied gains from a finer mesh size would prove to be unsustainable if the ecological balance is thereby disturbed. Most biologists would predict an increase in the availability of more valuable species if a larger mesh size were used (see also Pauly 1979 and Panayotou 1982). Hence, there is a need for more sophisticated models to account for such interactions.

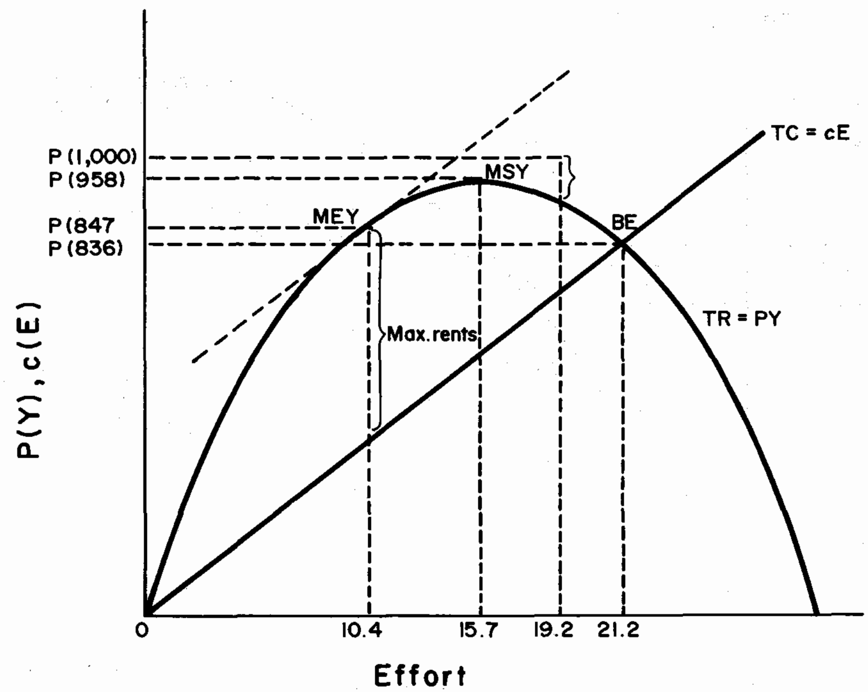

Fig. 9.2. Fixed price model applied to the Gulf of Thailand fishery (P_{1982} = ฿6.20/kg, mesh size = 2.5 cm). See Fig. 9.1 for abbreviations.

The Variable Price Model

The fixed price model just discussed is appropriate only when the fishery concerned accounts for too small a share of the market for variations in catch to affect fish prices. Otherwise, a variable price model should be used. The case with the Gulf of Thailand is not so clear-cut. While the Gulf of Thailand accounts for a very small share of the world fish market where part of the Thai catch is sold, the catch from Gulf accounts for over 50% of the domestic market which includes the market for trash fish. Therefore, although the variation in the Gulf catch is unlikely to affect world prices, it is likely to have some effect on the domestic fish prices since the link between the two markets is not a strong one except in the case of major export species such as crustaceans, cephalopods and molluscs. Thus, we estimate MEY and other factors with a variable model as well.

In order to apply the variable price model developed in Chapter 4, it is necessary to estimate first a demand function for fish which expresses quantity demanded as a function of price, the prices of substitute products and the consumers income. Alternatively, price may be expressed as a function of quantity, substitute prices and incomes. We estimated both linear and log-linear functions and selected the latter as it fits the data best, though the price of substitute products was statistically insignificant in both functions and was dropped. The estimated log-linear model with 1971-1982 price (P), quantity (Y) and real income (Z) data is as follows:

$$\ell n\, P = -17.81 - 0.558\, \ell n\, Y + 1.861\, \ell n\, Z \qquad \ldots (3)$$
$$(-9.02)(-1.75) \qquad (8.52)$$

$$\overline{R}^2 = .92 \qquad F = 64.8 \qquad D.W. = 1.12 \qquad N = 12$$

Equation (3) may then be reduced to a price-quantity relationship by substituting the relevant value of Z; in our case, the 1982 real income level of Thailand, since we will be comparing our results to the 1982 figures. Following this substitution, the reduced form of equation (3) becomes:

$$P = 372.7\ Y^{-0.558} \qquad \ldots (4)$$

From equation (4) we derive the total revenue (TR), average revenue (AR), and marginal revenue (MR) functions as follows:

$$TR = 372.7\ Y^{0.442} \qquad \ldots (5)$$

$$AR = 372.7\ Y^{-0.558} \qquad \ldots (6)$$

$$MR = 164.7\ Y^{-0.558} \qquad \ldots (7)$$

To obtain MEY we also need cost (AC) and marginal cost (MC) functions, which are given by equations (16) and (17) of Chapter 4. Assuming a 4 cm mesh size and using the corresponding cost and sustainable-yield-function parameters we obtain:

$$AC = \frac{(2)\,(183)}{77.1 \pm (5{,}949 - 7.5\ Y)^{1/2}} \qquad \ldots (8)$$

$$MC = \frac{183}{(5{,}949 - 7.5\ Y)^{1/2}} \qquad \ldots (9)$$

We may now proceed to estimate the level of effort which maximizes social benefits (MEY) by setting P = MC as described in Chapter 4. Similarly we obtain the bionomic equilibrium where all profits are dissipated by setting AR = AC. Finally, the monopoly position where profits are maximized is obtained where MR = MC. The results are reported and compared in Table 9.3 and Fig. 9.3.

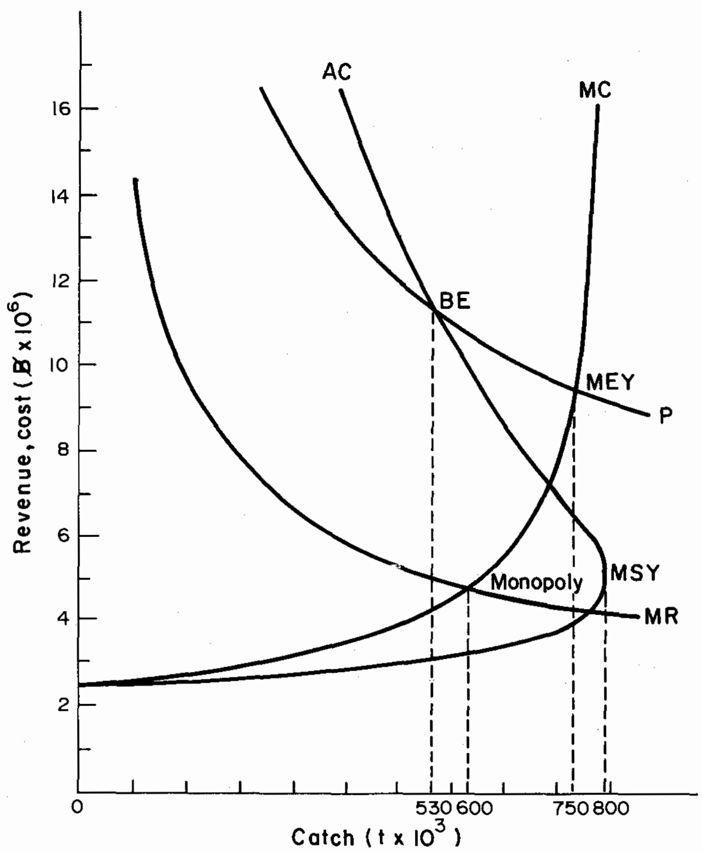

Fig. 9.3. Variable price model applied to the Gulf of Thailand fishery (mesh size = 4 cm).

Table 9.3. Comparison of annual catch, revenues, costs and profits in million baht at different levels of effort based on a variable price model, 4-cm mesh size and 1963-1982 data, Gulf of Thailand.

	Effort (St hr x 10^6)[a]	Catch (t x 10^3)	Revenues	Costs	Profits	Consumer surplus	Total benefit
Actual (1982)	25.6	1,000	6,200	4,685	1,515	9,976	11,491
MSY	20.6	796	7,133	3,770	3,363	9,019	12,382
MEY	15.6	750	6,900	2,855	4,045	8,832	12,877
Bionomic equilibrium	37.0	530	5,963	5,963	0	7,531	7,531
Monopoly	10.4	600	6,300	1,903	4,937	7,955	12,352

[a]Million standard hours.

The level of effort that yields the maximum economic yield with a variable price is found to be 15.6 x 10^6 standard hours, compared with the 1982 figure of 25.6 x 10^6 hours and the bionomic equilibrium (BE) at 37 x 10^6 hours. The MEY level of catch is 750,000 t compared to the 1982 figure of 1 x 10^6 t, the MSY of 796,000 t and the BE of 530,000 t. Profits at MEY are more than 2.5 times the 1982 level of profits and 20% higher than at MSY. The Thai society stands to lose 4,045 million baht per annum in profits alone by letting its fishery gravitate unmanaged towards a bionomic equilibrium.

The results of the variable price model differ from those of the fixed model (Table 9.1) in that the MEY catch and effort levels are higher by 10 and 22%, respectively. This is so because the variable price model permits the price to rise as the catch is reduced below the current level to the 25% lower MEY level. The higher price shifts the sustainable revenue function upwards justifying additional effort of 2.8 x 10^6 hours. Correspondingly the profits at MEY are more than twice as high under the variable than under the fixed price model because of the higher catch and higher price compared to only a modest increase in fishing costs.

Another difference between the fixed and the variable model is what constitutes maximum rents or MEY. Under the former, MEY is identical to maximum profits. Under the latter, MEY includes both profits which benefit the producer if not taxed away and consumer surplus which benefits the consumer. (Consumer surplus is the difference between what the consumer is willing to pay and what he actually pays). Thus, MEY is best understood as maximum social benefit and occurs at a level of effort higher than the level at which maximum profit is obtained. The maximum profit under the variable model is the monopoly solution.

In Table 9.3 the maximum social benefit of 12,877 million baht is at P = MC or MEY, not at MR = MC which is the monopolist's decision rule. True, monopoly generates more profits but part of these profits are not resource rents due to genuine resource scarcity but monopoly rents due to artificial scarcity created by the monopolist by withholding supplies (with catch of only 600,000 t) and, therefore, by reducing consumer surplus. However, the difference in social benefits between MEY, MSY and the monopoly solution are so small by comparison to their bioeconomic equilibrium level that operation of the fishery at any of these three points would be a great improvement over the bionomic eventuality.

Using the same procedure we estimate the MEY levels of catch, effort and profits for the commercial mesh size of 2.5 cm, and compare the results to the corresponding 1982 MSY and open-access figures in Table 9.4 and Fig. 9.4. The MEY level of effort is 40% lower, the catch 10% lower and profits 300% higher than the corresponding 1982 figures. As in earlier models, effort is lowest and profits highest at MEY; the reverse is true at the bionomic equilibrium. The catch at MEY is only slightly lower but effort is substantially lower and profits higher than at MSY.

By comparison to our earlier models, the variable price model with commercial mesh size indicates (for 1982) the least economic overfishing (deviation from MEY) in terms of catch and the most in terms of profits. According to this model, which is more realistic than the previous three, in 1982 the Gulf of Thailand fishery incurred a "loss" of 3,136 million baht by not operating at the MEY level of effort. This loss can be avoided by foregoing 100,000 t of catch, thereby raising the price of the remaining 900,000 t from 6.20 baht/kg to 8.08 baht/kg, increasing total receipts by

1,331 million baht, and at the same time saving 7.4 x 10° hours of excess effort costing the industry and the country 1,805 million baht. However, given the open-access status of the Gulf of Thailand, the individual fisherman has no incentive to reduce effort. What is more likely is that effort will continue to expand until all remaining profits are completely dissipated and the fishery comes to a rest at a bionomic equilibrium with 2.5 times the optimal level of effort, unless new external shocks (such as changes in technology and/or input costs and shifts in demand) disturb the process by creating new, short-term disequilibrium rents (or losses).

The total rents at MEY, which include both profits and consumer surplus, amount to 14,173 million baht, 23% higher than the actual level or 78% higher than the eventual bionomic equilibrium. (MSY management and monopoly give almost the same level of total benefit of about 13,700 million baht). The social loss from not operating at MEY was 1,386 million baht in 1982 and is expected to rise to 4,236 million baht per annum (under the 1982 bioeconomic parameters), if the fishery is allowed to reach an open-access bionomic equilibrium.

Table 9.4. Comparison of annual catch, revenues, costs and profits in million baht at different levels of effort based on a variable price model, 2.5-cm mesh size and 1963-1982 data, Gulf of Thailand.

	Effort (St hr x 10^6)[a]	Catch (t x 10^3)	Revenues	Costs	Profits	Consumer surplus	Total benefit
Actual (1982)	19.2	1,000	6,200	4,685	1,515	9,976	11,491
MSY	15.7	958	7,741	3,831	3,910	9,789	13,699
MEY	11.8	900	7,531	2,879	4,651	9,522	14,173
Bionomic equilibrium	25.8	600	6,295	6,295	0	7,960	7,960
Monopoly	8.2	740	6,904	2,001	4,903	8,735	13,638

[a]Million standard hours.

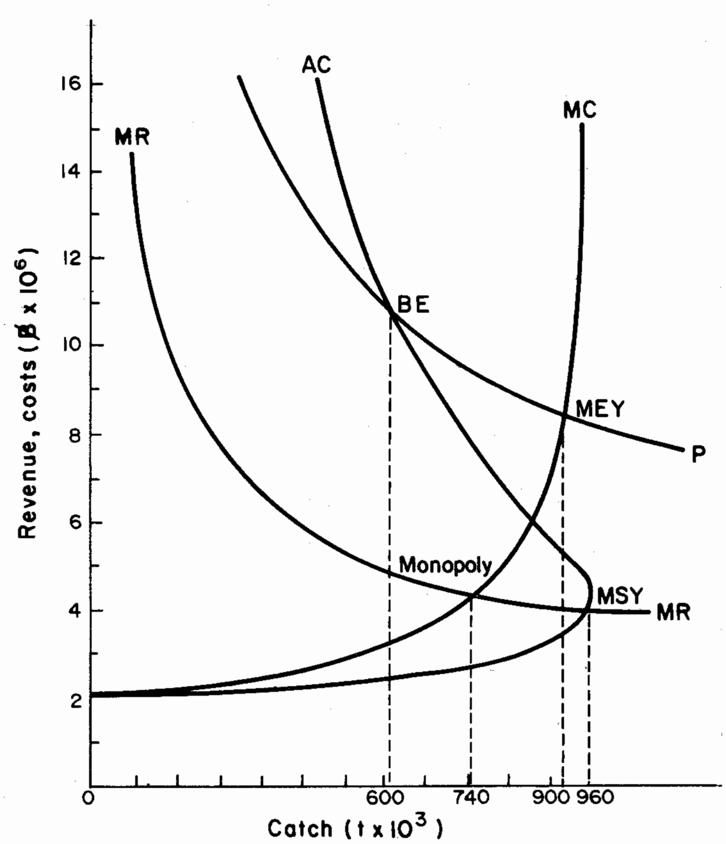

Fig. 9.4. Variable price model applied to the Gulf of Thailand fishery (mesh size = 2.5 cm).

CHAPTER 10

EEZS AND JOINT VENTURES

Almost unique among developing countries, Thailand maintains a sizeable distant-water fishing fleet operating throughout the South China Sea and the Indian Ocean. It is believed that about one half of the catch by the Thai trawl fishery originates from outside the Thai territorial waters (Marr et al. 1976; Anon. 1978). The implementation of 200-mile Exclusive Economic Zones (EEZs) by Thailand's neighbors has virtually eliminated the high-sea areas of the South China Sea and the Bay of Bengal, as well as other relevant parts of the Indian Ocean (see Marr 1976; Valencia 1978a). This, it was feared in Thailand and hoped in neighboring countries, would effectively put an end to the 'poaching' of fish resources by the distant-water fleet and enable coastal states to exploit and manage the resources within their extended fisheries jurisdictions.

It is recognized, however, that whereas Thailand's neighbors claim the right over these resources, only Thailand has the technical capability to exploit them fully. Naturally then, joint fishing ventures are regarded as the *deus ex machina* that would meet both sides' needs and interests. As a corollary, well-defined rights and joint ventures are expected to prevent overfishing by obviating the retreat of Thailand's distant-water fleet into the Gulf while regulating its activities outside the Gulf. The purpose of the present chapter is: (i) to examine the most likely effects on Thailand of the implementation of EEZs by neighboring countries and (ii) to evaluate the option of joint fishing ventures as an instrument for controlling overfishing, combating encroachment and mitigating overcapitalization.

Exclusive Economic Zones

The proclamation of 200-mile EEZs by Thailand's neighbors extends the national jurisdiction of coastal states over the entire South China Sea and most of the Bay of Bengal leaving little trawlable high-sea areas for distant-water fishing (Fig. 10.1). According to the Chairman of the Thai Fisheries Association, Thailand stands to "lose 300,000 square miles of fishing grounds" (Bangkok Post 1979c). Theoretically, the country's distant-water fleet would have to retreat into the Gulf of Thailand with the consequent "loss of an estimated 660,000 tons of marine fish and crustaceans annually, lowering the Thai annual marine harvest by some 40%" (Bangkok Post 1979d) and depriving the country of foreign exchange earnings of 2,000 to 3,000 million baht. Neither of these losses is a modest one for a country still suffering from protein-malnutrition and mounting balance-of-trade-and-payments deficits. Currently, marine products contribute over 5% to the total value of exports while over 50% of the domestic animal protein consumption consists of fishery products. To quote the local press:

> With a rising demand for food from an ever expanding population, the constraint placed [by EEZs] on marine fisheries, which have been this country's vital source of protein, would have proved to be catastrophic. (Bangkok Post, 1979d).

Even more catastrophic, one fears, would be the effect of EEZs on small-scale fishermen and fish resources within the Thai territorial waters: retreat of the distant-water fleet and consequent doubling of the number of vessels operating in the Gulf of Thailand is certain to obliterate both fish and fishermen. In Chapters 8 and 9, we have seen that the Gulf is already overfished by a fleet double its 'optimal' size and in Chapters 5 and 6, that operators of small otter trawlers and other small-scale fishermen whose fishing range is limited to the Gulf of Thailand barely eke out a subsistence. The consequences of the deployment of an additional fleet of several thousand highly 'efficient' distant-water vessels in the limited confines of the Gulf are difficult to imagine. Since the extent of depletion would be determined by the amount and duration of profits for vessels remaining, fishing operations will continue as long as operating costs are covered. Given further the high fishing efficiency attained by the distant-water fleet (to compensate for high travelling costs), the danger of destroying the Thai fish resources is not an unrealistic one. Even more certain is the exacerbation of social problems and conflicts in connection with coastal small-scale fishermen.

The repercussions for Thailand of the loss of 780,000 km^2 of fishing grounds and of the consequent retreat of the distant-water fleet into Thai waters are unquestionable. The question is rather whether the proclamation of 200-mile EEZs has triggered the above chain of events. That is, can neighboring countries enforce their claims over such an extensive sea area to the effective exclusion of the Thai fleet? Answering this question would also enable us to evaluate the option of joint ventures often suggested as the solution to the problems posed by EEZs.

The main countries off which Thai foreign catches are made are Bangladesh, Burma, India, Indonesia, Kampuchea, Malaysia, Philippines, Singapore and Vietnam (see Marr et al. 1976). Virtually all these countries have now proclaimed EEZs: Vietnam in 1977, Kampuchea and Bangladesh in 1978, the Philippines in 1979, Indonesia and Malaysia in 1980. However, with the exception of Vietnam which has demonstrated some capability in enforcing its EEZ (Valencia 1978a), none of these countries appears to have the enforcement capability required by such a vast area as the 200-mile EEZ. Past inability to enforce exclusive rights over such limited areas as a 12-mile territorial zone (as evidenced by the pervasiveness and profitability of encroachment) bespeaks of future enforcement difficulties over the far more extensive EEZs. Many authors, if not the countries themselves, have recognized the problem. Marr et al. (1976) speaks of "time lag between the proclamation . . . and the abilities to enforce"; Valencia (1978a) refers to "the general lack of enforcement capability in the region"; and Hongskul (1979) states that "the problems of enforcement . . . are critical within the region."

While any nation proclaiming an EEZ faces enforcement difficulties, the developing countries of Southeast Asia have more than their share, not only because of their low level of economic development but because of geographical and historical factors as well. The presence of archipelagos containing large water areas and small land masses, the ongoing territorial disputes and a long history of promulgation of laws and regulations without effective enforcement combine to hinder 'marine regionalism' (a concept defined below) as well as to weaken the enforceability of any single nation's claims over vast sea areas remote from its land base.

The ability of an individual state to exert sovereignty over the claimed marine areas and to enforce regulations vis-à-vis foreign activities depends, to a large extent, on the strength of its navy or marine police, the number and dispersion of naval bases and the size of its (naval) air force relative to the length of its coastline and the offshore area accruing to it under a 200-mile jurisdictional regime (Valencia 1978a). Table 10.1 attempts to give a comparative picture of the capacity of Southeast Asian states to enforce such jurisdictional regimes. The figures, though somewhat outdated, leave little doubt that most nations in the region are ill-prepared for the task. With the possible exceptions of Vietnam, China, Singapore and Taiwan, all other states:

> would have thousands of square miles of ocean area of hundreds of miles of marine perimeter to cover per patrol vessel or aircraft. Regulations and restrictions would, thus, not be readily enforceable with present naval capabilities on an individual state basis over much of the South China Sea (Valencia 1978b).

Even more severe are likely to be the enforcement difficulties of Thailand's neighbors in the Bay of Bengal (Burma, Bangladesh and India) which are relatively poorer than most Southeast Asian countries and have economic zones at least as large (Fig. 10.1).

The obvious alternative to individual state capability in enforcing extended marine jurisdictions is 'marine regionalism' in the sense of cooperative management and enforcement by the regional states or by a regional body representing these states. However appealing marine regionalism

Table 10.1. Capacity of Southeast Asian states to enforce extended fisheries jurisdiction (200-mile EEZ).[a]

Political entity	Area of entity ($km^2 \times 10^3$)	Length of coastline (km)	Offshore[b] area to 200 nm limit ($nm^2 \times 10^3$)	Navy (total fleet)	Major naval bases	No. of naval aircraft	No. of air-force aircraft	200 nm area/total fleet ratio	200 nm area/total aircraft ratio	Coastline/ total fleet ratio
Brunei	5.77	163	7.1	1	0	0	9	7,100.0	788.9	163.0
China	9,551.00	6,467	281.0	1,240	11	500	3,290	226.6	74.0	5.2
Hong Kong	1.03	111	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Indonesia	1,491.00	36,834	1,577.0	221	3	82	505	7,137.0	2,687.0	166.7
Kampuchea	181.00	435	16.2	16	3	0	12	1,012.5	1,350.0	27.2
Laos	236.00	0	0.0	n.a.	n.a.	n.a.	?	n.a.	n.a.	n.a.
Malaysia	332.00	3,432	138.7	60	4	0	175	2,311.0	792.6	57.2
Philippines	300.00	17,460	551.4	55	1	3	247	10,025.0	2,205.6	317.5
Singapore	0.58	140	0.1	20	1	0	50	5.0	2.0	10.0
Taiwan	35.96	870	114.4	216	5	0	648	529.6	176.5	4.0
Thailand	514.00	2,584	94.7	85	2[d]	0	474	1,114.0	199.8	20.4
Vietnam[c]	332.00	2,309	210.6	1,658	7	0	1,193	127.0	176.5	1.4
Total	12,990.00	70,805	2,991.5	3,566	37	585	6,603	—	—	—
Average[e]	1,082.5	6,487	299.2	357	3.7	58.5	660	—	—	—

[a]As the figures regarding navies, aircrafts and bases are somewhat outdated (early 1970s), the present capacity of some (if not all) of these states to enforce jurisdictional regimes is underestimated. Thus, the given figures should be regarded only as indicative of (relative) orders of magnitudes rather than as exact numbers.
[b]Offshore area accruing to each country under 200-nautical-mile jurisdictional regimes.
[c]The 'source' (see below) combines the figures for what were then North and South Vietnam.
[d]Thailand plans a major naval base at Phangnga on the Andaman Sea (Far Eastern Economic Review, January 14, 1977, p. 15.)
[e]Averages exclude Laos.

Source : Valencia (1978b).

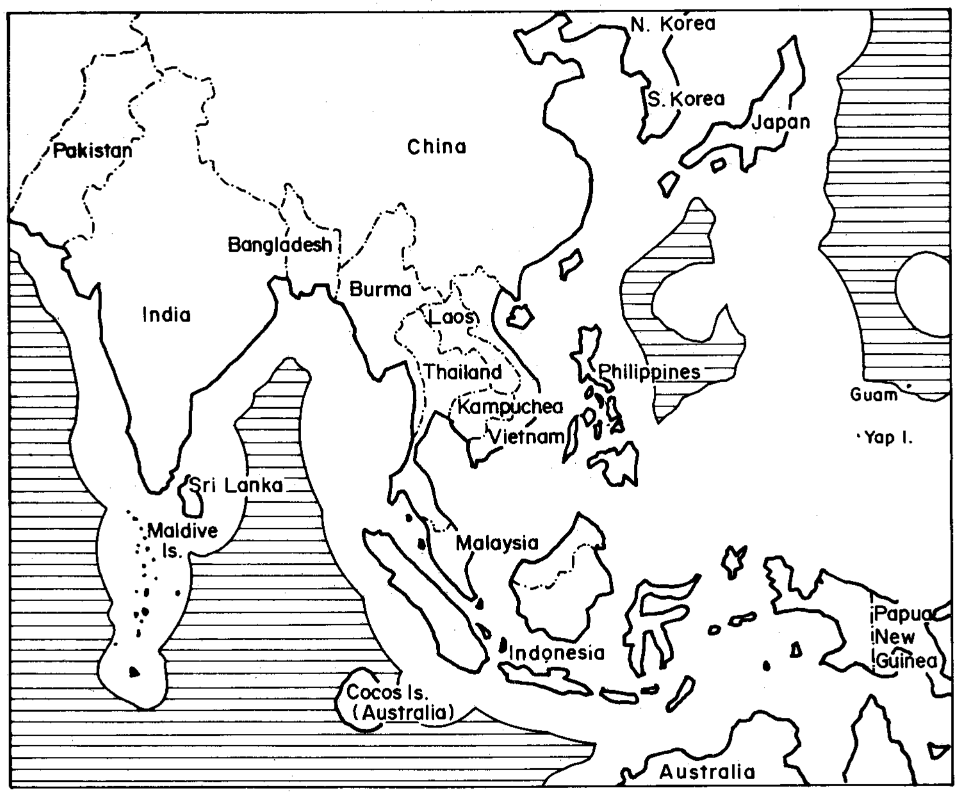

Fig. 10.1. Remaining high seas in South and Southeast Asia following the implementation of 200-mile exclusive economic zones by coastal states.

might be for closed or semi-closed seas with transboundary resources, the constraints posed by ideological differences, military conflicts and territorial disputes (all unrelated to EEZs) loom formidable. Consider, for instance, the ideological differences between the Association of Southeast Asian Nations (ASEAN) and the Indo-Chinese states, the military conflicts in Indo-China and the territorial disputes between China and Vietnam over Paracel Islands; among China, Vietnam, the Philippines and Taiwan over Spratly Islands; and between Thailand and Kampuchea over Kut, Wai, Panjang and Krah Islands. (See Valencia 1978b for these and other disputes as well as for a detailed account of the constraints to and prospects of marine regionalism in South China Sea.) There is also the diversity of interests and incompatibility of claims associated with extended jurisdictional regimes. For instance, China, Vietnam and Malaysia would probably favor exclusive jurisdictions; Indonesia and the Philippines may insist on the archipelagic principle; Thailand, Taiwan and Singapore might opt for jurisdictional extension with full utilization. According to the principle of 'full utilization', states which lack the capacity to harvest the entire 'allowable catch' within their EEZs should give other states access to the surplus, presumably at a certain agreed upon fee or share.

Boundary disputes and overlapping EEZs (such as those listed in Table 10.2) among Southeast Asian states are certain to frustrate any attempt in the foreseeable future towards concerted enforcement of EEZs and/or joint management of transboundary and migratory resources, although some bilateral agreements for disputed areas and joint ventures will undoubtedly be concluded.

With enforcement capabilities seriously deficient and marine regionalism unlikely, the possibility of effective implementation of EEZs in Southeast Asia will depend largely on the chances of persuading distant-water fishing nations to restrict the operation of their fleet within their own waters. This, in turn, presupposes some control by Thailand over its fleet as well as some leverage by neighboring countries over Thailand. While the latter may be found in Thailand's increasing need and desire for peaceful coexistence and economic cooperation with its neighbors, the former is conspicuously absent. Indeed, if Thailand has been unable to prevent its fleet from encroaching on the 12-mile territorial waters of bordering countries it cannot reasonably be expected to prevent

Table 10.2. Some specific boundary disputes and overlapping exclusive economic zones in Southeast Asia.

	Brunei	Burma	China	Hong Kong	Indonesia	Kampuchea	Malaysia	Philippines	Singapore	Taiwan	Thailand	Vietnam
Brunei												
Burma												
China								X[h]		X[h]		X[g, h]
Hong Kong			X									
Indonesia							X[c]					X[b]
Kampuchea											X[e]	X[f]
Malaysia	X		X		X				X[d]		X[a]	X[a]
Philippines					X		X			X[h]		X[h]
Singapore					X		X					
Taiwan			X					X				X[h]
Thailand		X				X	X					X[a]
Vietnam			X		X	X	X	X			X	

Note : Entries above the diagonal indicate specific boundary disputes (see legend below) while those below the diagonal indicate overlapping EEZs. Neither is meant to be exhaustive.

[a]A triangular area in the South China Sea off the East Coast of Peninsular Malaysia.
[b]Natuna Island.
[c]Ligitan and Sipadan Islands (uninhabited).
[d]Tiny Batu Puteh Island which commands the eastern approach to the Straits of Singapore.
[e]Krah and Kut Islands (dispute as a result of unihabiteral proclamation of continental shelf boundary by Kampuchea).
[f]Island of Phu Quoc and certain other small islands (unknown if dispute continues at present).
[g]Paracel Islands.
[h]Spratly Islands.

Sources : a, b, c, d from Whiting (1980); e, f, g, h from Valencia (1978a and b).

encroachment of the far more extensive 200-mile EEZs. Economic opportunities more attractive than distant-water fishing would certainly work but such opportunities can hardly be found in Thailand or within 200 miles from its shores. Well aware of this, Thailand has maintained that it will be the last Southeast Asian nation to declare a 200-mile EEZ. Indeed Thailand did not declare an EEZ until 23 February 1981, by which date all Thailand's neighbors had done so. Other countries are welcome to fish in the Gulf of Thailand, if they wish, in exchange for reciprocal rights. Not surprisingly, there have been no takers among Thailand's neighbors; not only do they lack the distant-water fleet for such expeditions but, more importantly, the Gulf of Thailand is thought to be an 'aquatic desert' by comparison with their own fishing grounds. For instance, the Bay of Bengal is reported to be about eight times richer in fish resources than the Gulf of Thailand (see Business Review, February 1979), although the virgin stock density is almost the same in the two areas (see Tables 8.4 and 8.5).

Joint Fishing Ventures

Under these circumstances, the initial enthusiasm for joint fishing ventures in Thailand and some of its neighbors was not surprising. Such ventures were seen as an opportunity for cooperation (instead of confrontation) between neighbors towards mutual benefit and an effective means of luring the refractory distant-water fleet into some form of joint control by Thailand and the host country. The mutual benefits from joint ventures are obvious enough. Thailand has excess fishing fleet in relation to its own fish resources ('overcapitalization') while neighboring countries have excess resources relative to their capacity to harvest them (surplus 'allowable' catch). Commonly, both sides are in need of additional sources of protein as well as income and employment to satisfy the nutritional needs and development aspirations of their rapidly growing populations.

Joint ventures, thus, constitute a 'Pareto improvement', that is, a change from the status quo that would benefit at least one of the parties without harming the other. But while the benefit to *both* sides is quite clear, reaching an agreement presents all the classic problems of bilateral monopoly and game theory. In bilateral monopoly "the bargaining power wielded and the tactics employed by the trading partners determine the resolution of this conflict, and on formal theoretical grounds it is possible to say only that almost anything can happen" (Scherer 1970). In games of strategy each player is seeking a strategy that will result in the attainment of a particular objective from his own standpoint. The final outcome depends jointly on the strategies chosen by all participants in the game (Chiang 1967). The prolonged negotiations of, and eventual stalemate in, the Thai-Bangladesh joint venture is a case in point. Bangladesh is reported to have initially agreed to a 20% share of the value of the catch and to have changed its mind later asking for 30%. Thailand refused on the ground that it would be unprofitable (see Bangkok Post 1979c). Currently the venture is in a new deadlock over Thailand's complaint that Thai vessels incur losses as a result of overestimation of the value of the catch by Bangladesh in claiming its share, and over Bangladesh's complaint that more than the agreed upon Thai vessels operate in its waters.

Moreover, it would be an arduous task to negotiate a sufficient number of joint ventures to employ the entire distant-water fleet. Marr et al. (1976) argue that no more than 100,000 t of fish can be expected to be obtained from all potential ventures. To this day, there have been discussions with many countries as far as Bahrain and Saudi Arabia, but few have resulted in a final agreement, mostly between private companies.

Assuming, however, that such ventures will eventually be agreed upon, how likely is it that they will succeed in attracting Thailand's distant-water fleet? The answer depends on the relative attractiveness (profitability) of joint fishing ventures vis-a-vis other opportunities open to the fleet. Were EEZs enforcable, retreat into the overfished Gulf of Thailand would have been the only alternative, and, most likely, an inferior one, considering that joint ventures allow access to under-exploited stocks and a share of the rents. As we have seen earlier, however, with the present enforcement capabilities, distant-water fishing will continue to be both possible and profitable for some time to come despite the proclamation of 200-mile EEZs. International agreements and larger appropriations for law enforcement within the extended fisheries jurisdictions may raise the cost of 'illicit' operations and drive out the marginal units, but substantial reduction of distant-water fishing is unlikely. As long as the rents to be earned are large enough to permit investment in faster boats, patrol detection equipment and other defensive mechanisms (including the bribing of enforcement officials), laws and proclamations will remain on paper until such day as the governments involved are able to match the technical sophistication and financial strength of Thailand's distant-water fleet.

Since joint ventures by definition introduce two additional rent claimants, the Thai government and the host country (in the form of license or catch fees), the share of the benefits allowed for the fleet itself may compare unfavorably with the profits from 'illicit' distant-water fishing even after all cost and risks are accounted for. For joint ventures to be successful in enticing Thailand's distant-water fleet, additional investments in attaining economies of scale, such as 'factory-ships' for the collection and processing of catch and other incentives would be needed. The Thai government and its neighbor-partners (assuming a strong interest on both sides) may choose to promote joint fishing ventures either by raising the costs of 'illicit' distant-water fishing through closer monitoring and stricter enforcement, or by lowering the 'private' cost of joint-venture fishing through investments in related infrastructure and reduction of their own shares.

Each of the above courses of action requires substantial outlays which may not be justified by potential benefits unless non-fishing, non-economic considerations, such as improvement in international relations, are brought into the picture. However, only through effective control of entry either at the source (Thailand) or at the place of operation (host country's EEZ) will successful joint ventures provide a solution to the problems of overcapitalization, encroachment and suboptimal exploitation of resources. Otherwise, joint ventures will directly or indirectly encourage the construction of new vessels, thus, exacerbating rather than alleviating these problems. Moreover, it must be remembered that joint ventures, however successful, cannot be but a transitory solution to chronic problems. Most likely, the host country would require that Thai interests are phased out as its own fishing capabilities are built up.

Existing Legislation and Policy Framework

The fisheries policy in Thailand is governed by two basic acts: the Act Governing the Right to Fish in Thai Waters of 1939 and the Fisheries Act of 1947. There are several other related acts and regulations concerning navigation (1913), fish markets (1953), fish processing factories (1963), fish exports (1980) and fishermen's cooperatives (proposed). The various acts and regulations of the Thai fisheries have been described in detail by Rientrairut (1983). Here, we will focus only on the 1939 and 1947 acts which are of direct relevance to the study. The Act of 1939 defines the Thai fishery waters as the Thai territorial waters of 12 miles from shore and any other waters in which Thailand is entitled to exercise fishing rights. According to this act all fishing vessels in Thai territorial waters are required to hold a fishing license. Fishing licenses are to be issued only to Thai nationals or to partnerships and companies in which 70% of the capital is owned by Thai nationals. Foreign vessels are not allowed to fish in Thai fishery waters except where there is an agreement with foreign countries. The authorities are empowered to seize any vessel operating in violation of the act, to confiscate its catch and to prosecute the individuals or companies involved.

The Fisheries Act of 1947, composed of 73 articles, deals with fishing areas, licenses, fishery statistics and fisheries control and prosecution of offenders as well as fish culture. This act classifies fishing areas into: (a) sanctuaries where fishing is prohibited; (b) leasable and reserved areas both of which are reserved for individual license holders, but the former permit unlicensed fishing by certain gears for home consumption as well; and (c) public areas for which no requirement for license is specified but fishing is subject to compliance with conditions imposed by the Minister of Agriculture and Cooperatives. The act empowers the Minister to issue: (a) notices requiring persons engaged in fishing to be registered and obtain a license; (b) notices requiring the licensing of any kind of fishing equipment; and (c) fishing regulations such as closed areas, closed fishing seasons, mesh size limitation, gear restrictions and catch quotas. The act also empowers the Minister, the Provincial Governor and authorized fisheries officers to enforce the act through the normal process of entry, search, arrest and seizure.

In addition to these two acts, of direct interest is the Thai Vessels Act of 1939 which requires all mechanically propelled fishing vessels of any size and non-mechanized boats of 6 GT or over to be registered with the Harbor Department, to ensure compliance with construction, seaworthiness and equipment standards.

In 1983, the government introduced a new licensing system which "aims to freeze the number of trawl fishing vessels at the current level and to reduce it thereafter" (Rientrairut 1983). According to this new system the construction of new trawl vessels is prohibited and no new trawl licenses will be issued; existing licenses are made non-transferable except by inheritance; and obsolete vessels cannot be replaced.

In response to the need to raise the income levels of small-scale fishermen and to resolve their conflict with the large-scale fishery, push netting and trawling are prohibited within 3 km from the shoreline. Efforts are also being made to develop alternative or supplementary employment opportunities such as fishfarming, tourism and cottage industry.

Chapter 11

POLICY IMPLICATIONS

While it is beyond the scope of this study to formulate a detailed and comprehensive package of policy recommendations for fisheries management in Thailand, it is a natural extension to extract the policy implications of the preceding analysis and make some general recommendations. In the light of our findings, the feasibility of stated government objectives and the effectiveness of current policies in achieving these objectives are evaluated. Modifications of fishery policy targets in the context of the country's broader development objectives as well as alternative policies are proposed.

Policy Issues

From the preceding analysis of the Thai fisheries three fundamental policy issues emerge: (a) how to reduce overfishing and induce a recovery of Thailand's demersal resources without reducing fishery production and employment; (b) how best to utilize Thailand's sizeable distant-water fleet and technological advantage and, at the same time, reduce the encroachment of neighboring countries EEZs and improve Thailand's international image; (c) how to improve the standard of living of small-scale fishermen and minimize their conflicts with large-scale fishermen without subsidizing and/or institutionalizing inefficient or economically unviable fishing units. Taken together these issues amount to a quest for a national fisheries policy which would maximize the overall benefits from the fishery to the society with due concern for their distribution and short-run adjustment problems.

This is admittedly a difficult task for any country, but especially for a developing country such as Thailand which has little tradition and experience in sustainable resource management and rather limited enforcement capability, although the Department of Fisheries is ahead of other resource-related departments in both management and enforcement capabilities. With the notable exceptions of aquaculture (in all its forms) and joint fishing ventures, it is difficult to think of management interventions that will not involve curtailment of fisheries production and employment and increased conflicts at least in the short run. Yet, if the fishing industry is not to have the same fate as the Thai forest industry which has exploited itself to extinction turning Thailand from a net exporter to a net importer of forest products, sustainable yield management is imperative. As our models of Chapters 8 and 9 have shown, whether the maximization of physical or economic yield is selected as the objective of management makes little difference by comparison to a situation of no management or open access.

As evidenced by the Fourth and Fifth National Development Plans (NESDB 1977, 1981) and other official statements the government does perceive these issues and attempts are being made to tackle them. The question is whether the existing legal and policy frameworks are appropriate and sufficient to deal with these issues especially in the light of budgetary and administrative constraints, the high enforcement costs and the targeted growth rate of 5.4% per year in fish production. To investigate this question, it is first necessary to review the existing legislation and policy framework.

In addition to the fisheries legislation and related management policies which aim at regulating fishing effort, the policy framework of the Thai fisheries includes input, output and trade policies which aim to raise fishermen's incomes, thereby subsidizing fishing effort. Such policies include financial support at subsidized interest rates, tax exemptions for fishing machinery and equipment, provision of storage and processing facilities, price support, export promotion and import discouragement (Rientrairut 1983). These policies are usually introduced as second best solutions or stop-gap measures at a time of a sudden shock or crisis but usually outlive their original purpose. For instance, in response to demands for subsidized fuel prices following the 1980 oil price shock the government froze the marketing fees and the license and registration fees. These policies persisted long after the tight oil market conditions ended.

Evaluation of Current Policies

The Fisheries Act of 1947 empowers the responsible Minister with both the authority to introduce a licensing system and fishing regulations such as closed areas and seasons, mesh size limitations, gear restrictions and catch quotas, and with the authority to enforce these measures. In practice, however, the Minister has not used his powers under the act to introduce an effective licensing system and other fisheries regulations because of both administration constraints and political considerations. As in many other countries, the budget, manpower and the authority of the Department of Fisheries (DOF) are clearly inadequate for operationalizing and enforcing a licensing system and/or other fisheries regulations. Moreover, political considerations militate against a substantial reduction of effort and even restrictions on its expansion.

Even the recently introduced licensing scheme which freezes the number of trawlers and prohibits their transfer and the construction of new vessels may be proved inadequate. Firstly, as the fishing vessels are to be registered with the Harbor Department while the gear is licensed by DOF, a loophole exists which enables registered fishing vessels to operate without a license for gear. Secondly, with the current budget and manpower it is not easy for the DOF to enforce the licensing system over an extensive and technologically advanced fleet which can operate from foreign ports. Thirdly, even if the system could be generalized and enforced it can only block new entrants and may reduce fishing effort by normal attrition but it will take a very long time to cut effort to about half its current level as required for maximum benefits. Lastly, even if effort could be reduced to its optimum level, without an effective mechanism of creaming off resource rents, the newly established rents (as a result of the reduction in effort) would create such a potent incentive to increase effort that rents will be again dissipated either through excess effort or higher enforcement costs.

Similarly, other regulations such as the prohibition of push netting and trawling within 3 km from the shore and the recommendation for a 4 cm mesh size are generally ignored as evidenced by the presence of large numbers of push nets and trawlers in the prohibited zone and the use of 2.5 cm mesh size. A two-month seasonal closure of the central western Gulf has been recently spatially reduced and might soon be removed under pressure from the industry.

The Department of Fisheries considers the Fisheries Act of 1947 inadequate for marine fisheries management and has drafted a new Fisheries Act which has been approved by the Ministry of Agriculture and Cooperatives and submitted for consideration to the Parliament in 1984. To the knowledge of the authors the new Fisheries Act has not been enacted yet.

Input policies, such as subsidized credit and tax exemptions for fishing machinery and equipment, while intended to relieve short-term hardships, are certain to deepen capital intensity at the expense of labor employment, to encourage new entry to the destruction of fish resources and to widen the dualism between small- and large-scale fishermen. Moreover, new entry will nullify any temporary gains to the fishermen necessitating new subsidies in the future which, having created a precedent, will be difficult to resist or remove.

Output policies such as price supports, while intended to raise fishermen's incomes and to ensure increased fish supplies for human consumption at low prices, are self-defeating in the long run. To the extent that they are effective in raising fishing incomes, new entrants are attracted into the fishery, and, as a result, the resource base deteriorates, incomes fall and new supports are required.

Intervention in international trade such as promotion of exports and tariffs on fish imports may temporarily succeed in raising fishing incomes, in improving the balance of payments and in protecting the local industry, but no lasting benefit can be expected under the present open-access status and depleted state of the resource. At present, increased fishery exports can be had only through destructive or 'piratical' fishing.

Effort is also being made to conserve fishery resources by encouraging distant-water fishing, especially through joint fishing ventures and other fishery agreements with neighboring countries (e.g., with Bangladesh, Malaysia, India and Indonesia). Although some additional fish supplies have been forthcoming as a result of these ventures, there is no evidence that overfishing in Thai waters and encroachment on foreign resources have been diminished. To the extent that joint ventures are successful, they tend to encourage the construction of new, larger vessels rather than the utilization of existing ones, although, in the absence of restrictions on entry, even the latter will create room for new construction.

In terms of supplementary sources of income and employment, especially for small-scale fishermen, brackishwater fisheries and coastal aquaculture as well as other fishery-related economic activities are currently promoted but their extent is still negligible by comparison with the number of coastal fishermen. A large part of the Department of Fisheries' budget goes towards the development of inland fisheries which have been practically at a standstill for the last decade. Out of the Department of Fisheries' 1979 budget of 213 million baht, 25% was allocated to freshwater fisheries, 23% to administration, 21.3% to marine fisheries including survey of fishing grounds, 15% to fishery resource conservation, 12.75% to the brackishwater fishery and 3% to improve fishery employment (see Business Review, February 1979).

Towards a National Fisheries Policy

Problems such as those facing the Thai fishing industry require a comprehensive fisheries policy in line with each country's broader development objectives. One possibility worth considering is to empower the Department of Fisheries in a country with the formulation and implementation of a national fisheries policy which would include upgrading its authority and budget and strengthening its enforcement capability. Here we simply outline the main components such a policy could include in the case of Thailand.

The first step in such a policy would be an immediate and effective freeze in the number of vessels in general and of trawlers in particular through prohibition of the construction of new vessels and the compulsory registration of the existing vessels *with the Department of Fisheries.* The next step would be the issuance of fishing licenses to existing vessels based on their current level of catching power, unless it is determined that the current mesh size is smaller than the optimum, in which case a larger mesh size should be specified. Licenses would need to be made non-transferable without exemptions and be retracted upon the retirement of either the owner or the vessel, whichever comes first, until the fleet is reduced to its optimum size. The license fees which are now negligible (e.g., 5 baht/m footrope for trawlers, 2 baht/m footrope for gill nets and purse seines and 150 baht per gear for push nets) would need to be raised to the estimated market value of the license. As effort is being reduced (or fish prices rise), the license fees should be revised upward to cream off the newly created rents and reduce the incentive for expansion of effort. Annual adjustments of the allowable effort and license fees may be necessary to take account of natural fluctuations in the resources and changes in fishing costs.

The government could speed up the attrition process by offering to buy back and cancel the licenses of fishermen who choose to leave the fishery, using the proceeds from the license fees. This last option could be made more attractive by offering to retrain and/or relocate those who leave the fishery as well as by developing alternative employment opportunities. Moreover, it is possible to use the licensing mechanism to discourage certain gears such as trawlers and encourage others such as purse seines if they are judged to have a differential impact on the state of the resources.

However, for a licensing system to work effective enforcement is necessary. At present, properly equipped patrol vessels are lacking and the penalties imposed on violators are too small to be taken seriously. For instance, the fine for fishing with an unlicensed gear is set at three times the annual license fee. Since the probability of being detected and arrested with an unlicensed gear is far less than 33%, it is not surprising that many fishing vessels use unlicensed gear. For effective enforcement both the fines and the probability of detection and arrest should be raised considerably so that the certainty-equivalent-fine (nominal fine multiplied by the probability of detection) exceeds the license fee and other related costs. Moreover, the enforcement effort should be uniform across provinces; otherwise, fishing vessels may shift their home base to the provinces of least enforcement. Care also should be taken to separate the enforcement and development functions; each function should be assigned to different officers to avoid conflict of interest.

Finally, every effort would need to be made to minimize enforcement costs through technical means and self-policing. This is particularly applicable to the government's efforts to improve the socioeconomic position of small-scale fishermen and reduce their conflicts with large-scale fishermen. One of the most difficult to enforce regulations has been the prohibition of trawling and push netting within the 3-km-from-the-shore strip reserved for small-scale fishermen. These fishing gears not only compete with coastal fishermen for limited resource but they are also believed to destroy the inshore nursery grounds and habitat, to catch large quantities of juvenile fish and to cause damage to stationary and other types of gear employed by small-scale fishermen. Small-scale fishermen, unable to compete with these gears often resort to equally destructive fishing methods such as dynamite, poison and fine nets.

An effective solution to these problems with minimum enforcement cost may be found through the concepts of territorial use rights in fisheries (TURFs) and artificial reefs which would act also as fish aggregation devices (FADs). TURFs can be created by dividing the coastal fishing grounds into fishing zones each to be allocated to the adjacent fishing community. Each community, once allocated exclusive and secure fishing rights to a fishing zone would use its internal enforcement mechanism (peer group pressure, community leadership, etc.) to prevent other communities from encroaching on its resources and to regulate the effort of its own members so that the resource is properly utilized. The community would have every incentive and the means to prohibit trawling, push netting, dynamite fishing and other destructive fishing methods as well as fishing during spawning seasons or in nursery grounds by its own members (for more details on the concept of TURFs see Christy 1982; Panayotou 1983; Smith and Panayotou 1984).

However, trawlers and push nets from offshore areas may continue to encroach on the community's TURF; in fact, the more the resource recovers as result of self-management and self-policing by the community the greater the incentive for encroachment. Small-scale fishermen are unlikely to have the technical capability of preventing such encroachment, which if not contained would reduce the community's incentive for self-policing. This is where the technical solution of artificial reefs as trawling obstacles may be proved of immense value as they will discourage trawling without the need for daily enforcement of the regulation. What is required is the construction of random physical barriers made of concrete or car bodies within 3 km or more from the shoreline. While the construction of such reefs would be costly, the expected benefits are sufficiently large to warrant a serious study (Munro and Polovina 1984). The expected benefits include: (a) reduction of the conflicts between small- and large-scale fishermen; (b) more effective management of inshore resources without the need for recurrent enforcement costs; (c) the artificial reefs acting as fish aggregation devices and barriers of access to nursery grounds would provide habitat for juvenile fish which will thereby survive to market size or reproductive age; and (d) higher incomes for small-scale fishermen who would benefit in the short run from the employment generated by the construction of artificial reefs and in the longer run from the reduction of competition from trawlers and the increased fish abundance as a result of FADs.

Objections to some of these approaches will arise. Reviewers of the draft of this manuscript have commented that the "buy-back program" is not advisable based on the Canadian experience and the large budget required, that the TURFs approach is difficult to implement and control and that artificial reefs are not true FADS and need further study before large-scale implementation. While we share these concerns and appreciate the difficulties, we nevertheless believe that there is scope for improvement in Thai fisheries management based on these concepts appropriately modified to fit the Thai circumstances (see also ADB 1985).

Once the construction of new vessels is halted and existing ones are brought under control, joint ventures could compensate for the loss of employment and catch resulting from the curtailment of destructive inshore fishing and of 'illicit' distant-water operations. Moreover, Thailand could invoke historical fishing rights, nutritional needs and its relatively disadvantaged geographical location to obtain legal access to the underfished resources of the region. At the same time, it must be recognized that any such access, like joint ventures, cannot be but a temporary arrangement until neighboring countries develop their own fishing capabilities. While far from being a cure-all remedy for the country's fishery related problems, these options, if wisely used, could prove of immense value during the transitional stage from a refractory open-access fishery to one of regulated access designed to maximize the overall welfare of the Thai society.

As joint ventures and fishing rights in distant waters are phased out, Thailand will have to rely increasingly on its own fish resources; hence the need for a speedy recovery of the fish resources within Thailand's 200-mile EEZ. It is unlikely, however, that the Thai fish resources, even after recovering to their maximum potential, can accommodate a fishing fleet of the current size; nor could they yield a sustainable catch of the current magnitude, hence the need for a gradual reduction of the fleet and development of alternative sources of both employment and protein such as fishfarming and livestock development. A national fisheries policy would provide for a detailed plan for aquaculture and inland fisheries development as well as for a process of smooth transition from capture to culture fisheries and other occupations.

Other important fishery policy issues not covered by this study concern improvements in product handling, quality control and environmental protection of the coastal zone from water pollution resulting from inland deforestation, destruction of mangrove forests, and industrial and mining waste. Improvements in these areas may contribute to the productivity of the resource and fishing incomes as much as the management measures discussed in detail herein, but any such gains would be short-lived without effective resource management.

The ultimate success of a national fisheries policy lies in the right and timely mix of fisheries management and nonfisheries development. Under the prevailing conditions of rising landlessness and swelling unemployment in the rest of the economy, only broad-based rural development will put an end to the continual drift into 'common-property' resources and major urban centers. In its absence, fisheries regulation cannot be effective and, if effective, will simply push the problems into some other sector: unemployed fishermen have little choice but to encroach on reserved forests, mineral concessions (as is already happening in Phangnga) and public lands or simply move into the urban centers creating a host of social and environmental problems.

CHAPTER 12

SUMMARY AND CONCLUSIONS

Two decades ago the Thai marine fishery was an economically insignificant sector employing mainly stationary gear and boats without engines. Today Thailand boasts one of the largest fishing industries in the world, employing over 20,000 motorized vessels and landing about 2×10^6 t of fish annually from fishing grounds as remote from Thailand as the coasts of India and China. A number of factors contributed to this radical transformation. The introduction of trawl technology, the rising demand for fish, and a *laissez-faire* government policy combined to attract powerful investors in what for decades used to be a poor-man's occupation. Small-scale fishermen, with few exceptions, lacked the funds and the access to institutional, low-interest-rate credit to acquire the new technology. Thus, a dualistic structure emerged with small-scale fisheries employing over 70% of the total number of fishermen while landing less than 30% of the total catch.

Our analysis of the economic conditions of the trawl fishery revealed the persistence of excess profits (resource rents) for most vessel classes despite massive entry and steep rises in fuel prices that led temporarily to losses. While changes in economic and biological parameters have altered the relative profitability among vessel classes, the opportunity of distant-water fishing served to relieve the pressure on inshore resources and along with technical improvements to maintain the profitability of the trawl fishery as a whole. In contrast, small-scale fishermen, lacking both mobility and resilience and being under incessant pressure from coastal trawling, struggle to hold on to fishing as a familiar source of income and a way of life but manage to eke out subsistence only through a variety of supplementary non-fishing occupations.

The fishing resources within the Gulf of Thailand are overexploited in that the catch exceeds the maximum sustainable yield and fishing effort is twice the economic optimum level. Moreover, as of the early 1970s, over half of the total landings have been made from distant-water fishing grounds including the coasts of neighboring countries. The advent of 200-mile exclusive economic zones, it was feared in Thailand and hoped in neighboring countries, would effectively put an end to distant-water fishing allowing coastal states to exploit and manage their resources while rendering the Thai fishery grossly overcapitalized. In anticipation of the threat posed by a retreating fleet to Thai resources and coastal fishermen, and in recognition of the lack of fishing capabilities on the part of neighboring states, joint fishing ventures have been contemplated as a panacea to the problems of encroachment, overcapitalization and resource mismanagement.

However, when considering the enforcement difficulties in the region as evidenced by past experience with encroachment of far more limited areas than EEZs as well as by the present naval and air force capabilities relative to the claimed areas of jurisdiction, one is forced to conclude that 'illicit' distant-water fishing is likely to continue into the foreseeable future. True, the costs of distant-water fishing may increase somewhat as a result of the implementation of EEZs. Nevertheless, joint ventures may still turn out to be an inferior alternative to 'illicit' distant-water fishing because of the additional rent claimants (the Thai government and the host country), unless appropriate investments are made to attain economies of scale. In the absence of restrictions on entry, however, successful joint ventures are likely to induce construction of new vessels exacerbating rather than alleviating the problems of overcapitalization, encroachment and resource mismanagement.

Naturally, Thailand is not anxious to see its distant-water fishing curtailed. Continuation of the status quo along with a few joint ventures are seen as an acceptable second best solution: fish supplies and foreign exchange earnings continue to be forthcoming and a cutthroat competition for the Gulf's resources is averted; more importantly, crisis and confrontation with the powerful trawl fleet is avoided for the time being. However, the present problems arising from the unchecked activities of Thai trawlers also persist and assume increasing severity over time.

Domestically, the continuing encroachment on coastal fishing grounds by trawlers runs against government efforts to upgrade the socioeconomic conditions of small-scale fishermen in line with the national planning objectives of "promoting social justice by reducing socioeconomic disparities and improving mass welfare" (NESDB 1977). Internationally, the continuing encroachment of neighboring countries' EEZs by Thai trawlers runs against the country's efforts for regional integration with its allies (Association of Southeast Asian Nations) and for peaceful coexistence with its ideological adversaries in Indo-China. From the fisheries management point of view, unchecked trawling (especially the use of fine nets in spawning areas) carries with it the danger of physical depletion of the more vulnerable species beyond recovery. More importantly, continuation of the construction of new vessels leads to an even greater problem in the future when joint ventures will be phased out and encroachment suppressed, following a gradual improvement of fishing and enforcement capabilities by coastal states.

While the Government is no doubt aware of these creeping problems and possible solutions have been under study for some time, fishery policies to this day have been largely stopgap measures in response to pressure from the industry to deal with rising fishing costs. In its desire to avoid confrontation with the trawl fleet and to ensure increasing fish supplies for domestic consumption and exports, the government has, at different times, contemplated and occasionally introduced input subsidies, output-price guarantee, and exemption from taxes, as well as export promotion and infrastructure development. However necessary and useful these policies might be as short-run relief measures, their consequences over the long run could be negative if access to the fishery is not effectively regulated.

An effective strategy for the solution of Thailand's fisheries-related problems calls for the immediate halt of the construction of new trawlers, the licensing and control of the activities of existing vessels, assistance to small- and large-scale fishermen through artificial reefs and community fishing rights, conclusion of more joint fishing ventures and development of alternative sources of animal protein, income and employment. It is hoped that the recent awakening to the futility of piecemeal policies and to the importance of combined resources management and broad-based rural development will be backed by sufficient political will to be articulated into such a strategy.

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Appendix Table A.1. Annual catch (t), value (thousand baht) and price (baht/kg) of major species of marine fish, Thailand, 1971-1982.

Items	Quantity	Value	Price[a]	Quantity	Value	Price[a]
		1971			1972	
Total fish	828,223	1,816,437	2.19	1,016,959	1,926,868	1.95
Pelagic fish	204,156	801,676	3.93	119,432	533,753	4.47
Demersal fish	624,067	1,014,811	1.63	897,527	1,453,115	1.62
Total shrimps and lobster	68,740	891,617	12.97	68,632	807,292	11.76
Total crab	18,876	76,080	4.03	19,040	73,770	3.87
Total squid and cuttlefish	37,521	196,441	5.24	72,833	372,270	5.11
Total molluscs	292,798	134,626	0.46	119,113	81,853	0.69
Total others	39	—	—	3,224	1,287	0.40
Grand total	1,246,197	3,115,251	2.50	1,299,801	3,323,340	2.56
		1973			1974	
Total fish	1,185,674	2,522,444	2.13	1,110,945	2,339,568	2.11
Pelagic fish	199,798	392,797	4.47	223,920	915,962	4.09
Demersal fish	985,876	1,629,647	1.65	887,025	1,423,606	1.60
Total shrimps and lobster	114,110	1,501,074	13.15	93,296	1,180,585	12.65
Total crab	20,083	95,985	4.73	28,023	140,922	5.03
Total squid and cuttlefish	61,222	279,246	4.56	64,629	355,863	5.51
Total molluscs	61,214	79,611	1.30	52,112	73,807	1.42
Total others	67,147	13,833	0.21	2,585	2,761	1.07
Grand total	1,509,450	4,492,193	2.98	1,351,590	4,093,506	3.03
		1975			1976	
Total fish	1,086,213	2,832,560	2.61	1,157,538	3,013,623	2.60
Pelagic fish	263,907	1,444,396	5.47	354,313	1,588,048	4.48
Demersal fish	822,311	1,388,164	1.69	803,225	1,455,565	1.81
Total shrimps and lobster	106,742	1,553,734	14.56	112,365	2,055,198	18.29
Total crab	23,675	134,233	5.67	26,014	134,314	5.16
Total squid and cuttlefish	64,825	427,439	6.59	63,952	559,928	8.76
Total molluscs	108,481	151,906	1.40	168,562	195,237	1.16
Total others	4,667	2,244	0.48	23,361	7,454	0.32
Grand total	1,394,608	5,102,116	3.66	1,551,792	5,968,754	3.85
		1977			1978	
Total fish	1,573,568	4,373,711	2.78	1,511,621	5,199,113	3.44
Pelagic fish	515,452	2,220,670	4.31	441,854	2,613,258	5.91
Demersal fish	1,058,116	2,153,041	2.03	1,069,767	2,585,855	2.42
Total shrimps and lobster	140,277	2,939,350	20.95	145,624	4,364,334	29.97
Total crab	27,638	249,320	9.02	31,057	343,526	11.06
Total squid and cuttlefish	93,694	817,003	8.72	93,654	1,184,640	12.65
Total molluscs	148,485	203,889	1.37	111,673	341,720	3.06
Total others	83,871	21,316	0.25	64,156	25,368	0.40
Grand total	2,067,533	8,664,589	4.19	1,957,785	11,458,701	5.85

Appendix Table A.1. (Continued)

Items	Quantity	Value	Price[a]	Quantity	Value	Price[a]
		1979			1980	
Total fish	1,389,393	4,365,358	3.14	1,302,102	4,957,674	3.81
Pelagic fish	416,234	2,224,695	5.35	328,182	2,308,985	7.04
Demersal fish	973,159	2,140,663	2.20	973,920	2,648,689	2.72
Total shrimps and lobster	132,603	5,123,358	38.64	134,280	3,631,117	27.04
Total crab	31,523	270,216	8.57	33,929	438,914	12.94
Total squid and cuttlefish	80,142	1,247,912	15.57	72,313	1,001,089	13.84
Total molluscs	122,235	287,849	2.36	102,111	470,913	4.61
Total others	57,262	23,858	0.42	3,218	7,819	2.43
Grand total	1,813,158	11,318,551	6.24	1,647,953	10,507,526	6.38
		1981			1982	
Total fish	1,377,196	5,728,745	4.16	1,392,044	5,809,921	4.17
Pelagic fish	388,383	2,902,159	7.47	395,540	2,998,083	7.58
Demersal fish	988,813	2,826,586	2.86	996,504	2,811,838	2.82
Total shrimps and lobster	149,821	5,228,471	34.90	188,588	5,417,636	28.73
Total crab	33,112	480,406	14.51	29,891	539,037	18.03
Total squid and cuttlefish	80,805	1,271,979	15.74	116,607	2,037,626	17.47
Total molluscs	154,281	491,345	3.18	157,173	382,064	2.43
Total others	29,229	12,495	0.43	102,541	59,890	6.58
Grand total	1,824.444	13,213,441	7.24	1,986,571	14,246,174	7.17

[a]Value/quantity.

— : Nil or negligible.

Source : DOF, Fisheries Record of Thailand, various issues.

Table A.2. Average price, catch per vessel and composition of catch of the Thai trawl fishery, 1969, 1974, 1977 and 1982.

Vessel class	Ave. price (baht/kg)	Total catch (t)	Composition (%)[a] EF	TF	C	M	Ave. price (baht/kg)	Total catch (t)	Composition (%) EF	TF	C	M
			1969						1974			
Otter trawler												
< 14 m	2.98	51.6	14.2	52.5	27.5	5.8	2.02	73.7	13.0	59.3	23.3	4.4
14-18 m	1.40	218.5	19.0	66.0	10.6	4.4	1.85	201.4	14.8	71.5	9.6	4.1
18-25 m	1.20	381.3	28.8	66.0	1.3	3.9	2.42	425.8	23.9	69.7	2.8	3.6
> 25 m	—	—	—	—	—	—	2.42	1,059.3	25.4	70.5	0.5	3.6
Pair trawler												
< 14 m	1.30	325.6	3.6	78.7	3.1	4.6	3.84	60.8	19.8	56.2	22.7	11.2
14-18 m	—	—	15.5	64.6	1.4	18.5	2.19	349.8	20.1	56.3	1.3	22.3
> 18 m	1.20	827.7	21.1	66.3	1.1	11.5	2.35	520.0	24.3	60.6	0.6	14.5
Weighted average	1.47	189.4	22.8	64.8	6.7	5.7	2.15	221.0	19.3	67.3	7.2	6.2
Percentage change	—	—	—	—	—	—	(+46%)	(+17%)	(−15%)	(+14%)	(+17%)	(+9%)
			1977						1982			
Otter trawler												
< 14 m	1.74	77.5	11.9	58.1	20.8	9.2	n.a.	n.a.	n.a.	n.a.		
14-18 m	2.89	230.8	12.6	71.6	9.6	6.2	5.93	313.1	34.0	66.0		
18-25 m	2.29	510.0	18.5	72.2	2.6	6.7	6.27	689.7	37.0	63.0		
> 25 m	5.41	1,174.3	31.6	59.5	4.2	4.7	n.a.	n.a.	n.a.	n.a.		
Pair trawler												
< 14 m	2.72	308.6	7.7	86.5	2.8	3.0	n.a.	n.a.	n.a.	n.a.		
14-18 m	4.45	322.8	20.9	55.1	1.5	22.5	6.35	476.2	38.0	62.0		
> 18 m	2.64	699.6	22.3	62.6	0.6	14.5	n.a.	n.a.	n.a.	n.a.		
Weighted average	2.85	223.3	17.4	66.2	7.7	8.7	n.a.	n.a.	n.a.	n.a.		
Percentage change	(+33%)	(+1%)	(−10%)	(−2%)	(+7%)	(+40%)	n.a.	n.a.	n.a.	n.a.		

n.a. Figures not available.

[a]Figures for 1969 not available. The indicated percentages are based on catches during June-December 1970 reported in Department of Fisheries, The Statistical Tables on Marine Fisheries 1970.

[b]The figures for edible fish in 1982 include crustaceans and molluscs.

Notation: EF = edible fish; TF = trash fish; C = crustaceans; and M = molluscs.

Sources: 1969 catch figures based on the results of the '1969 Cost and Earnings Survey' reported in Marr et al. (1976); these figures are too low by comparison with those reported in DOF (1969): 118.6, 127.1, 516.9, 363.6 and 1,054.8 in the above order; still other figures, in between, are found in DOF (1971). These discrepancies cannot be reconciled, a rather 'typical' feature of the Thai Fisheries Statistics. In this and other tables related to cost and earnings we follow the Cost and Earnings Surveys.

1974 and 1977 figures on catch and its composition from DOF (1979); 1982 figures from OAE (1983).

Average price: (gross) revenues/catch (see Table A.4 for revenues and figures above for catch).

Table A.3. Average cost (baht) and catch per unit of effort (kg), Thai trawl fishery, 1969, 1974, 1977 and 1982.

Vessel class	Average cost[a] per Kg of fish	Average cost[a] per Fishing hour	Standard hour[b]	Catch per fishing hour	Average cost[a] per Kg of fish	Average cost[a] per Fishing hour	Standard hour[b]	Catch per fishing hour
		1969				1974		
Otter trawler								
< 14 m	2.67	44.80	430.80	16.79	1.95	53.81	182.14	27.53
	n.a.	n.a.	n.a.	n.a.	(−27%)	(+20%)	(−58%)	(+64%)
14-18 m	1.17	45.80	189.20	39.06	2.12	99.78	197.87	47.11
	n.a.	n.a.	n.a.	n.a.	(+118%)	(+118%)	(+5%)	(+21%)
18-25 m	1.17	100.70	188.0	86.35	2.22	237.80	209.00	107.11
	n.a.	n.a.	n.a.	n.a.	(+90%)	(+136%)	(+10%)	(+24%)
> 25 m	n.a.	n.a.	n.a.	n.a.	2.02	675.42	188.43	334.16
	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Pair trawler								
< 14 m	0.90	12.30	146.70	61.75	5.85	384.95	545.83	32.92
	n.a.	n.a.	n.a.	n.a.	(+550%)	(+243%)	(+272%)	(−47%)
14-18 m	n.a.	n.a.	n.a.	n.a.	2.35	459.74	219.51	97.61
> 18 m	0.91	259.50	147.20	142.17	2.33	1,109.85	217.35	238.00
	n.a.	n.a.	n.a.	n.a.	(+156%)	(+328%)	(+48%)	(+67%)
		1977				1982		
Otter trawler								
< 14 m	1.86	49.62	144.52	26.61	n.a.	n.a.	n.a.	n.a.
	(−5%)	(−8%)	(−20%)	(−3%)	n.a.	n.a.	n.a.	n.a.
14-18 m	2.55	139.77	197.84	57.76	4.27	357.64	174.15	84.40
	(+12%)	(+40%)	(0%)	(+16%)	(+67.45)	(+155.88)	(−12%)	(+46%)
18-25 m	1.77	204.05	137.22	115.27	4.70	834.06	194.29	178.10
	(−20%)	(−14%)	(−34%)	(+8%)	(+165.50)	(+308.75)	(+42%)	(+54%)
> 25 m	2.50	794.13	193.54	214.26	n.a.	n.a.	n.a.	n.a.
	(+24%)	(+18%)	(+3%)	(−36%)	n.a.	n.a.	n.a.	n.a.
Pair trawler								
< 14 m	1.85	630.60	143.32	121.90	n.a.	n.a.	n.a.	n.a.
	(−68%)	(+64%)	(−74%)	(+270%)	n.a.	n.a.	n.a.	n.a.
14-18 m	3.63	589.05	281.75	84.40	5.33	973.35	213.87	183.15
	(+54%)	(+28%)	(+28%)	(−14%)	(+46.83)	(+65.24)	(−24%)	(+117%)
> 18 m	2.37	799.82	183.93	169.38	n.a.	n.a.	n.a.	n.a.
	(+2%)	(−28%)	(−15%)	(−29%)	n.a.	n.a.	n.a.	n.a.

n.a. Data not available.

( ) Figures in brackets give the percentage change from the previous reported year as given above. For example the drop in the cost per kg of fish by 27% between 1969 and 1974 is indicated as (−27%) below the 1974 figure.

[a] Average cost includes all costs except the opportunity cost of capital.

[b] Standard hour is obtained as the catch per commercial vessel divided by catch per unit of research vessel Pramong II in the Gulf of Thailand. Note that this is not completely legitimate since many vessels, especially the larger ones fish outside Thai waters.

Source : Total cost from Table A.4 below; catch per vessel from Table A.2 above; fishing hours from DOF (1969) and catch per hour by the research vessel Pramong II from Table 8.2.

Table A.4. Annual revenues, costs and profits (in thousand baht) per unit of the Thai trawl fishery, 1969, 1974, 1977 and 1982.

Vessel class[a]	Revenues[b]	Costs[c]	Profits[d]	Revenues[b]	Costs[c]	Profits[d]	Revenues[b]	Costs[c]	Profits[d]	Revenues[b]	Costs[c]	Profits[d]
		1969			1974			1977			1982	
Otter trawler												
< 14 m	153.7	137.8	15.9	148.9	144.0	4.9	135.4	144.5	−9.1	n.a.	n.a.	n.a.
14-18 m	173.9	149.1	24.8	372.5	427.5	−55.0	667.3	589.1	78.2	1,862.6	1,336.2	526.4
18-25 m	462.3	444.4	17.9	1,030.4	945.5	84.9	1,168.1	902.9	265.2	4,356.4	3,247.6	1,108.8
> 25 m	n.a.	n.a.	n.a.	2,566.2	2,141.2	425.0	6,357.0	4,352.3	2,004.7	n.a.	n.a.	n.a.
Pair trawler												
< 14 m	407.7	296.1	111.6	233.3	356.0	−122.7	840.5	570.6	269.9	n.a.	n.a.	n.a.
14-18 m	n.a.	n.a.	n.a.	766.1	823.7	−57.6	1,436.9	1,173.4	263.5	3,025.0	2,539.7	485.3
> 18 m	1,002.7	755.4	247.3	1,220.4	1,212.4	8.0	1,853.0	1,660.1	174.9	n.a.	n.a.	n.a.

[a]By type of gear (otter trawler and pair trawler) and size (length) of vessel in meters (m).

[b]The annual revenues for 1974 and 1977 were obtained by multiplying the monthly date on earnings, given in the sources below, by the number of fishing months for each vessel class (9.3, 11.8, 11.0, 11.7, 11.0, 11.0 and 11.0, respectively) obtained from the 1977 survey (see below).

[c]Costs including operating costs (crew remuneration, fuel, oil, ice, containers and other running expenses), maintenance of hull and engine, repair and renewal of gear, fees and charges; and depreciation cost; but, they exclude the opportunity cost of capital. The annual costs were obtained as follows: for 1977 the monthly cost figures given in the sources (below) were multiplied by the number of fishing months (see 'a' above) after subtracting the 'opportunity cost of capital' for 1974 the monthly depreciation and 'other running expenses' were first made comparable to those of 1977 by using fishing months rather than calendar months before multiplication of the reported total monthly costs with the number of fishing months to obtain the annual costs; for 1969, annual figures were available.

[d]Profits (= revenues — costs) are, thus, gross of the opportunity cost of capital.

n.a. = Not available.

Sources: DOF (1974); Reintrairut (1979) and Costs and Earnings Surveys, 1969 (unpublished data). The 1974 survey has been published under the title The Results of Cost and Earnings Survey of Major Marine Fisheries 1974. The 1969 figures are from Marr et al. (1976), while the 1977 figures are from Rientrairut (1979) and DOF (1979a). The 1982 figures are from OAE (1983).

Table A.5. Average current value of fishing assets and capital cost estimates (in thousand baht) per fishing unit of the Thai trawl fishery, 1969, 1974, 1977 and 1982.

Vessel class	1969 Current value	1969 Capital cost	1974 Current value	1974 Capital cost	1977 Current value	1977 Capital cost	1982 (Current value + Capital cost)/2
Otter trawler							
< 14 m	39.8	87.3	54.7	120.0	59.3	180.0	n.a.
14-18 m	84.0	164.4	173.1	339.0	352.9	691.8	728.5
18-25 m	245.0	530.0	409.5	886.0	599.3	1,296.6	2,004.6
> 25 m	—	—	1,409.0	1,863.0	4,226.7	5,589.0	n.a.
Pair trawler[a]							
< 14 m	65.3	187.0	95.3	274.0	132.1	378.4	n.a.
14-18 m	—	—	264.8	—	922.6	—	829.7
> 18 m	419.3	700.0	569.5	950.0	1,313.4	2,190.5	n.a.

[a]For pair trawlers a fishing unit is made up of two vessels while for otter trawlers a fishing unit is made up of one vessel.

Sources: Current value for 1974 and 1977 and capital cost for 1969 and 1974 are from the Costs and Earnings Surveys (unpublished data), DOF (1974) and Reintrairut (1979) (the former two series directly; the latter two through Marr et al. (1976). Current value 1969 and capital cost 1977 calculated on the basis of the 1974 relationship between current value and capital cost, an assumption tenable on the grounds that increases in the capital cost of (new) vessels would be reflected in the current valuations of existing vessels and vice versa. Note that in the 'Cost and Earning Surveys' the current value of fishing assets was obtained by directly questioning the fishermen as to how much they could sell their boat, engine and other equipment. Capital cost, on the other hand, represents the purchasing (or construction) cost of the fixed assets; by the way, this cost has been recovered from the 1969 and 1974 surveys by Marr et al. (1976). It must represent the original cost rather than the current market cost of the fishing asset. The current value and capital cost of fishing assets for 1982 was not presented directly in the OAE (1983). The average value of fishing assets can be calculated indirectly from the opportunity cost of capital shown in this report.

Table A.6. Annual fishing operation of demersal fishing gear, 1982 survey.

	Otter trawlers 14-18 m	Otter trawlers 18-25 m	Pair trawlers 14-18 m	Research vessel Pramong II
Sample size	19	7	14	
Total catch/unit (t)	313.1	689.7	476.2	
% Edible fish	34.0	37.0	38.0	
% Trash fish	66.0	63.0	62.0	
Total effort/unit				
No. of trips/year	16.0	11.0	30.4	
No. of months/year	8.8	11.0	9.0	
No. of days/trip	15.0	24.0	8.0	
No. of hours/year[a]	3,709.7	3,872.5	2,600.0	
No. of standard hours/year[b]	8,028.2	17,684.6	12,210.3	
Average catch/effort (kg)				
Catch/trip	19,570.0	62,700.0	15,650.0	
Catch/hour	84.4	178.1	183.1	39.0
Total cost/unit (฿ x 10^6)	1,398.1	3,436.1	2,611.5	
Average cost (baht)				
Per kg of fish	4.5	5.0	5.5	
Per trip	87,380.0	312,370.0	85,820.0	
Per hour	376.9	887.3	1,004.4	

[a]Fishing hours/day of the sample fishing gear obtained from the DOF "The Marine Fisheries Statistics based on the sample survey 1982" (unpublished preliminary results): No. of hours/year = (hours/day) x (days/trip) x (trip/year).

[b]Figures can be obtained by dividing total catch by Pramong II CPUE.

Source : Calculated from OAE (1983).

Table A.7. Number of vessels, catch and fishing effort of otter trawlers by size of vessels, all fishing grounds 1982.

	< 14 m	14-18 m	18-25 m	> 25 m
No. of vessels	5,219	2,406	1,529	204
Catch (t)	221,375	344,614	260,535	90,864
No. of hours/ vessel/year	1,130	2,461	1,593	2,550
No. of days/ vessel/year	97	159	108.8	176.3
No. of trips/ vessel/year	60	34.4	12.4	9.7
Hours/day	11.6	15.5	14.6	14.5
Days/trip	1.6	4.6	8.8	18.2
Catch/vessel (t)	42.4	143.2	170.4	445.4
Catch/hour (kg)	37.5	58.2	106.9	174.7

Source : DOF "The Marine Fisheries Statistics based on the sample survey 1982" (unpublished preliminary results).

Table A.8. Number of vessels, catch and fishing effort of pair trawlers by size of vessels, all fishing grounds, 1982.

	< 14 m	14-18 m	18-25 m	> 25 m
No. of vessels	51	593	755	7
Catch (t)	3,540	73,435	85,516	
No. of hours/ vessel/year	1,172	846	833	
No. of days/ vessel/year	101.8	78.8	63.5	
No. of trips/ vessel/year	80.4	22.1	6.7	
Hours/day	11.5	10.7	13.1	
Days/trip	1.3	3.6	9.5	
Catch/vessel (t)	69.4	123.8	112.2	
Catch/hour (kg)	59.2	146.3	134.7	

Source : DOF "The Marine Fisheries Statistics based on the sample survey 1982" (unpublished preliminary results).

Table A.9. Catch, effort, revenue, cost and profits of selected trawlers, based on the 1982 survey by the Office of Agricultural Economics.

	Otter trawler		Pair trawler	Weighted
	14-18 m	18-25 m	14-18 m	average
No. of vessels	2,406	1,529	593	—
Catch per vessel (t)	313	690	238	430
Trash fish as a % of catch	66	63	62	64
Effort per vessel (hr)	3,710	3,873	1,300	3,449
Effort per vessel (standard hr)	8,028	17,685	6,105	11,037
Cost per unit of effort (฿/st hr)	174	194	214	183
CPUE (kg/hr)	84	178	183	124
CPUE (kg/hr)	39	39	39	39
Catching power index	2.16	4.57	4.70	3.18
Price (baht/kg)	5.93	6.27	6.35	6.20
Cost (baht/kg)	4.27	4.70	5.33	4.70
Profit (baht/kg)	1.66	1.57	1.02	1.43
Revenues per vessel (฿ x 10^3)	1,856	4,326	1,511	2,666
Costs per vessel (฿ x 10^3)	1,337	3,243	1,269	2,021
Profits per vessel (฿ x 10^3)	519	1,083	242	645
Capital per vessel (฿ x 10^3)	728	2,005	830	1,118
Return (% 0)	71	54	29	58
Net profit per vessel (฿ x 10^3)	373	682	76	421

Source : Number of vessels from Table 5.4. The rest calculated from data given in OAE (1983).

Table A.10. Catch, effort, revenues, costs, and profits (in thousand baht) of the Thai trawl fishery for selected years (alternative estimates for 1982).

<table>
<tr><th>Year</th><th>No. of vessels</th><th>Total catch (t x 10^3)</th><th>Total effort (hr)</th><th>Total revenues</th><th>Total costs</th><th>Profits</th><th>Capital 1</th><th>Capital 2</th><th>Net profits 1[b]</th><th>Net profits 2[c]</th></tr>
<tr><td>1969</td><td>2,107</td><td>383</td><td>3.7</td><td>560</td><td>476</td><td>84</td><td>192</td><td>383</td><td>46</td><td>8</td></tr>
<tr><td>1974</td><td>4,868</td><td>969</td><td>16.7</td><td>2,074</td><td>2,122</td><td>–49</td><td>915</td><td>1,767</td><td>–234</td><td>–404</td></tr>
<tr><td>1977</td><td>5,868</td><td>1,209</td><td>25.7</td><td>3,673</td><td>2,852</td><td>822</td><td>1,966</td><td>3,621</td><td>428</td><td>100</td></tr>
<tr><td>1982[a]</td><td>4,528</td><td>1,949</td><td>50.0</td><td>12,071</td><td>9,151</td><td>2,920</td><td colspan="2">5,062</td><td colspan="2">1,906</td></tr>
</table>

[a]The 1982 figures include otter trawlers 14-18 m and 18-25 m and pair trawlers 14-18 m, while the 1969, 1974 and 1977 figures include also otter trawlers < 14 m and > 25 m and pair trawlers < 14 m and > 18 m. Not only are the 1982 figures not strictly comparable to the three earlier years but they should also be regarded with caution since they are derived from different sources.

[b]Net profits 1 = profits minus opportunity cost of capital assumed to be 20% capital 1 (= current value of fishing assets).

[c]Net profits 2 = profits minus opportunity cost of capital assumed to be 20% of capital 2 (= original purchase value of fishing assets).

Source : The 1982 figures were calculated from Table A.9. The 1969, 1974 and 1977 figures are reproduced here from Table 5.1 for comparison with the 1982 figures.