Indonesian Marine Capture Fisheries

C. Bailey
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F. Marahudin

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The importance of the sea, the multispecies nature of fisheries resources (top) *and the perilous life of a sailor* (bottom) *have long been recognized by Indonesians as shown in these bas reliefs from the Borobodur Temple, Central Java, circa 900 A.D. The prominence of the turtle* (top) *reflects the symbolic importance of this creature. Photos by C. Bailey.*

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Cover: Large sail powered boats find a sheltered anchorage along a river near Labuan, West Java. Photo by C. Bailey.

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CONTENTS

PREFACE

This study is one of a series of research efforts by interdisciplinary teams which consolidate and synthesize existing knowledge relating to the marine fisheries of Southeast Asia. The goal of these reviews is to make more readily accessible to policymakers and researchers alike the broad range of available information relevant to their individual and programmatic needs. By reviewing published and unpublished materials, these studies draw attention both to what is known and to critical gaps in understanding which require research. The first of these country-specific reviews, Philippine Municipal Fisheries: A Review of Resources, Technology and Socioeconomics (Smith et al. 1980), was a joint undertaking of the Fishery Industry Development Council (Philippines) and the International Center for Living Aquatic Resources Management (ICLARM). A similar manuscript on Thai fisheries is forthcoming.

This review of Indonesian marine capture fisheries is the result of a cooperative effort among researchers from the Directorate General of Fisheries (DGF), the Marine Fisheries Research Institute (MFRI) and ICLARM. Work on this project began in October 1981. To obtain the information required, the authors found it necessary to travel extensively throughout Indonesia. During the course of these travels, the team interviewed government officers, university researchers, fishermen, fish buyers and leaders of coastal fishing communities. A large volume of "grey" literature not otherwise available was obtained from regional universities and government agencies. Complete sets of these reports have been photocopied and deposited in the libraries of the three institutions which the authors represent.

A quick look through the reference section of this review will suffice to show that a wealth of information already exists on the biological, technical and socioeconomic aspects of Indonesian marine fisheries. However, much of the knowledge and literature remains scattered and underutilized. The authors seek to address this problem in the hope and belief that valuable insights can be gained by taking stock of what already is known.

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F. Marahudin

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LIST OF ACRONYMS AND ABBREVIATIONS

AARD	Agency for Agricultural Research and Development
ADC	Agricultural Development Council
BAPPENAS	National Development Planning Agency
BIMAS	Bimbingan Masal (Mass Guidance Credit Program)
BPPL	Balai Penelitian Perikanan Laut (Marine Fisheries Research Institute)
BPS	Biro Pusat Statistik (Central Bureau of Statistics)
BRI	Bank Rakyat Indonesia (People's Bank of Indonesia)
CFRDI	Central Fisheries Research and Development Institute
CPUE	Catch per unit effort
DGC	Directorate General of Cooperatives
DGF	Directorate General of Fisheries
DGT	Directorate General of Transmigration
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FTRI	Fisheries Technology Research Institute
GT	Gross tons
GTZ	German Technical Assistance Agency
ha	Hectare
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre of Canada
IFRI	Inland Fisheries Research Institute
IKPI	Induk Koperasi Perikanan Indonesia (National Federation of Indonesian Fisheries Cooperatives)
IPB	Institut Pertanian Bogor (Bogor Agricultural Institute)
JETINDOFISH	Joint Eastern Tropical Indian Ocean Fishery Survey
KIK	Kredit Investasi Kecil (Small Investment Credit Program)
KMKP	Kredit Modal Kerja Permanin (Working Capital Credit Program)
KUD	Koperasi Unit Desa (Village Unit Cooperative)
LON	Lembaga Oseonolgi Nasional (National Oceanographic Institute)
LPPL	Lembaga Penelitian Perikanan Laut (Marine Fisheries Research Institute; now BPPL)
MFRI	Marine Fisheries Research Institute
MSY	Maximum sustainable yield
REPELITA	Indonesian government's five-year development plan
Rp	Rupiah (unit of Indonesian currency)
SCS	South China Seas Fisheries Development and Coordinating Programme
TPI	Tempat Pelelangan Ikan (Fish Auction Hall)
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WHOI	Woods Hole Oceanographic Institution

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CHAPTER 1

OVERVIEW OF INDONESIAN MARINE CAPTURE FISHERIES

C. Bailey

Abstract

In an archipelagic nation such as Indonesia, the marine environment is both a dominating physical reality and a source of national wealth. Indonesia's marine capture fisheries provide important foreign exchange earnings and play a critical role in supplying high-quality protein to domestic consumers. As an introduction to the more detailed chapters which follow, the basic structure of this sector is outlined. The potentials and problems associated with further development and exploitation of available fisheries resources are discussed. Sources of information are described, most of which are in the form of scattered "grey" literature not widely available and hence underutilized. The rationale behind this review is to synthesize and critically assess existing knowledge, to identify important gaps in understanding and to do so in a manner and form useful to both policymakers and researchers.

The Indonesian Perspective on the Sea

An appreciation for the importance of the sea in Indonesian consciousness can be derived from two concepts Indonesians have of their country. Tanah-air kita translates literally as "our lands and waters" and is an explicit recognition that the Indonesian homeland embraces both land and sea. Nusantara, the second concept, is a word formed by combining nusa (island) and antara (between) literally meaning archipelago but used more broadly in reference to the "Indonesian homeland" (Nusantara Indonesia). Islands and the surrounding (or perhaps more accurately, connecting) seas are perceived as a single entity which together define the Indonesian nation. It is not surprising that Indonesia has adopted the archipelagic principle in defining her territorial waters, including all areas lying between the country's 13,667 islands as part of the national domain; these territorial waters total 3.1 million km^2. With the promulgation of the 200-mile Exclusive Economic Zone (EEZ) in March 1980, a further 2.5 million km^2 have been added to Indonesia's maritime jurisdiction.

The seas surrounding Indonesia have shaped its history and will continue to play a major part in determining its future. Strategically located along the sea lanes between East and South Asia (Fig. 1.1), and beyond to Europe, Indonesia's culture and history have been profoundly influenced by the sea. In the ninth century, the empire of Srivijaya rose to regional prominence by controlling trade through the Malacca Straits, a role inherited

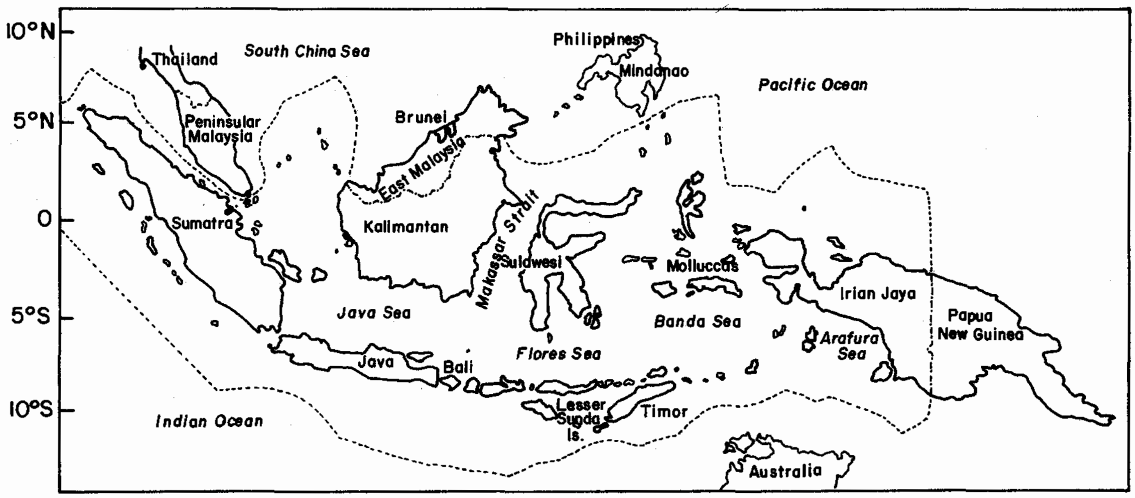

Fig. 1.1. Indonesian territorial waters and Exclusive Economic Zone (adapted from Prescott 1981).

by the Majapahit empire in the thirteenth century. Hinduism, Buddhism and later Islam came to Indonesia by sea, brought by traders from South Asia, Persia and the Middle East. Portuguese, English and Dutch colonialists followed the same paths, carving out empires based on control of maritime trade. Overseas contacts, the wealth generated by trade, the importance of the sea for communication and the consequent location of major administrative and population centers on the coast, have led to a strong maritime orientation in Indonesian history (Wolters 1967; see also Emmerson 1980a for a regional maritime perspective).

A leading Indonesian marine scientist eloquently stated the importance of the sea for his country (Soegiarto 1981):

> The Indonesian waters, an area of over five million square kilometers, cover two-thirds of the Indonesian territory. Therefore, how fully and wisely these waters are utilized in the coming decade will affect our economy, our ability to meet the increasing demand for food and raw materials, our position and influence in the regional community of nations, our national resilience, and the environmental quality of the country as a whole, in which the marine environment is the dominating physical factor.

In more recent years, the sea has become increasingly significant as a source of national wealth. The exploitation of petroleum resources in Indonesian waters, combined with land-based operations, has made a significant contribution to the Indonesian treasury and has permitted large investments in national and rural development. Fishery products also have contributed to Indonesia's export earnings, totalling US$253.6 million in 1982 (BPS 1984). Shrimp accounted for US$181.2 million of this total. Tunas (including skipjack) are the second most important export commodity, valued at $21.4 million. Floyd (1984) presented a detailed description of Indonesia's foreign trade in fisheries products.

Indonesia's Marine Fisheries

Indonesia straddles the equator, and its climate is distinctly tropical. Seasonal variations in rainfall and wind direction are determined by the northwest and southeast monsoons. The heaviest rainfall throughout most of the archipelago comes with the northwest monsoon (November-February), when strong winds blow in a generally easterly direction. The southeast monsoon comes to Indonesia during June to August, bringing relatively little rainfall but winds and rough seas, which adversely affect fishing operations along the entire Indian Ocean shoreline. Other fishing grounds are relatively sheltered during the southeast monsoon but are more exposed to winds of the northwest monsoon. The weather is relatively calm throughout the archipelago during transition periods between the two monsoons.

Indonesia's narine environment is extremely complex. Polunin (1983) reviewed a large body of literature pertaining to this topic and noted that many groups of marine organisms reach the peak of speciation in Indonesian waters. Sidarto (1979) reported some 2,500 species of fish to be present. Indonesia's marine environment also is characterized by great physical diversity, with extensive continental shelves in the western half of the archipelago giving way to great oceanic depths in eastern waters. The coastal areas contain mangrove forests, seagrass beds, coral reefs and estuaries (Burbridge 1983; Polunin 1983). Each of these coastal ecosystems supports biologically and commercially important marine populations. Generally, fisheries resources within Indonesia are most densely concentrated in nearshore waters (see Chapter 2).

The bulk of Indonesia's total marine fisheries landings is caught in coastal waters by small-scale fisheries. As is common in this part of the world, Indonesia's marine fisheries may be characterized as multispecies and multigear. Most Indonesian fishermen exploit a number of different species depending on weather conditions and seasonal availability. The DGF reports annual landings by quantity and value for 45 finfish species or species groups, seven species or groups of both crustaceans and molluscs and four other species groups (seaweeds, turtles, sea cucumbers and jellyfish). To exploit this diversity of fishing grounds and commercially valuable species, a wide range of gear types and fishing vessels is in use. The DGF publishes landings statistics for 29 of the most important gear, ranging from simple "traditional" hand lines to more technically complex "modern" gear (e.g., trawls and purse seines).

Indonesia's marine fisheries sector is divided for planning purposes into small-, medium- and large-scale subsectors, which are described in greater detail in Chapter 3. Small-scale fisheries, by far the most important in terms of employment, numbers of fishing units and quantity of landings, are distinguished from the other subsectors by type (or absence) of boat employed. All fishing units which do not employ boats, use boats without engines or use boats powered by outboard engines are defined as small-scale.

Both medium- and large-scale fisheries are distinguished from the small-scale subsector by use of boats powered by inboard engines. Large-scale fisheries are defined by legal status and may be differentiated from medium-scale fisheries on the basis of investment levels and areas in which they are permitted to operate. Privately owned large-scale domestic fisheries are organized under the Domestic Capital Investment Law of 1968. Joint venture fishing enterprises are chartered under the Foreign Capital Investment Law of 1967. There are, in addition, six government-owned fishing enterprises defined as large-scale. Each type of large-scale fishing enterprises is characterized by substantial investments both in fleets of boats and in shore-based facilities and is restricted to operating in areas where there is no competition with other (usually small-scale) fisheries.

Unlike large-scale fishing enterprises, the medium-scale subsector is owned exclusively by Indonesian citizens and operates throughout the archipelago. Ownership within this subsector typically is in the hands of individual entrepreneurs who have little or no investment in shore-based facilities and who own one or several fishing units.

The Importance of Marine Fisheries

Fish provides the single most important source of animal protein and the only affordable source to the majority of the population. Given the relatively high cost of meat, eggs and milk products, fish is likely to continue to be the most important source of animal protein in Indonesia. In 1982, annual per capital fish supply was approximately 12.9 kg, though there was considerable variation between islands and regions (Table 6.1).

In 1982, marine fisheries landings totalled 1.49 million tonnes (t), accounting for 75% of Indonesia's total fisheries production of just under 2 million t (Table 1.1). Inland capture fisheries contributed 265,000 t (13%), followed by brackishwater and freshwater pond production of 129,000 t (6.5%) and 69,000 t (3.5%), respectively. Rice-fish culture contributed a further 2% (42,000 t), and provided a particularly important source of protein in isolated interior regions where fresh fish otherwise were unavailable. Cage culture of fish, a system with great potential, is in its infancy in Indonesia, with total production in 1982 of only 890 t. Table 1.1 summarizes Indonesia's fisheries production during 1968 to 1983.

Tabel 1.1. Produksi menurut sub sektor perikanan, 1968-1982.[a]
Table 1.1. Fisheries landings by subsector, 1968-1982.[a]

Tahun	Jumlah produksi	Kenaikan	Produksi perikanan laut	Kenaikan	Produksi perikanan lain	Kenaikan
Year	Total harvest (t)	Increase (%)	Marine fisheries landings (t)	Increase (%)	Harvest All other fisheries (t)	Increase (%)
1968	1,159	–	723	–	436	–
1969	1,214	4.8	785	8.7	429	–1.8
1970	1,229	1.2	807	2.8	421	–1.8
1971	1,245	1.3	820	1.6	425	1.0
1972	1,269	2.0	836	1.9	432	1.6
1973	1,278	0.7	889	6.2	389	–11.0
1974	1,336	4.6	949	6.8	389	0.0
1975	1,390	4.0	997	5.1	394	1.3
1976	1,483	6.7	1,082	8.5	402	2.0
1977	1,572	6.0	1,158	7.0	414	3.2
1978	1,648	4.8	1,227	6.0	420	1.5
1979	1,748	6.1	1,318	7.4	430	2.4
1980	1,850	5.8	1,395	5.8	455	5.4
1981	1,915	3.5	1,408	0.9	482	5.9
1982	1,998	4.3	1,491	7.5	507	5.2
1983[b]	2,120	6.1	1,600	7.3	520	2.6

[a]Sumber/Source: DGF (1984).
[b]Estimasi/Estimated.

Whatever the importance of inland fisheries and aquaculture, it is clear that marine capture fisheries contribute the bulk of total harvests and that over the past 20 years, this sector has grown in overall importance (Fig. 1.2). Marine landings more than doubled between 1968 and 1983 and nearly every year increased at a rate higher than that of the fisheries sector as a whole (Table 1.1). During this period, the total fishing fleet declined in numbers, but the number of motorized fishing boats increased at a remarkably rapid pace, particularly since the late 1970s (Fig.1.3). Employment in the marine fisheries sector also increased since 1975 despite the decline in fleet size.

Indonesia's fisheries scientists and policymakers are confident that recent marine landings are sustainable and can be increased substantially. During the current Five Year

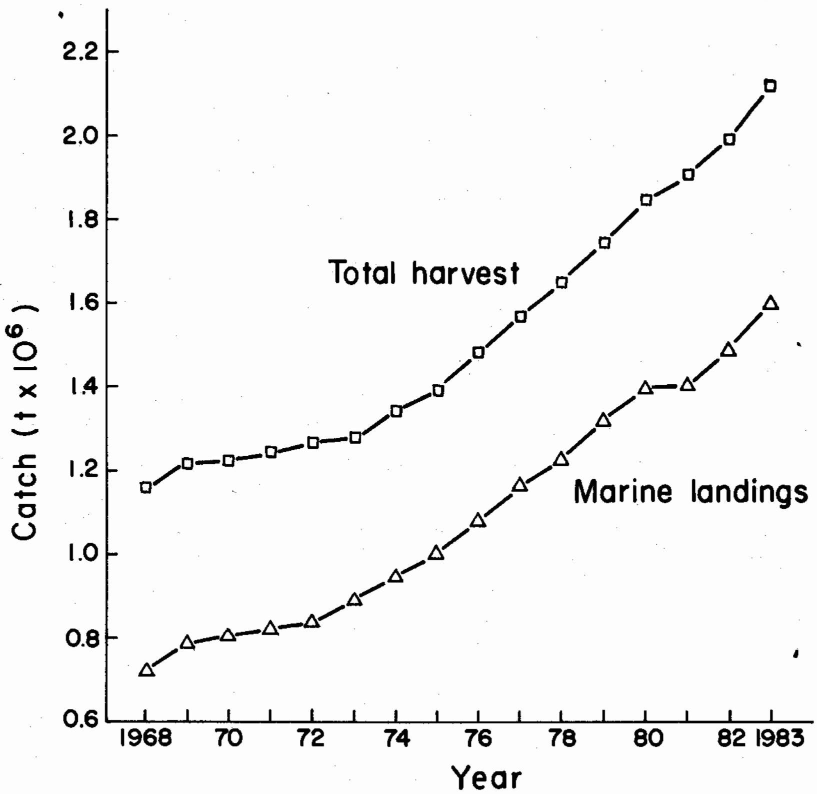

Fig. 1.2. Increased marine landings account for growth in total fish harvest, 1968-1983.

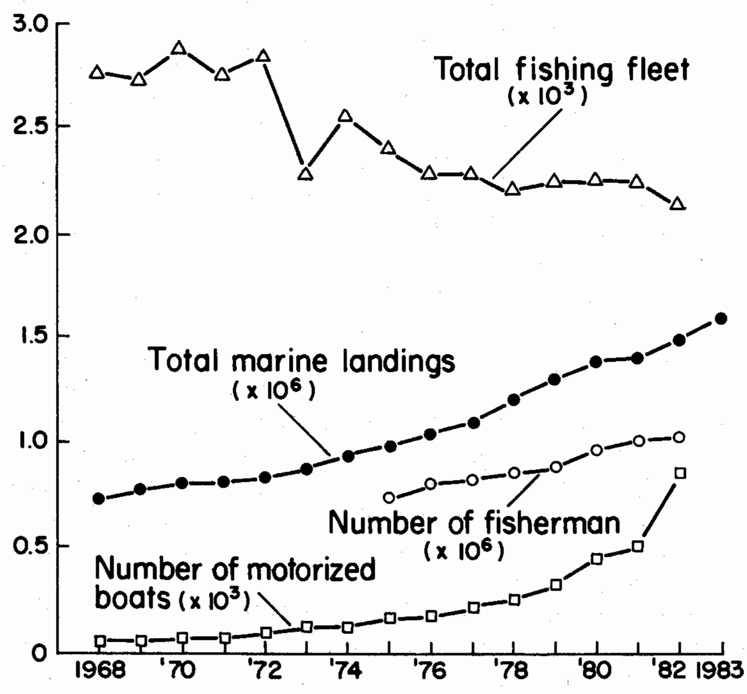

Fig. 1.3. Time series data on Indonesian marine fisheries (DGF 1984).

Development Plan (REPELITA IV, 1984-1988), marine landings are projected to increase at an average annual rate of 5.1% (DGF 1983).

The DGF and MFRI (1983) estimated 4.5 million t can be harvested on a sustainable basis from Indonesia's territorial waters and a further 2.1 million t from the Exclusive Economic Zone. Hotta (1982), however, suggested that such estimates may be too high given the relative lack of solid research, especially on pelagic resources. The data upon which these estimates are based and the estimates themselves are reviewed and reassessed in Chapter 2.

Indonesia's marine fisheries resources are unevenly exploited. Some fishing grounds are under heavy pressure, with levels of fishing effort greater than necessary to achieve maximum sustainable yields. In other areas, available stocks are underexploited and would support expanded fishing effort and larger harvests. Generally, shallow inshore fisheries are heavily exploited and, with the exception of coastal waters surrounding some of the more sparsely populated islands, offer distinctly limited potential for expanded production. What potential exists for the most part is limited to offshore fisheries resources, the exploitation of which typically requires more sophisticated fishing technology and higher levels of investment than are common among the majority of Indonesia's 1.2 million marine fishermen (DGF 1984), 90% of whom are small-scale operators (Chapter 3). Small-scale fishermen are limited by their boats and gear to operating in nearshore waters which, as a consequence, are under heavy fishing pressure. This is particularly true for the Malacca Straits and the north coast of Java, where 37% of all Indonesian fishermen are found (DGF 1984; see Table 7.6).

The concentration of fishermen in these two areas reflects the uneven distribution of Indonesia's population, which totalled approximately 155 million in 1982 (BPS 1984), fifth largest in the world. Of this total, 125 million (81% of the national population) live on the islands of Java, Madura and Sumatra (Table 6.1). The large population of these islands provides a ready market for the catch, which serves to encourage fishing operations in nearby waters. Conversely, exploitation of more distant waters is discouraged due to limited local demand (a function of sparse population) and the difficulty of distributing a highly perishable commodity over great distances to markets on more densely populated islands. Matching fisheries resources and their exploitation to areas of demand is an issue of fundamental importance to fishermen and policymakers alike.

During the 1970s, heavy pressure was exerted both by large numbers of small-scale fishermen and medium-scale trawlers on the inshore fisheries resources of the Malacca Straits and the north coast of Java. Trawlers were attracted to these areas by the presence of shrimp, a high valued export commodity. In 1980, there were approximately 2,500 small otter trawlers (10-30 GT) in Indonesia which accounted for 12.5% of total marine fisheries production in that year (DGF 1982c). More than half of these trawlers (1,557) operated in the Malacca Straits and off the north coast of Java, the two most productive fishing grounds in Indonesia. Trawlers accounted for 20% of total landings from the two areas (DGF 1982c).

The rapid expansion of fishing effort by trawlers in these two areas contributed significantly to overexploitation of coastal fisheries and negatively affected landings and incomes of small-scale fishermen operating passive gear of relatively limited fishing power (Bailey 1984). Tensions were further aroused by frequent damage to small-scale gear caused by trawlers, resulting in occasional outbreaks of violence along the north and south coasts of Java and in the Malacca Straits. Efforts to restrict trawler operations to offshore fishing grounds (reviewed in Chapter 4) proved inadequate due to weak enforcement of existing regulations (Sardjono 1980).

Government authorities recognized the threat posed by trawlers both to important fishery resources and the livelihoods of small-scale fishermen. In response, trawler operations in waters off Java and Sumatra were banned by Presidential Decree No. 39 of 1980. This ban came into full effect by 1 January 1981 and was extended by Presidential Letter of Instruction No. 11 of 1982 to include all of Indonesia except the Arafura Sea as of 1 January 1983. The implications of this dramatic action are discussed in the Chapters which follow.

Indonesia's trawl ban represents an important reaffirmation of small-scale fisheries development as a national priority. As Indonesia strives to restructure her marine fisheries in light of this action, the need for sound management and development policies is great. A major goal of this review is to assist this process by making more readily available the wide range of information which exists on Indonesia's marine fisheries sector.

Sources of Information on Indonesian Fisheries

Prior to 1977, the DGF performed both research and development functions. In that year, as part of a larger reorganization that affected the Ministry of Agriculture (within which the DGF is located) as well as other ministries, research functions were removed from the DGF and placed under the Ministry's Agency for Agricultural Research and Development (AARD). The Central Fisheries Research and Development Institute (CFRDI) is responsible for coordinating the research activities of research institutes focusing on marine fisheries, coastal aquaculture and freshwater fisheries. Each of these institutes publishes research findings in its own regular journals or in special reports which are widely circulated within Indonesia. Researchers are awarded points for their publications, a strong incentive for research dissemination as promotions and salary increases are dependent on points earned.

The separation of research functions from the DGF, which retains responsibility for fisheries management and development, is not in all cases clearly defined. The DGF, while not engaged directly in research, supplies valuable data for researchers, especially in the field of stock assessment, as well as for development planners and administrators. Administrative officers of the DGF at the subdistrict, district and provincial levels prepare annual reports on conditions within their jurisdictions. Local statistical reports are reviewed and summarized in the annual Fisheries Statistics of Indonesia prepared by the DGF headquarters staff in Jakarta. Data published since 1975 are of considerably higher quality than those of preceding years, which must be treated with some caution (Simpson 1982).

The annual reports contain valuable information on numbers of fishermen, boats, types of gear in use and volume, value and species composition of the catch. The data are disaggregated on a regional basis between 11 coastal areas and the provinces within these areas. In some cases, landings within a single province (e.g., Central Java) are reported in two separate coastal areas (e.g., north and south coasts of Java). The physical and resource characteristics of these coastal areas are described in the next chapter.

Despite their wealth of statistical detail, these annual reports are of limited utility to planners and researchers concerned with social and economic aspects of Indonesia's fisheries. Recognizing the need for such information, the DGF has been directly involved in several socioeconomic surveys (DGF 1976; DGF 1978b, 1982; BPS and DGF 1979). Perhaps more significantly, the DGF has commissioned a large number of studies by university researchers on issues related to community development, transmigration, cooperatives and technology transfer. Other government agencies, including the MFRI, also have sponsored research work in coastal communities by local universities. Official sponsorship of research on socioeconomic aspects of fisheries development has contributed significantly to continued interest among students and faculty researchers.

A major source of information on Indonesia's fisheries is to be found in student theses and reports by university faculty. Seven Indonesian universities have faculties of fisheries or departments of fisheries within a larger faculty in another discipline. These fisheries faculties and departments train students in a wide range of disciplines, including marine biology, fisheries technology and fish processing. Students from faculties of economics or socioeconomics also have become involved in fisheries-related research where well-established fisheries programs exist, for example at Hasanuddin University (South Sulawesi), Diponegoro University (Central Java) and the Bogor Agricultural Institute (West Java). Other universities such as the University of North Sumatra, Brawijaya University

(East Java) and Sam Ratulanggi University (North Sulawesi) also have substantial commitments to fisheries-related research.

Student theses and faculty research reports are especially significant as sources of social and economic data, although the quality is uneven and the utility is lessened by the limited time spent in actual field research. In some cases, however, especially where research is conducted as part of a government-commissioned study, the quality is quite high. The Agricultural Development Council (ADC) also has made a major contribution in training students and has sponsored a number of valuable studies on socioeconomic aspects of fisheries.

More recently, the International Center for Living Aquatic Resources Management (ICLARM) and the International Development Research Centre of Canada (IDRC) have established an Asian Fisheries Social Science Research Network in Southeast Asia. In Indonesia, network members include Diponegoro University and the Center for Agro-economic Research of AARD.

The usefulness of student and faculty research is constrained by limited distribution of the resulting reports and theses. There is no single clearinghouse or abstracting service for dissemination of research results, and funding limitations preclude the production of adequate numbers of copies for widespread distribution. Problems associated with limited distribution of research results are compounded by the great distances and hence costs of travelling between various universities, especially those on different islands. As a result, researchers commonly work in isolation from colleagues based at other universities.

The problem of isolation among researchers and between researchers and policymakers has been overcome, to some extent, by frequent seminars and workshops sponsored by various universities and government agencies. In 1978, for example, the Marine Fisheries Research Institute (MFRI) sponsored a major Symposium on the Modernization of Small-Scale Fisheries which attracted fisheries administrators, planners and researchers and resulted in the publication of scores of papers on marine biology, stock assessment, fishery technology, fish processing and socioeconomics. Papers presented at the Symposium were bound and placed in major libraries in Indonesia; a set of abstracts was published separately (LPPL 1979).[1] In 1982, CFRDI organized a Workshop on Fisheries Socio-Economics attended by social scientists and policymakers. The following year, the Proceedings of this Workshop were published (Pusat Penelitian dan Pengembangan Perikanan 1983).

Previous efforts to compile information available on Indonesia's fisheries sector provided a good starting point for the current review. The study by Collier et al. (1977), while focused on the north coast of Java, contains an extensive reference section on socioeconomic aspects of Indonesian fisheries. A manuscript on the marine environment in Indonesia prepared by Soegiarto and Pollunin (1982) and Polunin's (1983) refinement of this earlier work are extremely useful reviews of literature on that topic.

Staff of the National Oceanographic Institute (LON) have prepared seven annotated bibliographies related to marine resources and environments (Ongkosongo and Soegiarto 1980; Soegiarto et al. 1975a, 1975b, 1975c; Soegiarto and Soegiarto 1976, 1978; Thawab et al. 1979). These bibliographies are extremely useful but do not include socioeconomic studies. The central library of the Ministry of Agriculture at Bogor, formerly known as the Bibliotheca Bogoriensis, has published a list of its fisheries holdings, which include a number of socioeconomic studies (Pusat Perpustakaan Biologi dan Pertanian 1981). Even this collection, however, contains but a small proportion of the studies unearthed by this review team.

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[1] In 1981, the Lembaga Penelitian Perikanan Laut (LPPL) was renamed the Balai Penelitian Perikanan Laut (BPPL). References cited in this Review follow the name in use at time of publication.

Need and Purpose of this Review

A large and rapidly growing body of literature on Indonesia's fisheries has been generated by researchers working in a wide range of disciplines. Much of this literature is scattered and underutilized, and this is so particularly in the fields of economics and socioeconomics. The purpose of this study is to review existing knowledge, literature and data regarding Indonesia's marine capture fisheries, and thereby make the insights gained by past effort more accessible to researchers and policymakers alike. Rather than simply report the results of previous research, however, the authors feel it more appropriate and useful to examine and reassess certain research findings in the context of fisheries management and development policies. Therefore, this is a critical review which focuses on the contributions of research to our understanding of Indonesia's fisheries, to the needs and achievements of fisheries development programs and to the interactions between research and development efforts.

In preparing this review, the authors relied primarily on secondary data. The intent was to establish the parameters of existing knowledge as a springboard to future research aimed to critical gaps in understanding. Efforts to collect primary data were made chiefly to verify data from other sources. Therefore, to a significant degree the focus of this study is limited by what research has been accomplished by others. The review itself is largely descriptive because most of the available literature have followed this approach. There are major gaps in the literature which we can do little more than identify in the hope that others will build on the foundation of past research effort.

CHAPTER 2

INDONESIA'S MARINE FISHERIES RESOURCES

A. Dwiponggo

Abstract

This chapter reviews (a) the basic oceanographic features of Indonesia's major fishing grounds; (b) the fisheries for 12 areas separately, using in most cases surplus production models to assess the state of resource exploitation; (c) the demersal and pelagic fisheries of Indonesia as a whole; and (d) the areas for possible expansion of the fisheries. In most parts of western Indonesia, the demersal stocks appear to be strongly exploited, offering little room if any for expansion. The pelagic resources are generally less exploited, and there seems to be scope for expansion in the sector.

The total potential for the Indonesian marine fisheries was estimated at 4.4 million tonnes/year (t/yr), against a present catch of 1.4 million t/yr. However, the upper figure being estimated in most cases from considerations linking primary to secondary and tertiary production, is very rough and will need to be reassessed when presently underexploited pelagic stocks become fully exploited.

Introduction

A large and growing body of literature is available on Indonesia's marine fisheries resources, reflecting the importance of this topic among both scientists and policymakers. The rapid growth in large- and medium-scale fisheries and the continued high levels of fishing pressure exerted on important coastal fisheries by small-scale fishermen have led to a growing concern regarding the sustainability of harvests of marine resources and an awareness that effective steps must be taken to manage fisheries resource exploitation. In this matter, research which provides accurate stock assessment is of fundamental importance. As conditions change and new information becomes availabe, previous research results need to be reevaluated and updated. The purpose of this chapter is to provide such an update, and to review and reassess existing information on marine fisheries resources of Indonesia as presented, e.g., in Sujastani (1981), and expanding previous reviews of the marine resources of Indonesia (Soegiarto and Polunin 1982; Polunin 1983) in which the fish resources received limited coverage.

Marine fisheries production in Indonesia nearly doubled during the period 1968-1980 and has grown at a rate of over 6%/yr since 1973 (Table 2.1). However, Indonesia's marine fisheries resources are unevenly exploited, with the majority of all fishermen and the largest part of total production coming from the islands of Sumatra and Java. Approximately 55% of all production (approximately 1.4 million t in 1980) was landed by small-scale fishermen who operate primarily in heavily exploited nearshore waters from which further increases in production are unlikely (DGF 1982b). This is particularly true in the case of the Malacca Straits and along the north coast of Java, where 39% of all Indonesian fishermen reside (Table 1.2). Offshore waters and fishing grounds in the eastern portion of Indonesia are less intensively exploited and appear to present opportunities for increased production. The significance of small-scale fishermen in

Tabel 2.1. Daerah perairan pantai menurut propinsi, volume pendaratan dalam ton (1979), persentase dan urutan tingkat besarnya volume ikan laut yang didaratkan di masing masing perairan pantai.

Table 2.1. Standard coastal area fisheries identified by province, landings in tonnes (1979), percentage of national landings and rank of coastal area in marine fisheries landings.[a]

	Coastal area	Province	Landings (t)	Landings %	Rank
I.	Malacca Strait	Aceh (east coast) North Sumatra (east coast) Riau	271,305	20.6	2
II.	East Coast of Sumatra	Jambi South Sumatra Lampung (east coast)	87,116	6.6	4
III.	North Coast of Java	DKI. Jakarta West Java (north coast) Central Java (north coast) East Java	303,292	23.0	1
IV.	South and West Coast of Kalimantan	West Kalimantan Central Kalimantan	69,155	5.2	9
V.	East Coast of Kalimantan	South Kalimantan East Kalimantan	69,930	5.3	8
VI.	West Coast of Sumatra	DI. Aceh (west coast) North Sumatra (west coast) West Sumatra Bengkulu Lampung (west coast)	72,165	5.5	5
VII.	South Coast of Java	West Java (south coast) Central Java (south coast) East Java (south coast)	43,779	3.3	11
VIII.	Bali-Nusa Tenggara-Timor	Bali West Nusa Tenggara East Nusa Tenggara Timor Timur	70,967	5.4	6
IX.	South Coast of Sulawesi	South Sulawesi Southeast Sulawesi	180,882	13.7	3
X.	North Coast of Sulawesi	North Sulawesi Central Sulawesi	60,438	4.6	10
XI.	Maluku	Maluku	70,364	5.3	7
XII.	Irian Jaya	Irian Jaya	18,307	1.4	12
		Total marine production	1,317,744	100.0	

[a]Sumber/Source: DGF (1981).

production and employment, and the importance of coastal fisheries in supplying high-quality food to domestic markets and export products (especially shrimp) for international trade, underscore the need to adopt rational management programs to protect vulnerable inshore fisheries. At the same time, marine resources capable of higher yields offer opportunities and challenges for fisheries development efforts. Programs of resource management and fisheries development both require adequate assessment of resource potentials to achieve success.

Because of the wide diversity of exploited species and fishing grounds in Indonesia, and the significant variations in levels of pressure exerted on marine resources, this chapter examines the state of fisheries resources and levels of exploitation in each of the 12 standard coastal areas used by the DGF in reporting fisheries statistics, which include total catch, catch by species, number and type of fishing gear and species landed by gear. (Note that "coastal" area is a misnomer as it includes all waters off a certain coast, including offshore fishing grounds.) Table 2.1 identifies the 12 coastal areas by province and provides data on total fisheries production, percentage of national production and rank of each area in terms of overall fisheries production.

Unless otherwise stated, all catch-and-effort data are derived from the DGF's annual Fisheries Statistics of Indonesia, with 1979 being the last year for which complete data are available.

For each coastal area, previous estimates of maximum sustainable yield (MSY) are reviewed and updated where possible. For those areas where stock assessment data are not yet available or have not yet been analyzed, estimates were derived using both linear and exponential correlations of effort and catch per unit of effort based on the simple Schaefer model and the Gulland-Fox model. Where applicable, separate analysis is provided for each area for demersal, shrimp and pelagic resources. A list of the most important demersal and pelagic species in Indonesia may be found in Table 2.2, which includes 1979 production figures by species.

Tabel 2.2. Jenis-jenis ikan demersal dan pelagis serta binatang berkulit keras, binatang lunak, dan jenis lain-lain yang berada di perairan Indonesia menurut produksinya dalam tahun 1979.
Table 2.2. Demersal and pelagic fish species, crustaceans, molluscs and other species found in Indonesian waters, with landings by species in 1979.

Kumpulan / Group	Nama Indonesia / Indonesian name	Nama Inggeris / English name	Nama Latin / Scientific name	Produksi (t) / Production (t)
Demersal				
1. Ikan (Fishes)	Ikan Sebelah	Indian halibuts	Psettodidae	5,665
	Ikan Lidah	Tongue soles	Cynoglossidae Pleuronectidae	2,632
	Ikan Nomei	Bombay duck	*Harpodon nehereus*	5,274
	Ikan Peperek	Ponyfishes/Slipmouths	Leiognathidae	41,235
	Manyung	Marine catfishes	*Tachysurus* spp.	21,995
	Beloso	Lizardfishes	*Saurida* spp.	5,336
	Biji nangka	Goatfishes	*Upeneus* spp.	7,427
	Ikan Gerot-Gerot	Grunters/sweetlips	*Pomadasys* spp.	3,728

Continued

Table 2.2. Continued

Kumpulan Group	Nama Indonesia Indonesian name	Nama Inggeris English name	Nama Latin Scientific name	Produksi (t) Production (t)
	Ikan Merah/Bambangan	Red snappers	Lutjanidae	17,806
	Kerapu	Groupers	Serranidae	6,087
	Lencam	Emperors	*Lethrinus* spp.	9,547
	Kakap	Barramundi breams	*Lates calcarifer*	8,456
	Kurisi	Threadfin breams	*Nemipterus* spp.	9,859
	Swanggi	Big eyes	*Priacanthus* spp.	1,110
	Ekor kuning/Pisang-Pisang	Yellow tail/Fusiliers	*Caesio* spp.	10,087
	Gulamah/Tigawaja	Croakers, drums	Sciaenidae	26,747
	Cucut	Sharks	Carcharhinidae, Sphyrnidae, Orectolobidae	20,254
	Pari	Rays	Trigonidae	11,147
	Bawal putih	Silver pomfrets	*Pampus argenteus*	8,809
	Kuro/Senangin	Threadfins	*Polynemus* spp.	9,468
	Layur	Hairtails	*Trichiurus* spp.	12,717
2. Binatang berkulit keras (Crustaceans)	Rajungan	Swimming crabs	*Portunus* spp.	2,741
	Kepiting	Mangrove crabs	*Scylla serrata*	1,081
	Udang barong	Spiny lobsters	*Panulirus* spp.	258
	Udang windu	Tiger prawns	*Penaeus monodon* *Penaeus semisulcatus*	9,027
	Udang putih/Jrebung	Banana prawns	*Penaeus merguiensis* *Penaeus indicus*	31,620
	Udang Dogol	Endeavour prawns	*Metapenaeus* spp.	14,652
	Jenis-jenis udang lain, seperti, rebon udang pasir	All shrimps other than those listed above		75,618
	Binatang berkulit keras lainnya	All crustaceans other than those listed above		2,095
3. Binatang lunak (Molluscs)	Tiram	Cupped oyster	*Crassostrea* spp.	912
	Simping	Scallops	*Amusium* spp.	484

Continued

Table 2.2. Continued

Kumpulan Group	Nama Indonesia Indonesian name	Nama Inggeris English name	Nama Latin Scientific name	Produksi (t) Production (t)
	Remis	Clams	*Meretrix* spp.	2,556
	Kerang darah	Blood cockles	*Anadara* spp.	32,183
	Cumi-cumi	Common squids	*Loligo* spp.	12,812
	Sotong	Cuttlefishes	*Sepia* spp.	1,827
	Gurita	Octopuses	*Octopus* spp.	37
	Binatang lunak lainnya	All molluscs other than those listed above		258
Pelagic				
1. Ikan (Fishes)	Bawal hitam	Black pomfret	*Formio niger*	5,988
	Alu-alu	Barracudas	*Sphyraena* spp.	4,076
	Ikan Layang	Scads	*Decapterus* spp.	78,162
	Selar	Trevallies Yellow striped trevallys	*Selar* spp. *Selaroides* spp.	47,094
	Kuwe	Jacks, trevallys	*Caranx* spp.	8,910
	Tetengkek	Hardtail scads	*Megalaspis cordyla*	6,705
	Daun bambu/Talang-talang	Queenfishes	*Chorinemus* spp.	3,360
	Sunglir	Rainbow runner	*Elagatis bipinnulatus*	4,447
	Ikan terbang	Flyingfishes	*Cypselurus* spp.	14,326
	Belanak	Mullets	*Mugil* spp.	14,430
	Julung-julung	Garfish and Halfbeaks	*Tylosurus* spp. *Hemirhamphus* spp.	19,648
	Teri	Anchovies	*Stolephorus* spp.	96,147
	Japuh	Sardines	*Dussumieria* spp.	7,304
	Tembang	Fringescale sardinella	*Sardinella fimbriata*	79,168
	Lemuru	Indian oil sardinella	*Sardinella longiceps*	45,625
	Golok-golok/Parang-parang	Wolf-herrings	*Chirocentrus* spp.	9,529
	Terubuk	Tolishads (Chinese herrings)	*Clupea toli*	1,483
	Kembung	Indo-Pacific mackerels	*Rastrelliger* spp.	84,485
	Tenggiri papan	Indo-Pacific Spanish mackerels	*Scomberomorus guttatus*	5,165

Continued

Table 2.2. Continued

Kumpulan	Nama Indonesia	Nama Inggeris	Nama Latin	Produksi (t)
Group	Indonesian name	English name	Scientific name	Production (t)
	Tenggiri	Narrow-barred Spanish mackerels	*Scomberomorus commersoni*	27,711
	Tongkol	Eastern little tunas	*Euthynnus* spp.	66,582
	Tuna	Tunas Bigeye tunas Broadbill/Swordfishes Indo-Pacific marlins Indo-Pacific sailfishes	*Thunnus* spp. *Parathunnus obesus* *Xiphias* spp. *Makaira* spp. *Istiophorus orientalis*	17,899
	Cakalang	Skipjack tunas	*Katsuwonus pelamis*	42,834
	Ikan-ikan lain (demersal dan pelagis)	All fishes other than those listed above (demersal and pelagic)		183,716
Lain-lain	Rumput laut	Seaweeds	*Eucheuma* spp. *Gracilaria* spp.	5,945
Others	Penyu	Marine turtles		292
	Teripang	Sea cucumbers		246
	Ubur-ubur	Jellyfishes		2,395
	Lainnya	Others		36

A summary discussion is presented, focusing on stock assessment and levels of exploitation, indicating areas where potentials for increased production exist and areas where MSY has already been reached and where fishing effort is excessive. Potential yields for Indonesia's marine fisheries are estimated based on the preceding analysis by area. Estimates derived from resources surveys are supplemented by estimates based on tertiary productivity converted from primary and secondary biological production, following Cushing (1971).

It should be noted that the two approaches used have to infer potential yields in areas where major fisheries do not exist and provide only rough approximations. This is true for Gulland's (1971) method of estimating potential yield from virgin biomass and an estimate of natural mortalities (see below) which has been found to be generally biased upward (often by a factor of 200-400%) by Beddington and Cooke (1983), as well as for Cushing's method, whose estimate can be erroneous by as much as a factor of 10.

In the following section, before discussing the individual coastal area fisheries, basic oceanographic information is provided upon which estimates of primary, secondary and tertiary production are based.

Indonesia's Marine Fishing Grounds

Indonesia's territorial waters cover an area of approximately 3.1 million km^2, a figure based on the archipelagic principle whereby all waters within this island nation's boundaries are considered territorial waters. With the promulgation of the 200-nautical mile Exclusive Economic Zone (EEZ) in 1982, Indonesia's jurisdiction now extends over a further 2.5 million km^2.

Indonesia's territorial waters consist of three major ecosystems -- the Sunda Shelf, the Sahul Shelf, the Indian Ocean -- and other deep seas. The area in km^2 of these ecosystems and the specific bodies of water which they include is presented in Table 2.3. Both pelagic and demersal fisheries exist in the broad continental shelves, while in the Indian Ocean and other deep seas, exploitation is limited primarily to pelagic stocks, except the south coast of Java (Cilacap) where shrimp resources have been exploited by trawlers.

Tabel 2.3 Luas wilayah perairan laut Indonesia, km^2.

Table 2.3. Extent of Indonesia's territorial waters by area and sub-area, in km^2.

Area and sub-area	Km^2
Sunda Shelf	686,000
Malacca Straits	55,000
South China Sea (Indonesian portion)	250,000
Java Sea (including Sunda Straits)	381,000
Sahul Shelf	160,000
Arafura Sea	143,500
Other waters	16,500
Indian Ocean	132,500
Sumatra, west coast	70,000
Java, south coast	30,000
Bali Straits	2,500
Southern Lesser Sunda Islands	30,000
Other deep seas	1,694,000
Makassar Straits, waters around Sulawesi, northern Lesser Sunda Islands	594,000
Flores Sea	100,000
Banda Sea	100,000
Moluccas (including north and west Irian Jaya)	900,000

Most of Indonesia's shallow shelves are considered trawlable although there are areas covered by coral reefs, sponge beds and rocky outcrops. Bottom conditions in the Sunda Shelf area have been mapped (Salm and Halim 1984). An analysis of the superficial bottom sediment of the Java Sea has been presented by Emery et al. (1972). In general, the pattern of bottom sediment shows the presence of widespread modern silt and clays in the axial part of the shelf between Sumatra, Java and Kalimantan, and detrital sands along most of the shores except Eastern Sumatra and West Kalimantan. Most of the outer shelf is covered by coarse sand. Bottom gravel is common around the islands between Sumatra and Kalimantan. In the South China Sea, mud, sand mud and sand predominate. The widespread presence of deep soft coral and coral hills on ridges in the Java sea has caused problems in operating trawl gears (Losse and Dwiponggo 1977).

Other bodies of water in Indonesia have been less thoroughly studied than the Sunda Shelf. Nonetheless, a large body of hydrologic and oceanographic literature is available, collated primarily by the National Oceanographic Institution (Lembaga Oseonologi National or LON). Of particular significance to knowledge regarding Indonesia's marine fisheries is the information available on current systems, water temperature, salinity, oxygen supply and primary productivity, reviewed below.

Surface current system

Surface current systems in Indonesian waters have been described by several authors (Wyrtki 1961; Soegiarto and Birowo 1975; Salm and Halim 1984). Surface currents in Indonesia are more strongly influenced by currents from the Pacific Ocean than the Indian Ocean, as may be seen from Fig. 2.1 and 2.2.

Surface currents are also greatly influenced by the winds of the prevailing monsoons. North of the equator during November through March, the monsoon winds come out of the northeast. At the equator, the winds blow from the north; while south of the equator to 10° south latitude, winds come from the northwest. The current tends to flow in the same direction as the prevailing winds (Fig. 2.1).

From June to September, the southeast monsoon (or north of the equator southwest monsoon) dominates, marked by currents flowing in a northwesterly direction around Australia and the island of New Guinea. During this period, the circulation of surface waters is reversed through the Banda, Flores, Java and South China Seas (Fig. 2.2). The southeast monsoon is relatively milder than the northwest monsoon. Current velocities are in the range of 12-23 cm/sec, as opposed to 25-38 cm/sec in the northwest monsoon.

Temperature and salinity

As in other tropical waters, seasonal changes in surface temperature in Indonesia usually do not exceed 3°C, from 30°C (April-May) to 27°C (December-January). Surface water temperatures are about equal to average air temperature at sea level and are influenced by seasonal wind and rainfall patterns. Heavy rainfall during the northwest monsoon accounts for reduced surface temperatures during December-January (Wyrtki 1960).

The mean range in salinity of the surface waters within the Indonesian archipelago is 30.8 ppt to 34.3 ppt in the eastern section, and 30.6 ppt to 32.6 ppt in the western section (Soeriaatmadja 1956).

Surface salinity varies by season along coastal areas within a range of 31.0 ppt and 33.0 ppt. Heavy rains and the discharge from rivers influence the salinity of coastal waters, especially during the northwest monsoon. Where rivers flow into a bay, such as Jakarta Bay, the surface salinity is markedly reduced. During the southeast monsoon, when rain and river flows are reduced, high salinity waters from the Pacific enter the Java Sea, raising salinity to 32.5-33 ppt.

Primary productivity

The growth and development of fisheries stocks depend on primary production (phytoplankton) which is used by herbivores (primary consumers), which are themselves consumed by marine organisms further up the food chain (secondary and tertiary consumers). The concentration of nutrients in seawater, consisting of phosphate-phosphorus, nitrate-nitrogen and silicate-silicon in various Indonesian waters has been studied by LON and the results have been published in the Oceanographic Atlas of Indonesian and Surrounding Waters (Soegiarto and Birowo 1975).

The collection of primary production data by radio-carbon techniques in Indonesia was started in 1957 (Steeman-Nielsen and Jensen 1957). Since then several other studies have been conducted (Cushing 1971; Soegiarto and Birowo 1975). However, limited numbers of observations were made which in some cases only covered one season. The data are inadequate to provide anything but a general indication of primary productivity.

In the Sunda Shelf and Sahul Shelf, primary production is generally high due to the influence of river water discharge with a high nutrient content; moreover, shallow waters allow for adequate mixing of the water column. High values have been obtained from the Malacca Straits both in the northeast monsoon and the southwest monsoon. In south

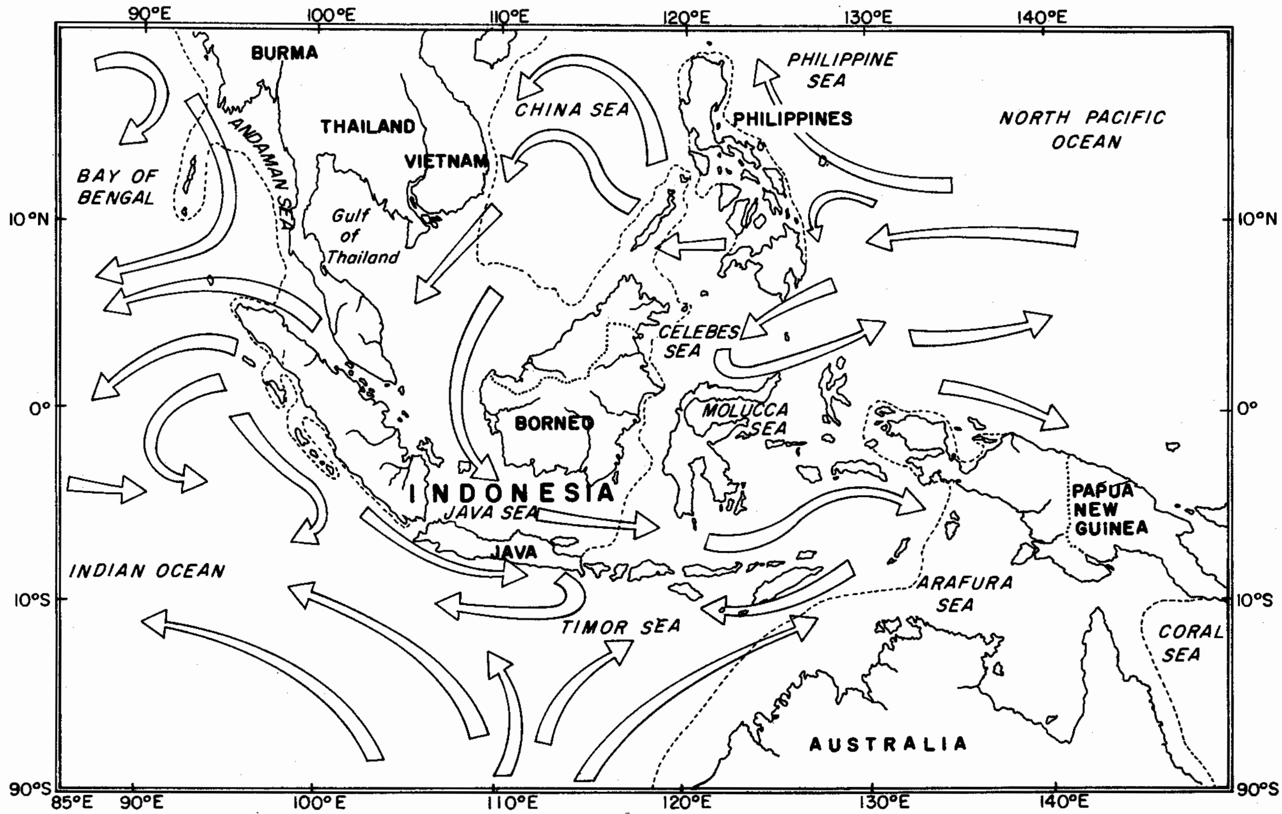

Fig. 2.1. Surface current directions around Indonesia in February.

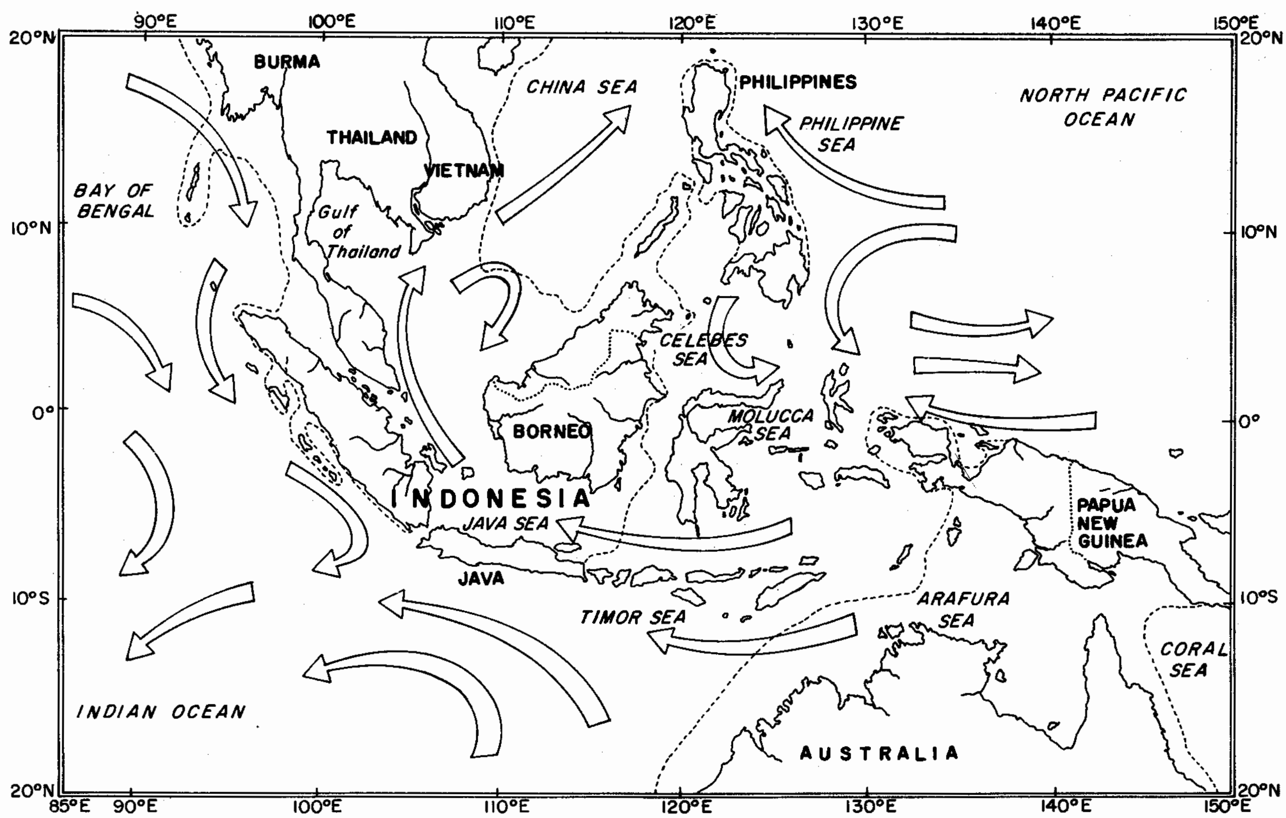

Fig. 2.2. Surface current directions around Indonesia in August.

Kalimantan, high productivity has occurred only in the northeast monsoon (Soeriaatmadja 1956).

Dotty et al. (1963) undertook radio-carbon observations in the Malacca Straits, South China Sea and western Java Sea. Average primary production was highest in the Malacca Straits, greater than 0.30 g C/m^2/day, with some areas showing production greater than 0.70 g C/m^2/day. The results of Dotty et al. were reanalyzed and raised by a factor of 1.45 by Cushing (1971).

Cushing (1971) also used radiocarbon analysis to estimate tertiary production off the west coast of Sumatra, the south coast of Java, and other adjacent waters, defining tertiary production as 1% of primary production (and 10% of secondary production). The distribution of estimated tertiary production during the northeast and southwest monsoon seasons is indicated in Figs. 2.3 and 2.4. Cushing believes that between one-third and one-half of total tertiary production can be harvested.

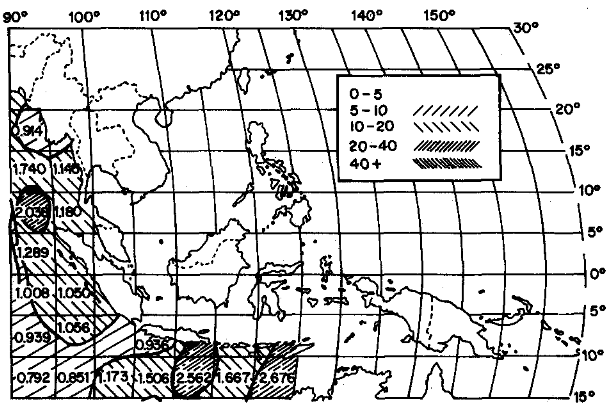

Fig. 2.3. The distribution of tertiary production in million tonnes wet weight/5° square, estimated as average of 1% of the primary production and 10% of the secondary production during the northeast monsoon.

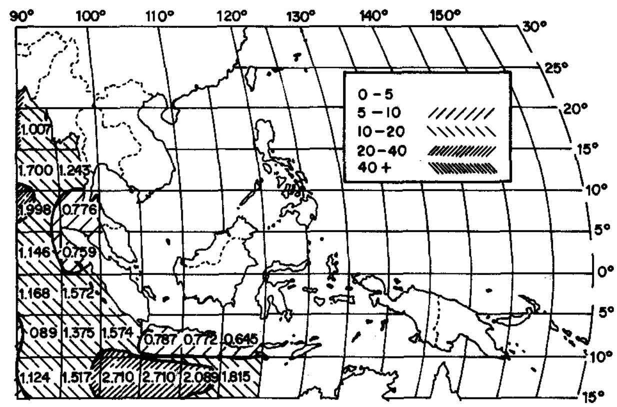

Fig. 2.4. The distribution of tertiary production in million tonnes wet weight/5° square, estimated as average of 1% of the primary production and 10% of the secondary production during the southwest monsoon.

Primary, secondary and tertiary productions are significantly influenced by upwelling in certain parts of Indonesia. Wyrtki (1961, 1962, 1964); Rochford (1962); and Cushing (1971) have described upwelling areas off Java, northwest Australia, and in the Flores, Banda and Arafura Seas. Upwelling off northwest Australia occurs during July-August (Wyrtki 1961) and is associated with the prevailing winds and currents of the northeast monsoon. The most important area of upwelling occurs along the south coast of Java during July-August and is associated with the seasonal Sardinella longiceps fishery of the Bali Straits (Wyrtki 1961, 1962; Dwiponggo 1974; Ritterbush 1975; Pusat Penelitian dan Pengembangan Perikanan 1982). Wyrtki (1962) estimated the extent of upwelling along the south coast of Java, the Bali Straits and the south coasts of Bali and Lombok islands to be 400 km wide and 1,200 km long and the rate of upwelling to be 2.4 million m^3/sec.

A general review of upwelling areas in Indonesia and the influence of upwelling on biological productivity has been made by Cushing (1971) and his summary results are shown in Table 2.4.

The Statistical Basis for Fisheries Resources Assessment

During the mid-1970s, major improvements were made in the collection and presentation of fisheries statistics. Since 1975, the DGF's annual statistical reports have provided information on total production and numbers and types of gear by coastal area

Table 2.4. Estimated productivity in the upwelling areas.[a]

	Area ($\times 10^3$ km^2)	Season (days)	Primary Carbon (season) ($\times 10^6$ t)	Secondary A Carbon (season) ($\times 10^6$ t)	Secondary B Carbon (season) ($\times 10^6$ t) $\times$ 1.33	0.01 C ($\times 10^4$ t)	0.1 D_1 ($\times 10^4$ t)	0.1 D_2[b] ($\times 10^4$ t)	Wet wt (season) ($\times 10^6$ t)	Wet wt (season) ($\times 10^6$ t)
Indian Ocean										
NW Australia	300	150	18.5	2.12	2.82	18.5	21.2	28.2	1.48	1.74
Indonesia										
Java	300	150	27.1	2.64	3.51	27.1	26.4	35.1	2.00	2.32
E. Arafura	250	120	17.0			17.0			(1.28)[c]	
Flores	100	120	8.8			8.8			(0.7)	
Banda	100	120	11.3			11.3			(0.85)	
Gulf of Thailand	75	150	20.8			20.8			(1.56)	
Vietnam	200	120	44.2			44.2			(3.32)	

[a]Sumber/Source: Cushing (1971).
[b]D_2 = assumed a longer generation time (x 1.33).
[c]The estimates in brackets are derived from the values of primary production alone.

and by province. Further improvements in data collection were made in 1977 with the introduction of a new production survey methodology and the use of standard FAO definitions. Fish landings have since included not only the marketed catch but the amount of fish consumed by fishermen and their families and the amount given fishermen in lieu of wages or shares in production.

Production figures are based on actual landings at major fishing ports, which are directly monitored. Because of difficulties in monitoring landings from the numerous small fishing communities scattered along the coast, catch estimates are made from these areas. These estimates are supported by irregular spot checks and interviews with local small-scale fishermen. These fishermen rarely maintain records, however, and given the importance of production from the small-scale subsector, the use of estimates introduces a degree of uncertainty in reports of total production. This problem is compounded in some areas where landings from small-scale fishermen are assigned a fixed percentage of production based on landings at major fishing ports which are monitored. The problem with this is that medium-scale fishing gear with significantly greater fishing power is then used to estimate production from more numerous fishing units of lesser (and varying) fishing power.

Further problems are introduced by the difficulty of counting numbers of fishing units, particularly in small coastal communities where different gear are used on a seasonal basis. Moreover, the number of operating days for individual fishing units, and hence, the level of fishing effort -- a critical variable in stock assessment -- often is estimated based on operations from major fishing ports. Boats from these ports tend to be larger and are usually motorized, while the majority of small-scale boats operating along the coast are smaller and for the most part not motorized, and thus will be less able to operate during seasons of high winds and rough seas. In some areas, a sample of coastal communities is monitored, providing information necessary for adjusting number of operating days by gear and vessel type. The DGF's annual fisheries statistics do not report number of days of operation or other direct measures of fishing effort, but estimated values are used to derive production from communities of fishermen which are not monitored.

Errors in classifying species landed, even as to major fishing group, also exist, introducing problems of assessing specific fishery resources. Moreover, in some areas more than 30% of all fish landed are classified as "other fish"; nationally the landing so classified is 16%. The catch listed as "other fish" suggests that catch figures for some species are too low. This is particularly true for undersized demersal fish species caught by trawlers, and also for pelagic species landed by a number of gear types including, in some cases, trawlers operating in coastal waters.

Finally, it should be noted that such figures are based on place of landing, which may not be the same as actual fishing grounds. For example, some purse seiners based along the north coast of Java operate in waters off Kalimantan and Sulawesi, but their production is credited to landings from Java's north coast.

Despite these problems, Indonesia's fisheries statistics provide reasonably accurate information on the status of marine resources and fisheries production, and are a major source of data for stock assessment purposes. As is true with most fisheries statistics, those of Indonesia must be treated with some caution and cross checked with information from other sources. Fortunately, there are a number of alternative sources of data available in Indonesia, including the results of resource surveys; experimental fishing cruises; and individual reports on particular fisheries, fishing communities and major fishing parts. Such sources need to be consulted in assessing marine resources within particular areas.

Fisheries and Marine Resources by Coastal Area

It is not always easy to distinguish between demersal and pelagic species, especially in coastal fisheries. Gear are more easily classified. For purposes of this review, demersal species are defined as those caught mainly by demersal gear and pelagic species are those caught mainly by pelagic gear.

Malacca Straits

The Malacca Straits divide Peninsular Malaysia from Sumatra and specifically the eastern coasts of the provinces of Aceh and North Sumatra, and Riau Province. The Indonesian portion of the Malacca Straits, which are divided with Malaysia on the principle of equidistance (Prescott 1981), covers an area of approximately 55,000 km^2. Bottom conditions are generally sandy or muddy with some rocky areas. Trawlers in Indonesia were first introduced via Malaysia at the port of Bagan Siapiapi (Riau Province) in the late 1960s and from there spread during the early 1970s throughout the Malacca Straits and into the Java Sea (Unar 1972). Favorable bottom conditions and abundant demersal resources, especially shrimps, resulted in profitable operations and insured the rapid growth of the trawler fleet, individual boats typically displacing 5-20 GT, though some larger (40-100 GT) trawlers were also in use (Unar 1972). By the end of 1971, at least 800 trawlers were operating in the Malacca Straits (Unar 1972). By 1978, the number of trawlers was reported to be 1,310 (Naamin and Farid 1980), though the DGF reported only 935 in that year and 790 in 1979 (DGF 1980, 1981). The discrepancy may reflect the existence of unlicensed trawlers (BPS and DGF 1979).

Marine fisheries production in 1979, the year before the trawler ban was decreed, totalled over 271,000 t, 21% of Indonesia's total (Table 2.1). The Malacca Straits coastal area ranked second behind the north coast of Java in terms of total marine fisheries production. Table 2.5 provides annual demersal and pelagic catch data during the period

1975-1979. Table 2.6 shows the distribution of demersal and pelagic average annual yield (1975-1979) by gear and major species. Trawlers accounted for 55,000 t or 39% of total demersal catch from the Malacca Straits. Shrimps, the target species of both trawlers and various small-scale gear types, were the dominant species group landed in 1979, totalling 66,500 t, 47% of the total demersal catch and 27% of total catch from the Straits. However, high valued penaeid shrimps comprised only 25% of total shrimp production with other shrimps known as rebon (a mixture of mysid and sergestid shrimps and juvenile penaeid shrimps) accounting for the remainder. Rebon usually are caught near estuaries with beach seines, tidal traps and other small-scale gear and are commonly manufactured into shrimp-paste known as terasi.

The rapid growth of trawler operations in the Malacca Straits led to growing concern regarding overexploitation of demersal resources in that area. In response to these concerns, trawl surveys were conducted in 1973 and 1975. In 1975, the average catch rate for all stations surveyed was reported as 106.3 kg/hr. The highest catch rate of 158.2 kg/hr occurred at a depth range of 40-49 m (Saeger et al. 1976). It was concluded that the low density of the demersal stocks in the Malacca Straits compared with other areas was due to heavy fishing pressure by the trawlers exploiting shallow waters (less than 40 m) where shrimp stocks were most abundant. Based on results of three trawl surveys, Sujastani et al. (1976) estimated total standing stock of demersal finfish to be 73,000 t, or 1.33 t/km^2. The virgin stock was estimated to have been 146,000 t or 2.66 t/km^2. The distribution of demersal finfish stock density at various depth ranges is shown in Table 2.7.

Maximum sustainable yields (MSY) of demersal fish and shrimps and corresponding appropriate levels of effort may be derived from Fig. 2.5-2.7. Details on the derivation of these and subsequent yield curves in these sections (Fig. 2.8-2.21) are provided in the next section, dealing with overall resource assessments.

Sujastani et al. (1976) analyzed catch- and effort data collected from provincial fisheries offices in Aceh, North Sumatra and Riau, and interviewed trawler captains. They concluded that the MSY of the Malacca Straits demersal fishery was approximately

Tabel 2.5. Selat Malaka: hasil tengkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.5. Malacca Straits: Catch in tonnes by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan / Gear type and catch	1975	1976	1977	1978	1979	Rata-rata / Average
Jumlah produksi / Total catch	175,080	124,249	129,673	128,698	154,024	142,344.8
Udang penaeid / Penaeid shrimp	18,851	15,692	16,980	18,472	16,091	17,217.2
Demersal						
Udang lain / Other shrimp	1,781	47,109	49,565	51,557	50,391	40,080.6
Ikan demersal / Demersal fish	154,448	61,448	63,128	58,669	86,168	84,772.2
Pelagis / Pelagic						
Ikan pelagis / Pelagic fish	115,048	110,347	102,202	93,639	84,584	101,164

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

85,000 t/yr and that demersal resources were fully exploited. Their findings indicated that by the early 1970s, trawler owners already were shifting their base of operations to the Java Sea (Unar 1972).

In 1976, the South China Sea Fisheries Development and Coordinating Programme (SCS) sponsored a workshop on fisheries resources in the Malacca Straits. Noting that trawler operations were concentrated in shallow waters, the MSY of demersal resources in areas of trawler operations was estimated at 88,000 t/yr. Given greater stock densities in deeper waters, however, total demersal MSY was estimated at 120,000 t/yr (SCS 1976). It was estimated that the MSY for penaeid shrimps was approximately 20,000 t/yr and that this resource was fully exploited.

Between 1975-1979, pelagic fisheries of the Malacca Straits accounted for 42% of total production (Table 2.5). Scoop nets, drifting gill nets and purse seines dominated pelagic fisheries production (Table 2.6).

Tabel 2.6. Selat Malaka: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.6. Malacca Straits: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t), 1975-1979 / Average production (t)	Rata-rata persentasi produksi, 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t), 1975-1979 / Average production (t)	Rata-rata persentasi produksi, 1975-1979 / Average production (%)
Demersal	Trawl	54,931.0	39.0	Udang lain/Other shrimp	40,080.6	35.6
	Jermal/Stow nets	27,389.6	19.0	Udang penaeid/Penaeid shrimp	17,217.2	15.3
	Sero/Guiding barriers	19,889.4	14.0			
	Pancing/Hook and line	10,465.0	7.0	Gulamah/Croakers	15,056.4	13.4
				Kakap/Baramundi	7,575.0	6.7
	Pukat pantai/Beach seine	10,074.8	7.0	Kurisi/Threadfin	6,352.0	5.6
				Kerapu/Groupers	4,114.6	3.6
	Perangkap lain/Other traps	9,266.8	6.5	Manyung/Marine catfish	3,091.0	2.7
	Jaring insang tetap/Set gill net	2,097.2	1.4	Bawal putih/Silver pomfret	2,887.0	2.6
				Pari/Rays	2,783.0	2.5
				Ekor kuning/Yellow-tail fusilier	2,457.0	2.2
Pelagis Pelagic	Serok/Scoop net	31,416.2	30.0	Kembung/Indo-Pacific mackerel	13,288.0	16.4
	Jaring insang hanyut/Drift gill net	25,140.6	25.0	Tongkol/Eastern little tuna	9,192.8	11.4
	Pukat cincin/Purse seine	21,417.8	21.0	Tembang/Fringe scale sardine	8,291.4	10.3
	Payang	7,845.4	8.0			
	Bagan tancap/Stationary liftnet	5,495.6	5.0	Teri/Anchovies	8,051.0	10.0
				Parang-parang/Wolf herring	7,566.4	9.4
	Pancing tonda/Troll lines	2,978.8	2.9	Selar/Yellow striped trevally	7,532.0	9.3
	Jaring angkat lain/Other liftnets	2,832.6	2.8	Tenggiri/Spanish mackerel	7,154.6	8.8
	Jaring insang lingkar/Encircling gill net	2,480.4	2.5	Layang/Scad mackerel	4,281.6	5.3
				Sardin/Sardine	3,587.0	4.0
				Tetengkek/Hardtail scad	2,838.0	3.5

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

trawler operations is the limitation of trawlable grounds caused by coral formations and extensive beds of giant cup sponges (Poterion spp.) in the South China Sea and northwest of Bangka Island (Sudradjat and Beck 1978). A joint venture company, P.T. Misaya Mitra, conducted the first trawl survey off the east coast of Sumatra in 1968 but two years later moved its base of operations to Kalimantan due to poor catches (Unar 1972). Relatively few trawlers moving south from the Malacca Straits in the early 1970s stayed in the area, preferring to operate along Java's north coast where catches were higher. In 1979, the DGF reported only 54 trawlers operating in the provinces of Jambi and Lampung and none in South Sumatra (DGF 1981), though there may have been additional unregistered trawlers.

Compared to the lack of research activities regarding pelagic fisheries, demersal resources in this area have attracted considerable attention. The shrimp fishery has been analyzed by Unar (1972), Yamamoto (1977) and Naamin et al. (1980). In addition, several papers presented at the National Shrimp Seminar in 1977 and regional seminars in 1976

Tabel 2.9. Timur Sumatera: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.9. East Sumatra: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan	Jenis alat tangkapan	Rata-rata produksi (t), 1975-1979	Rata-rata persentasi produksi, 1975-1979	Jenis ikan/udang	Rata-rata produksi (t), 1975-1979	Rata-rata persentasi produksi, 1975-1979
Fishery	Type of gear	Average production (t)	(%)	Species of fish/shrimp	Average production (t)	(%)
Demersal	Pancing/Hook and line	6,938.0	27.0	Manyung/Marine catfish	3,748.0	15.2
	Jaring klitik/Shrimp gill net	4,964.6	19.3	Kurisi/Threadfin bream	2,275.0	9.3
				Udang penaeid/Penaeid shrimp	2,242.8	9.0
	Otter trawl	2,811.0	11.0			
	Jaring insang tetap/Set gill net	2,465.6	9.6	Ikan merah/Red snapper	2,100.0	8.5
				Peperek/Slipmouths	1,908.0	7.8
	Pukat pantai/Beach seine	1,916.8	7.4	Layur/Hairtail	1,565.8	6.4
				Gulamah/Croakers	1,384.4	5.6
	Perangkap lain/Other traps	1,634.0	6.3	Udang lain/Other shrimp	1,345.0	5.5
	Jermal/Stow nets	1,516.4	6.0	Cucut/Sharks	1,343.0	5.5
	Sero/Guiding barriers	895.0	3.5	Pari/Rays	1,238.0	5.0
	Dogol/Danish seine	727.0	2.8			
	Rawai tetap/Set longline	547.4	2.1			
Pelagis Pelagic	Bagan tancap/Stationary liftnet	17,585.0	35.5	Teri/Anchovies	9,871.2	25.5
				Tembang/Fringe scale sardine	4,978.6	12.8
	Jaring insang hanyut/Drift gill net	13,119.0	26.5			
				Selar/Yellow striped trevally	3,751.0	9.7
	Payang	8,440.0	17.0			
	Bagan perahu/Rakit-boat/raft liftnet	7,095.4	14.3	Tenggiri papan/Indo-Pacific Spanish mackerel	3,343.6	8.6
	Jaring angkat lain/Other liftnets	2,410.0	4.9	Tenggiri/Spanish mackerel	3,038.8	7.8
				Lemuru/Oil sardine	2,872.4	7.4
	Jaring insang lingkar/Encircling gill net	1,566.8	3.2	Tongkol/Eastern little tuna	2,650.2	6.9
	Serok/Scoop net	712.2	1.4	Parang-parang/Wolf herring	2,089.4	5.4
	Rawai hanyut/Drift longline	569.0	1.1			
				Belanak/Mullets	2,001.8	5.2
				Bawal hitam/Black pomfret	1,384.4	3.6

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

and 1980 sponsored by the SCS (1976, 1980b) discussed shrimp fisheries and resources of Sumatra's east coast.

Nasution et al. (1972) reported on a joint exploratory survey in the South China Sea and Karimata Strait by the Directorate General of Fisheries and an Indonesian private company in cooperation with Chi Feng Fishing Cooperation, Taiwan. The survey was conducted with large pair trawlers (200 GT, 550 hp). Average catch per haul (1.5-2.0 hours) was 0.69 t between depths of 20 and 80 m, with the highest catch rate of 1.0 t in waters 51-60 m deep. Snappers (Lutjanus spp.) and breams (Nemipterus spp.) were the dominant species caught.

Liu et al. (1978) reported that similar Taiwanese pair trawlers operating commercially further south on the Sunda Shelf averaged 0.94 t per haul in 1971 but decreased to 0.58 t per haul in 1975. It may be assumed that these commercial trawling operations concentrated on areas of highest standing stocks, unlike the exploratory survey cruises conducted further south. This may explain the difference in catch rates in 1971 and 1972. The decline in production in the southern Sunda Shelf reflects fishing effort by the Taiwanese pair trawlers and other trawlers operating in the same waters.

Liu et al. (1978) estimated the demersal standing stock for the Indonesian portion of the South China Sea (northern Sunda Shelf) to be 5.6 t/km^2. SCS (1978b) estimated demersal stock densities in this area to be 3-5 t/km^2 depending on what escapement factor was used. Saeger et al. (1976) and Sudradjat and Beck (1978) reported lower densities, with approximately 3 t/km^2 at the depth range of 20-29 m with other depth zones being substantially less (down to 1.5 t/km^2). Average stock density was reported to be 2.4 t/km^2. One reason for this discrepancy in findings may be the vessels employed, with the Taiwanese pair trawlers more effective at greater depths and more efficient generally. The lower values agree with Gulland's (1970) estimates for the South China Sea (based on extrapolations from the Gulf of Thailand) of 3-5 t/km^2 for the most productive zones and 1.5-2.5 t/km^2 for other areas.

The estimate of demersal stock density by Sudradjat and Beck (1978) of 1.8 t/km^2 is 36% lower than that reported from a similar survey two years earlier. The surveys were carried out during different seasons, which may have influenced results. Survey designs also differed. However, the possibility that increased fishing pressure accounted for some parts of the decline cannot be ignored. Until results of more recent surveys by the Indonesian Fisheries Development Project are analyzed, the results reported by Sudradjat and Beck should be considered to reflect the present situation.

Sustained research to assess demersal resources closer to the island of Sumatra has provided more consistent results than those obtained further north. The Marine Fisheries Research Institute (MFRI) with cooperation of the German Technical Assistance Agency (GTZ) conducted a series of annual demersal surveys in the Java Sea, including some stations along the southeast coast of Sumatra (Saeger et al. 1976; Losse and Dwiponggo 1977; Sudradjat and Beck 1978; Dwiponggo and Badrudin 1978, 1979, 1980). The distribution of demersal species in the Java Sea has been mapped (Dwiponggo 1977). The results of these surveys are summarized in Table 2.10. Additional analyses of demersal stocks for these waters are found in Sujastani et al. (1977).

Maximum sustainable yields of demersal fish and shrimps from catch-and-effort data are contained in Figs. 2.8 and 2.9.

North coast of Java

The north coast of Java ranked first in Indonesian marine fisheries production in 1979 with landings over 303,000 t, 23% of the national total (Table 2.1). In that year, 241,000 fishermen were reported operating in the coastal fishery area, more than twice the number of any other area and 27% of all Indonesian fishermen (DGF 1981a).

The fishing grounds included in this coastal area are in the Java Sea. The water column in the Java Sea, especially in coastal waters, is constantly mixed by currents and

Tabel 2.10. Perkiraan kedapatan dan standing stok sumberdaya perikanan demersal diperairan laut Jawa.

Table 2.10. Estimated density and standing stock of the Java Sea.

Sub-area		Area (km^2)	Mean catch rate (kg/hr)		Estimated/density (t/km^2)		Estimated standing stock ($t \times 10^3$)	
1. South Sumatra		22,305	170		2.7			60
2. DKI/West Java		12,166	174		2.7		33	
Central Java		15,390	153		2.4		37	
East Java		9,490	248		3.8		37	
Subtotal		37,046		Subaverage	3.0	Subtotal		107
3. Central Kalimantan (I)		17,049	435		6.9		118	
Central Kalimantan (II)		13,177	556		8.8		116	
South Kalimantan		18,248	494		7.8		143	
Subtotal		48,474		Subaverage	7.8	Subtotal		377
4. Strait of Makasar		59,139	216		3.4			
5. South K. East Java								
(Madura)	N	33,226	82		1.3		49	
	S	56,047	192		3.1		174	
6. Central Kalimantan								
Central Java	N	56,706	202		3.2		182	
	S	44,145	212		3.4		148	
7. South Sulawesi								
West Java	N	51,234	116		1.8		93	
	S	26,547	114		2.3		61	
Total area		380,710		Subaverage	2.5			

[a]Sumber/Source: Losse and Dwiponggo (1977).

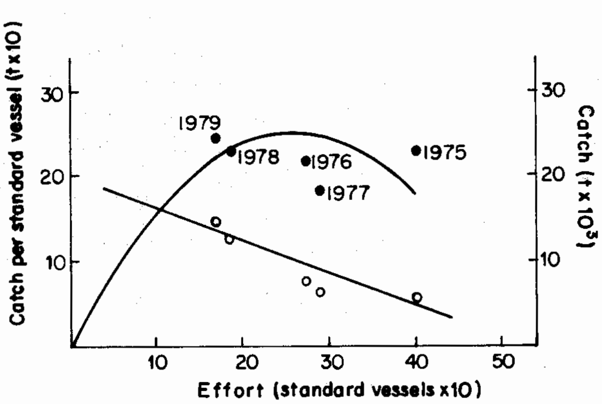

Fig. 2.8. East Sumatra: Total catch, standard effort and catch per unit of effort of demersal fish and shrimp production by the demersal gear in 1975-1979.

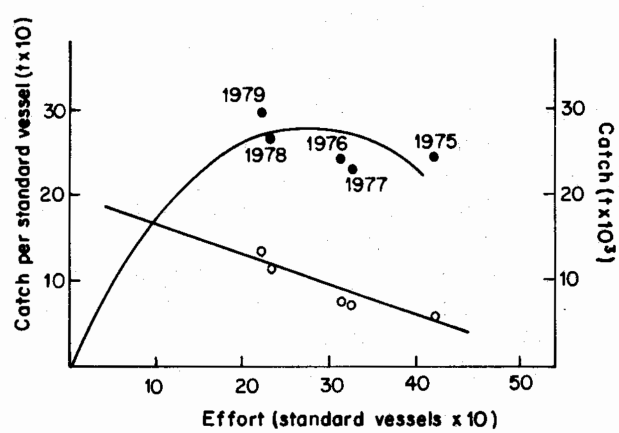

Fig. 2.9. East Sumatra: Total catch, standard effort and catch per unit of effort of demersal fish production by the demersal gear in 1975-1979.

winds. River runoff contributes to the high natural productivity of the inshore waters where the majority of fishermen operate.

From Table 2.11, it may be seen that catches by pelagic gear account for 58% of total landings from this area. Purse seiners (33.8%), traditional seine nets as payang (25.3%) and drifting gill nets (23.7%) account for the bulk of the pelagic catch (Table

Tabel 2.11. Utara Jawa: hasil tangkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.11. North Java: Catch by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	77,037	115,824	109,147	110,791	116,894	105,938.6
Udang penaeid Penaeid shrimp	5,322	6,802	6,711	6,822	7,790	6,690.2
Udang lain Other shrimp	1,384	3,508	10,685	5,896	3,527	4,940.0
Ikan demersal Demersal fish	70,331	105,514	91,751	98,073	105,577	94,249.2
Pelagis Pelagic						
Ikan pelagis Pelagic fish	111,034	114,631	144,326	165,232	185,347	144,114.0

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

2.12). Payang and drifting gill nets are used by both small- and medium-scale fishermen but no data are available to separate production in these two subsectors. Purse seiners are primarily medium-scale gear. Round scads (Decapterus spp.) are the single most important pelagic species (Table 2.12), followed by sardines (S. fimbriata and S. longiceps), anchovies (Stolephorus spp.) and Indo-Pacific mackerels (Rastrelliger spp.).

Prior to the introduction of the purse seine during the early 1970s, the traditional payang seine was the dominant pelagic gear. Operation of the payang was described by Van Kampen (1909, reported by Hardenberg 1932) who reported round scads to be the most important species exploited by this gear. The dominance of this species, with average landings during the period 1975-1979 twice that of any other species, pelagic or demersal (Table 2.12), has led to detailed investigation. Delsman (1924) reported that round scad eggs were associated with low salinities around Bawean Island (140 km north of Surabaya) during the end of the northwest monsoon, but that round scad fry and fingerlings were absent in surface waters. Buzeta (1977) suggested that immature round scads remain in deeper waters offshore.

Little information is available on the migratory habits of round scads. Hardenberg (1938) noted that peak catches were recorded during the peaks of the northwest and southeast monsoon. He hypothesized the existence of separate stocks, one originating in the east and following surface currents into the Java Sea during the southeast monsoon (July-September), the second stock entering the western portion of the Java Sea from the Indian Ocean through the Sunda Strait. A third stock from the north may enter the Java Sea from the South China Sea during the northwest monsoon. The validity of Hardenberg's hypothesis has yet to be tested.

Despite the importance of pelagic species in this area, little stock assessment research has been accomplished. Hasan (1972) and Unar (1974) have noted that round scad landings increased up to the early 1970s but that this was due to increasing fishing effort while catch per unit of effort remained largely unchanged. Based on statistical data for 1969-1975, Sujastani (1978 estimated MSY to be 76,000 t/yr. More recent data from

Tabel 2.12. Utara Jawa: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]
Table 2.12. North Java: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Ave. production (t)	Rata-rata persentasi produksi 1975-1979 / Ave. production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Ave. production (t)	Rata-rata persentasi produksi 1975-1979 / Ave. production (%)
Demersal						
	Trawl	42,950.4	40.0	Peperek/Slipmouths	16,096.2	26.8
	Dogol/Danish seine	13,771.4	13.0	Udang Penaeid/Penaeid shrimp	6,690.2	11.0
	Jaring klitik/Shrimp gill net	9,643.2	9.0	Udang lain/Other shrimp	4,940.0	8.0
	Pancing/Hook and line	9,571.2	9.0	Manyung/Marine catfish	4,307.4	7.2
	Perangkap lain/Other traps	8,866.8	8.4	Cucut/Sharks	3,869.0	6.4
	Jala/Cast net	4,809.0	4.5	Layur/Hairtail	3,090.0	5.0
	Jaring insang tetap/			Beloso/Lizardfish	2,883.4	4.8
	Set gill net	4,339.0	4.0	Cumi-cumi/Squid	2,601.8	4.3
	Pukat pantai/Beach seine	3,830.8	3.6	Ikan merah/Red snapper	2,401.8	4.0
	Sero/Guiding barriers	2,643.4	2.5	Pari/Rays	2,368.8	3.9
Pelagis / Pelagic						
	Pukat cincin/Purse seine	48,794.2	33.8	Layang/Scads	40,847.2	28.0
	Payang	36,579.2	25.3	Tembang/Fringe scale sardine	20,891.0	14.3
	Jaring insang hanyut/			Sardin/Sardine	20,773.6	14.3
	Drift gill net	34,224.2	23.7	Teri/Anchovies	16,922.6	11.6
	Bagan tancap/Stationary			Kembung/Indo-Pacific		
	liftnet	16,843.8	11.0	mackerel	15,196.8	10.4
	Jaring insang lingkar/			Tongkol/Eastern little tuna	11,137.8	7.6
	Encircling gill net	2,161.2	1.5	Selar/Yellow striped trevally	10,727.8	7.4
				Tenggiri/Spanish mackerel	4,064.8	2.8

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

DGF (1975-1979) have been analyzed and suggest a much higher MSY of 290,000 t. Indeed, average annual pelagic catch in this period was 164,000 t (Table 2.11).

Demersal resources have been more adequately studied, most notably by the annual trawl surveys mentioned in the preceding section. Based on these surveys, the biggest standing stocks occurred in depths of 10-19 m, followed by waters of 20-29 m depth; deeper waters (60-80 m) contained low standing stocks result (Saeger et al. 1976; Dwiponggo and Badrudin 1979a, 1980b).

Saeger et al. (1976) estimated demersal stock density for the whole Java Sea in the 10-19 m range at 3 t/km^2 and 2.6 t/km^2 for the 20-29 m range. Losse and Dwiponggo (1977) provided an estimate of 2.97 t/km^2 along the north coast of Java. Using catch-and-effort data, Sujastani (1978) estimated demersal MSY in this area to be 63,000 t/yr while Dwiponggo (1978) estimated 57,000 t/yr based on data from the annual trawl surveys. Both authors concluded that the demersal fishery, especially in coastal waters, was at least fully exploited and possibly overexploited. These estimates were discussed at the 1978 SCS workshop (SCS 1979) which, while noting that inshore demersal fish and shrimp resources along the north coast of Java were fully exploited, proposed that trawlers be encouraged to obey existing depth zone regulations and operate in areas under less intensive pressure, or even shift to the use of other gear types. The SCS workshop's estimate of MSY was 67,000 t.

Further analysis of DGF statistical data (1975-1979) and other sources of information presented below indicated the existence of 20% excess effort for demersal gear. These data were collected prior to the trawler ban and there is a pressing need to update stock assessment data in light of this measure.

Catch-effort data and yield curves for the demersal and pelagic fisheries for the north coast of Java are presented in Fig. 2.10-2.12.

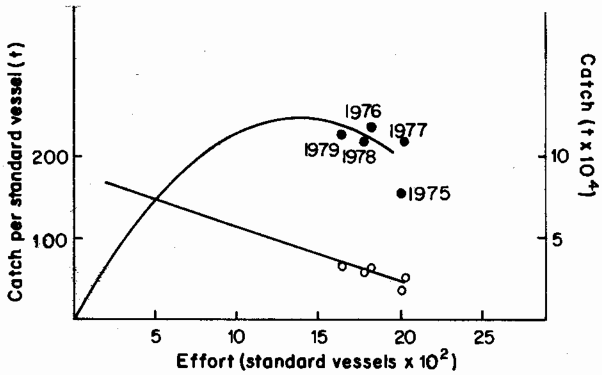

Fig. 2.10. North Java: Total catch, standard effort and catch per unit of effort of demersal fish and shrimp production by the demersal gear in 1975-1979.

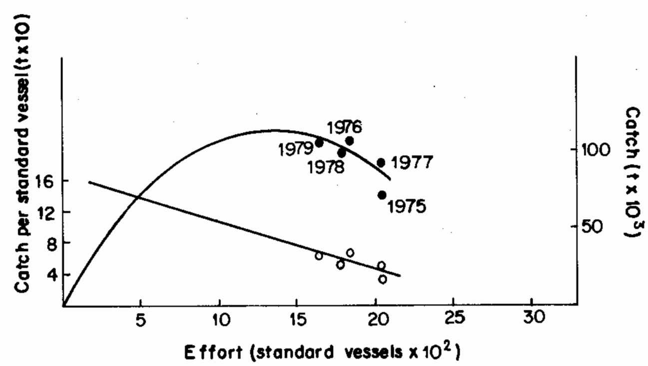

Fig. 2.11. North Java: Total catch, standard effort and catch per unit of effort of demersal fish production by the demersal gear in 1975-1979.

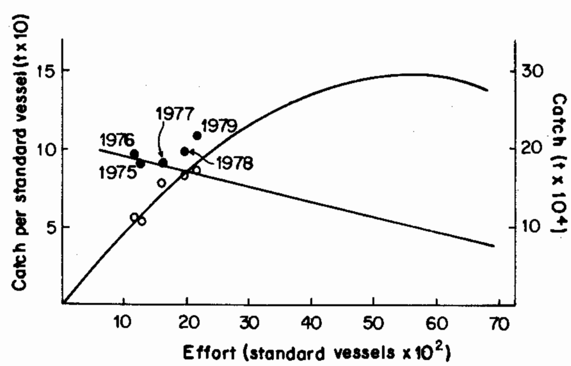

Fig. 2.12. North Java: Total catch, standard effort (st. purse seine) and catch per unit of effort of pelagic fish production by the pelagic gear in 1975-1979.

As noted in Chapter 1, the banning of trawlers came about due to the twin concerns of excess fishing effort and conflict between trawlers and small-scale fishermen. Trawlers originating from the Malacca Strait began operating along Java's north coast in the early 1970s and quickly assumed a dominant position, averaging 40% of total demersal production between 1975 and 1979 (Table 2.12) while gill net catches declined (Unar 1972). In 1979, over 600 trawlers were reported in this area (DGF 1981a). The primary target species of trawlers were penaeid shrimps but slipmouths (Leiognathidae), a popular food item in Java, also were landed in large quantities. Combined, these two species groups accounted for 38% of demersal landings (Table 2.12).

Given the relatively high standing stock in shallow coastal waters composed to deeper offshore fishing grounds, it is not surprising that trawler operations tended to concentrate in the former. Moreover, shrimp resources are more abundant inshore (Unar 1972). The result was direct competition with fishermen using Danish seines, shrimp gill nets, traps and other small-scale gear as well as increased pressure on a resource already heavily exploited by local fishermen. Hadikoesworo (1977) and Martosubroto (1978), among others, noted the negative effect of this competition on productivity and incomes within the small-scale subsector.

The removal of trawlers from Java's north coast is likely to relieve pressure on the resource and improve conditions within the small-scale subsector. However, the presence of numerous fixed gear, such as tidal traps and liftnets and other gear with extremely fine meshed nets operated by small-scale fishermen, poses a continuing threat to vulnerable fish fry in shallow water nursery grounds (Pauly 1977a; Dwiponggo 1978b).

South and West Kalimantan

This coastal area encompasses the provinces of West and Central Kalimantan, the former facing the Karimata Straits which connect the South China and Java Seas, and the latter bordering the Java Sea itself. Production from this coastal fishery area is divided nearly equally between demersal and pelagic gear (Table 2.13).

Tabel 2.13. Kalimantan Tenggara: hasil tangkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.13. Southwest Kalimantan: Catch by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	27,589	37,316	25,965	32,323	39,312	32,502.2
Udang penaeid Penaeid shrimp	2,889	2,513	3,712	4,051	5,405	3,714.0
Udang lain Other shrimp	4,586	5,538	98	7,896	8,729	5,389.4
Ikan demersal Demersal fish	20,114	29,165	22,155	20,376	25,178	23,397.6
Pelagis Pelagic						
Ikan pelagis Pelagic fish	24,806	17,198	26,627	31,180	29,837	25,929.6

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Trawlers dominate demersal production, accounting for 36% of the total during the period 1975-1979 (Table 2.14). It is likely that the share of trawlers increased during this period as the number of trawlers grew from 319 in 1975 to 583 in 1979 (DGF 1977, 1981a). The increase in numbers of trawlers has been paralleled by increased production of penaeid shrimps during the period 1975-1979 (Table 2.13). Shrimps are also captured by small-scale fishermen using shrimp gill nets, guiding barriers and other gear. Unlike the situation along Java's north coast, however, competition between trawlers and small-scale fishermen appears to have generated little conflict, perhaps due to the continued abundance of demersal resources and the presence of fewer small-scale fishermen.

Tabel 2.14. Kalimantan Tenggara: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.14. Southwest Kalimantan: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Ave. production (t)	Rata-rata persentasi produksi 1975-1979 / Ave. production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Ave. production (t)	Rata-rata persentasi produksi 1975-1979 / Ave. production (%)
Demersal						
	Trawl	11,653.8	35.8	Cumi-cumi/Squid	5,917.2	26.1
	Jaring insang tetap/Set gill net	6,365.4	19.6	Udang lain/Other shrimp	5,389.4	23.8
	Sero/Guiding barriers	3,368.2	10.3	Udang penaeid/Penaeid shrimp	3,714.0	16.4
	Rawai tetap/Set longline	2,358.6	7.2	Manyung/Marine catfish	3,169.0	14.0
	Pukat pantai/Beach seine	2,915.6	8.9	Cucut/Sharks	2,504.6	11.1
	Jermal/Stow nets	2,477.4	7.6	Kuro/Senangin-Threadfins	1,338.2	5.9
	Perangkap lain/Other traps	1,094.2	3.3	Pari/Rays	1,135.0	5.0
	Pancing/Hook and line	974.2	2.9	Kakap/Baramundi	984.8	4.3
	Jaring klitik/Shrimp gill net	724.0	2.2	Ikan merah/Red snapper	798.2	3.5
				Peperek/Slipmouths	455.6	2.0
Pelagis Pelagic						
	Jaring insang hanyut/ Drift gill net	15,502.0	59.8	Kembung/Indo-Pacific mackerel	5,970.0	29.0
				Tenggiri/Spanish mackerel	3,376.4	16.6
	Jaring insang lingkar/ Encircling gill net	4,826.2	18.6	Tongkol/Eastern little tuna	3,114.8	15.3
				Tembang/Fringe scale sardine	1,182.0	5.8
	Serok/Scoopnet	2,366.8	9.0	Teri/Anchovies	1,158.2	5.7
	Bagan tancap/Stationary liftnet	1,342.4	5.0	Parang-parang/Wolf herring	1,074.0	5.3
				Belanak/Mullets	929.2	4.6
	Jaring angkat lain/Other liftnets	1,038.4	4.0	Sardin/Sardine	486.0	2.4
				Selar/Yellow striped trevally	427.2	2.1
	Rawai hanyut/Drift longline	579.0	2.3	Tenggiri papan/Indo-Pacific Spanish mackerel	330.4	1.6

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Trawling operations off Kalimantan were not restricted by the ban which was applied to Java, Bali and Sumatra. Trawlers from these areas were prohibited from shifting their base of operations to other waters, including Kalimantan.

The first trawlers to operate in this coastal area were those of a larger-scale joint venture company which began operations in 1969 but later shifted to shrimp fishing in the Arafura Sea due to declining catches in Kalimantan waters (Unar 1972; Naamin et al. 1980). Their large boats (97-377 GT) were unsuited to local shallow waters. Trawling by local fishermen was established by the early 1970s (Unar 1972) but with smaller boats than those used by trawler operators in the Malacca Straits and the north coast of Java (5-10 GT and 6-33 hp engines compared with 20-30 GT and 110 hp).

The annual trawl surveys referred to above indicate the presence of rich demersal resources in this area. Losse and Dwiponggo (1977) reported on the survey in 1976 of demersal stock in the Central and South Kalimantan areas. Standing stocks were estimated to be between 6.9 and 8.8 t/km^2, the highest in the Java Sea. In the 1977 survey, these results were confirmed, with substantial catches in the 20-29 m depth zone of large food fish species (sicklefish, grunts and snappers) rarely found elsewhere in the

Java Sea (Dwiponggo and Badrudin 1978a). Snappers were also reported abundant in the 1976 trawl survey off West Kalimantan (Saeger et al. 1976). High catch rates for squid were also noted along this coast (Dwiponggo 1977); indeed, squid account for 26% of total demersal production, and at 5,900 t, are the dominant demersal species in this area.

The dominant pelagic species in this area is the Indo-Pacific mackerel, averaging 29% of pelagic production during the period 1975-1979, followed by Spanish mackerels and eastern little tunas (17% and 15%, respectively). The dominant gear type is the drifting gill net, accounting for an average of 60% of pelagic production.

Pelagic resource assessment in this area remains to be done. Sujastani (1974) studied the population dynamics of the Indo-Pacific mackerel for the Java Sea and suggested that the Rastrelliger brachysoma found along the south coast of Kalimantan and the north coast of Java belong to the same population.

Susanto (1960) studied the Indo-Pacific mackerel fishery in Kalimantan and noted the use of stake traps set several kilometers from the coast in waters 10-15 m deep. Susanto reported that the peak season was October-April and that Rastrelliger brachysoma was predominant along the coast of West Kalimantan where freshwater runoff resulted in lower salinities favoring this fish.

East coast of Kalimantan

This coastal fishing area includes South and East Kalimantan provinces, the former facing the Java Sea and the latter, the Makassar Straits. East Kalimantan waters are relatively deep and rough, especially during June-October, so that small-scale fishermen generally operate in a narrow band of coastal waters.

Pelagic gear account for about 60% of total production (Table 2.15), with drifting gill nets and encircling gill nets accounting for over half the average total during 1975-1979 (Table 2.16). The Indo-Pacific mackerel is the dominant pelagic species accounting for 30% of the catch. No estimates of pelagic stock sizes or MSY are available.

Tabel 2.15. Timur Kalimantan: hasil tangkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.15. East Kalimantan: Catch by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	20,669	23,312	14,797	26,592	32,767	23,627.0
Udang penaeid Penaeid shrimp	3,336	2,961	2,952	4,258	5,490	3,799.4
Udang lain Other shrimp	925	1,976	2,737	3,558	5,305	2,900.2
Ikan demersal Demersal fish	16,408	18,375	9,108	18,776	21,972	16,927.8
Pelagis Pelagic						
Ikan pelagis Pelagic fish	32,939	26,690	37,603	39,262	36,969	34,692.6

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Tabel 2.16. Timur Kalimantan: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.16. East Kalimantan: Average annual production and percentage of total production of important gear types end species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Jermal/Stow nets	3,552.8	15.0	Udang penaeid/Penaeid shrimp	3,799.4	17.3
	Jala/Cast net	3,010.2	12.7	Udang lain/Other shrimp	2,900.2	13.2
	Jaring insang tetap/Set gill net	2,799.8	11.8	Kuro/Senangin-Threadfins	2,872.8	13.0
	Sero/Guiding barriers	2,704.4	11.4	Manyung/Marine catfish	2,624.0	12.0
	Bubu/Portable traps	1,145.2	8.4	Cucut/Sharks	1,803.0	8.0
	Pancing/Hook and line	1,788.4	7.5	Kakap/Baramundi	1,468.0	6.7
	Otter trawl	1,748.8	7.4	Gulamah/Croakers	1,415.8	6.4
	Trawl lain/Other trawls	1,619.8	6.8	Ikan merah/Red snapper	1,246.0	5.6
	Perangkap lain/Other traps	1,145.2	4.8	Bawal putih/Silver pomfret	874.0	4.0
	Jaring klitik/Shrimp gill net	1,130.4	4.7	Peperek/Slipmouths	798.8	3.6
Pelagis Pelagic						
	Jaring insang hanyut/Drift gill net	11,884.8	34.2	Kembung/Indo-Pacific mackerel	8,013.0	29.0
				Teri/Anchovies	3,291.8	11.9
	Jaring insang lingkar/ Encircling gill net	8,670.0	25.0	Tembang/Fringe scale sardine	2,607.6	9.4
				Tenggiri/Spanish mackerel	2,452.2	8.8
	Bagan tancap/Stationary liftnet	4,638.0	13.4	Layang/Scads	1,753.4	6.3
				Tongkol/Eastern little tuna	1,582.4	5.7
	Payang	4,060.0	11.7	Tenggiri papan/Indo-Pacific mackerel	1,383.0	5.0
	Rawai hanyut/Drift longline	1,773.6	5.1			
	Serok/Scoop net	1,184.0	3.4	Selar/Yellow striped trevally	1,361.8	5.0
	Pancing tonda/Troll lines	1,040.0	3.0	Bawal hitam/Black pomfret	1,208.0	4.3
				Belanak/Mullets	1,158.6	4.1

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

The demersal fisheries are dominated by small-scale gear types (Table 2.16). Penaeid shrimp catches during 1975-1979 averaged 3,800 t/yr but showed a dramatic increase in 1979 (Table 2.15). In that year, penaeid and other shrimp accounted for nearly one-third of demersal production in this area. No information is available on the distribution of shrimp catch between trawlers and small-scale fishermen using guiding barriers, traps, shrimp gill nets and other gear.

Trawlers were introduced to this area in 1970 by P.T. Misaya Mitra, the fishing company formerly based in South Sumatra which transferred its nine trawlers to South Kalimantan (Unar 1972). By 1979, 80 trawlers of 20-30 GT were reported to be operating in this area, with over 330 small trawlers (3-7 GT) operating in waters less than 4 m depth near Samarinda, East Kalimantan (Naamin 1982). Naamin and Uktolseya (1976) estimated that MSY for shrimp in this coastal area was 3,400 t/yr and concluded that the shrimp fishery was fully exploited. In 1975, penaeid shrimp landings totalled 3,336 t but increased to 5,490 t in 1979 (Table 2.15). The catch consisted primarily of young Penaeus merguensis in the offshore area.

West coast of Sumatra

This coast stretches along the entire western seaboard of Sumatra and includes a number of islands running parallel to the coast 100 km away. The continental shelf along this coast is narrow except off the western shore of North Sumatra Province, the only area of extensive trawlable grounds; elsewhere the shelf is characterized by extensive rock formations (DGF 1982d). Seas are rough and coastal currents are strong in this area, especially during the southwest monsoon which blows unimpeded from the Indian Ocean.

Pelagic gear account for two-thirds of total landings (Table 2.17), with hook and line (30%), purse seine (15%), troll lines (12%) and payang seines (12%) accounting for the bulk of the catch (Table 2.18). Indo-Pacific mackerel, anchovies and eastern little tunas constitute nearly half of total pelagic catches (Table 2.18).

Uktolseya and Barus (1975) reported that troll fishing using 4.5 hp outboard engines and plastic lures began in 1955. By 1967, boats of 10-20 GT with 33-hp inboard engines were in use. The peak season was September-December, with fishing trips of 8-10 days duration. Catch per trip was between 1,300 and 2,800 kg with skipjack accounting for 56.5% and yellowfin tuna, 16% of the total. In 1979, there were 703 fishing units using troll lines along this coast (DGF 1981).

Three separate studies of pelagic resources in this area have been conducted. In 1972, a tuna longline survey was carried out jointly by the governments of Indonesia and South Korea in waters off Bengkulu Province. Average catch rates were reported to be 2.9 fish/100 hooks with Thunnus maccoyi as the dominant species. Other species included T. alalunga and T. albacares (Uktolseya 1973).

Tabel 2.17. Barat Sumatera: hasil tangkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.17. West Sumatra: Catch by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	19,632	21,930	22,417	19,799	24,395	21,634.0
Udang penaeid Penaeid shrimp	1,091	749	493	787	953	814.6
Udang lain Other shrimp	353	1,171	558	263	325	384.2
Ikan demersal Demersal fish	18,188	20,010	21,366	18,749	23,117	20,286.0
Pelagis Pelagic						
Jumlah produksi Total catch	30,461	42,400	48,911	49,893	47,581	43,849.0
Tuna	869	1,251	2,177	2,764	3,151	2,042.4
Cakalang Skipjack tuna	3,438	4,617	2,243	3,242	5,333	3,774.6
Ikan pelagis kecil Small pelagic fish	26,154	36,532	44,491	43,887	39,097	38,032.2

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Tabel 2.18. Barat Sumatera: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.18. West Sumatra: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Otter trawl	7,867.0	36.4	Peperek/Slipmouths	1,920.0	12.5
	Pukat pantai/Beach seine	5,101.0	24.0	Cucut/Sharks	1,791.8	11.6
	Jaring insang tetap/Set gill net	4,241.8	19.6	Kurisi/Threadfin bream	1,507.4	9.9
	Jala/Cast net	1,538.3	7.0	Ikan merah/Red snapper	1,434.6	9.3
	Jaring klitik/Shrimp gill net	1,519.4	7.0	Kerapu/Groupers	950.8	6.2
	Dogol/Danish seine	1,146.0	5.3	Pari/Rays	910.6	6.0
	Rawai tetap/Set longline	815.2	3.8	Kakap/Baramundi	815.4	5.3
	Perangkap lain/Other traps	535.2	2.4	Udang penaeid/Penaeid shrimp	814.4	5.3
				Biji nangka/Goatfish	683.0	4.4
				Kuro/Senangin-Threadfins	644.6	4.2
Pelagis Pelagic						
	Pancing/Hook and line	13,264.0	30.0	Kembung/Indo-Pacific mackerel	8,568.2	19.3
	Pukat cincin/Purse seine	6,741.6	15.4	Teri/Anchovies	7,011.4	15.8
	Pancing tonda/Troll lines	5,281.2	12.0	Tongkol/Eastern little tuna	6,359.0	14.3
	Payang	5,273.0	12.0	Cakalang/Skipjack tuna	3,774.6	8.5
	Bagan perahu/rakit-Boat/ Raft liftnet	4,687.2	10.7	Selar/Yellow striped trevally	2,781.0	6.3
				Tembang/Fringe scale sardine	2,405.8	5.4
	Jaring insang hanyut/ Drift gill net	4,062.8	9.2	Tuna	2,042.4	4.6
				Lemuru/Oil sardine	2,014.6	4.5
	Jaring insang lingkar/ Encircling gill net	2,072.2	4.7	Tenggiri/Spanish mackerel	1,817.6	4.1
				Kuwe/Jacks, trevally	1,231.8	2.7
	Bagan tancap/Stationary liftnet	1,197.8	2.7			
	Serok/Scoop net	996.6	2.3			
	Jaring angkat lain/Other liftnets	238.2	0.5			

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

In 1977, a joint Indonesia-Thailand survey of Simeulue Island (Aceh) and Enggano Island (Bengkulu) was conducted to determine resource potentials and test the appropriateness of various gear types. Drifting gill nets yielded 137.9 kg/km of netting; sharks were the major catch. Tuna longline hook rates around Simeulue Island varied between 0.3 and 2.4 with small yellowfin tuna (22 kg average weight) predominant. Catch rates around Enggano Island were lower (0.9 fish/100 hooks) but the yellowfin tuna captured were larger, averaging 33 kg.

The third pelagic demersal resource survey of this coastal area was a joint project by DGF, Australia and GTZ (JETINDOFISH) to explore fisheries potential in the Indian Ocean. The results of the Indonesian portion of this study, which included waters off the south coast of Java and the southern Lesser Sunda Islands, are still being analyzed.

Demersal resources in this area remain largely uninvestigated although the joint Indonesia-Thailand survey noted above tested other trawls, hand lines and traps in addition to pelagic gear. The effectiveness of traps was limited by strong currents. Hand lines in waters of 30-50 m yielded good catches of large demersal fish such as red snapper, sharks and other fishes in some areas (best catch 2.34 kg/hook-hr). Trawlers landed an average of 221 kg/hr, with trash (discards) 74% of the total. The 40-50 m depth range showed the best catches (303 kg/hr). Coral and rough bottom conditions were encountered beyond 60 m. The most productive fishing grounds were associated with the presence of nearby river outlets.

Badrudin and Widodo (1974) reporting on a MFRI trawl survey noted that shrimp catches were best in shallow waters (11-20 m) with an average catch of 17.5 kg per haul; trawling grounds were restricted to a narrow strip. From catch-effort analysis based on 1975 landings, it was estimated that the demersal and shrimp fishing in the coastal areas is fully exploited (Fig. 2.13 and 2.14).

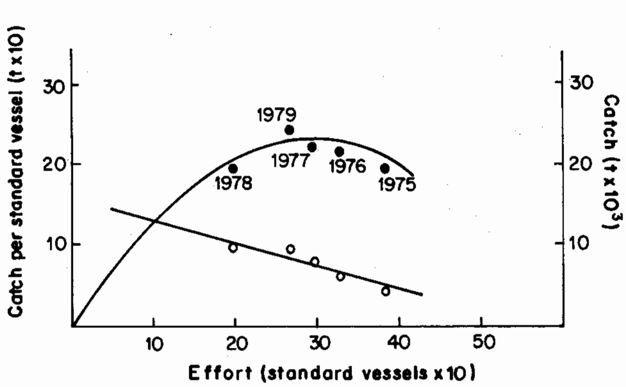

Fig. 2.13. West Sumatra: Total catch, standard effort and catch per unit of effort of demersal fish and shrimp production by the demersal gear in 1975-1979.

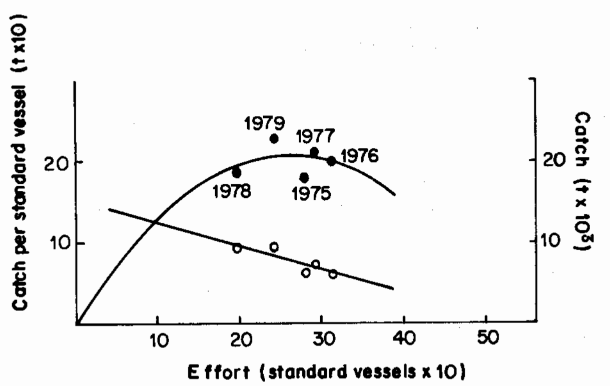

Fig. 2.14. West Sumatra: Total catch, standard effort and catch per unit of effort of demersal fish production by the demersal gear in 1975-1979.

Trawling along Sumatra's west coast was introduced from the Malacca Straits in the early 1970s and until the trawl ban came into effect was concentrated in waters of North Sumatra Province with the part of Sibolga as base. Trawlers in this area are similar to those in the Malacca Straits (15-40 GT, 66-120 hp). Naamin (1980b) reported that 32 trawlers were operating in these waters by 1973, a total which grew to 124 by 1976. The DGF's figures show 134 trawlers in that gear compared to only 91 in 1979 (DGF 1978a, 1981a).

South coast of Java

Java's south coast is characterized by a narrow strip of shallow shelf which drops off sharply to the deeper waters of the Indian Ocean. Extensive rock and coral formation limits effective trawlable area to approximately 5,200 km^2 (Naamin 1980a). For the majority of local fishermen using traditional small-scale gear, fishing is a seasonal activity limited by the rough seas of the southeast monsoon.

Average annual marine fisheries production (1975-1979) from this area was 42,000 t, with demersal gear accounting for 56.5% of the total (Table 2.19). Medium-scale trawlers dominated demersal production with 63% (Table 2.20). Shrimp constituted 26% of the demersal catch, with penaeid shrimp accounting for just under half (Table 2.20). As elsewhere, shrimp were the target species of trawlers, who were in competition with small-scale fishermen along the narrow coastal shelf. Trawler operations in this area are centered around the part of Cilacap, Central Java.

Tabel 2.19. Selatan Jawa: hasil tangkapan dengan alat penangkap demersal dan pelagis (tonnes), 1975-1979.[a]
Table 2.19. South Java: Catch by demersal and pelagic gears in tonnes, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	11,822	25,512	28,378	27,625	25,899	23,847.2
Udang penaeid Penaeid shrimp	3,019	1,857	1,625	2,653	2,890	2,409.0
Udang lain Other shrimp	92	3,048	4,470	3,039	3,098	2,749.4
Ikan demersal Demersal fish	8,711	20,607	22,283	21,933	19,911	18,689.0
Pelagis Pelagic						
Jumlah produksi Total catch	5,175	18,409	32,015	18,466	17,681	18,349.2
Tuna	–	66	168	47	85	91.5
Cakalang Skipjack tuna	487	896	1,791	851	1,191	1,043.2
Ikan pelagis kecil Small pelagic fish	4,688	17,447	30,056	17,568	16,405	17,232.8

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

The Cilacap shrimp trawling industry has been extensively studied (Naamin 1972a, 1980a; Van Zalinge et al. 1977; Martosubroto and Sudrajat 1977). The trawlers are mostly 20-30 GT with an engine of 33-120 hp. Naamin (1980a) noted that beginning with 13 units in 1971, the number of trawlers in Cilacap increased to 234 in 1977 before declining to 167 in 1979. He reported substantial declines in catch per unit effort for trawlers and the demise of several small-scale gear previously used for exploiting shrimp. Naamin estimated the MSY for shrimp along Java's south coast to be 4,000-6,000 t/yr, with optimum fishing effort equivalent to 100-116 trawlers. He noted that in 1978, the DGF regulated the number of trawlers in Cilacap to 90 but that this had little effect as they simply shifted their base of operations and continued operations in the same waters.

The author has calculated MSY based on catch and effort for Cilacap shrimp fisheries at 4,000-5,600 t and that the shrimp resources are fully exploited (Fig. 2.15). Catch-and-effort data on demersal fish production in this area are shown in Fig. 2.17.

Reseach on demersal and pelagic resources in this area has focused on offshore waters which remain largely unexploited. In 1972, a joint Indonesia-South Korea trawl survey was conducted using a larger (1,000 GT) research vessel to explore deepwater resources. The results were reported in Dwiponggo et al. (1972). The highest catch was recorded south of Central Java in waters of 65 m (6,000 kg/hr). Small quantities of deepwater shrimp (Solenosera premineutis) were caught at 300 m. The Cilacap area proved to be a good fishing area for shrimp.

The following year, Indonesia and South Korea conducted exploratory surveys using tuna longline and trawl gear along Indonesia's Indian Ocean coastline, including Java.

Tabel 2.20. Selatan Jawa: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.20. South Java: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Otter trawl	14,970.8	62.8	Udang lain/Other shrimp	2,749.4	14.0
	Pukat pantai/Beach seine	2,952.0	12.4	Layur/Hairtail	2,639.8	13.3
	Dogol/Danish seine	2,048.0	8.6	Udang penaeid/Penaeid shrimp	2,409.0	12.2
	Jaring insang tetap/Set gill net	1,721.0	7.2	Ikan nomei/Bombay duck	1,803.4	9.0
	Jaring klitik/Shrimp gill net	1,167.2	5.0	Peperek/Slipmouths	1,599.8	7.9
	Rawai tetap/Set longline	344.10	1.4	Cucut/Sharks	1,385.6	6.5
	Sero/Guiding barriers	284.6	1.2	Manyung/Marine catfish	892.6	6.0
				Beloso/Lizardfish	673.2	3.4
				Cumi-cumi/Squid	658.4	3.3
				Ikan sebelah/Indian halibuts	571.2	2.9
Pelagis Pelagic						
	Bagan tancap/Stationary liftnet	5,568.6	30.3	Teri/Anchovies	4,686.6	22.0
	Jaring insang hanyut/Drift gill net	4,429.0	24.0	Tongkol/Eastern little tuna	3,828.6	18.4
				Kembung/Indo-Pecific mackerel	1,450.8	7.0
	Pukat cincin/Purse seine	2,980.8	16.2			
	Payang	2,515.4	13.7	Lemuru/Oil sardine	1,337.6	6.4
	Pancing/Hook and line	2,388.2	13.0	Tembang/Fringe scale sardine	1,268.8	6.1
				Cakalang/Skipjack tune	1,043.0	5.0
				Tenggiri/Spanish meckerel	976.8	4.7
				Layang/Scads	354.0	1.7
				Sardin/Sardine	211.8	1.7
				Belanak/Mullets		

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

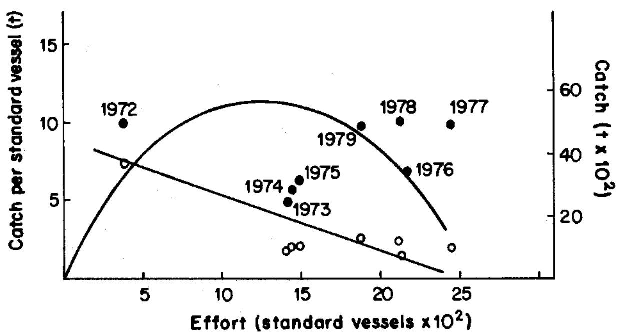

Fig. 2.15. South Java: Total catch, standard effort and catch per unit of effort of shrimp by the shrimp trawler in 1972-1979.

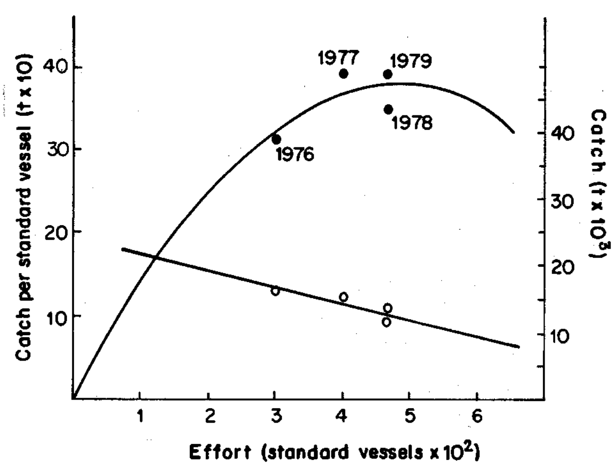

Fig. 2.16. South Java: Total catch, standard effort (st. purse seine) and catch per unit of effort of pelagic fish production by the small pelagic gear in 1976-1979.

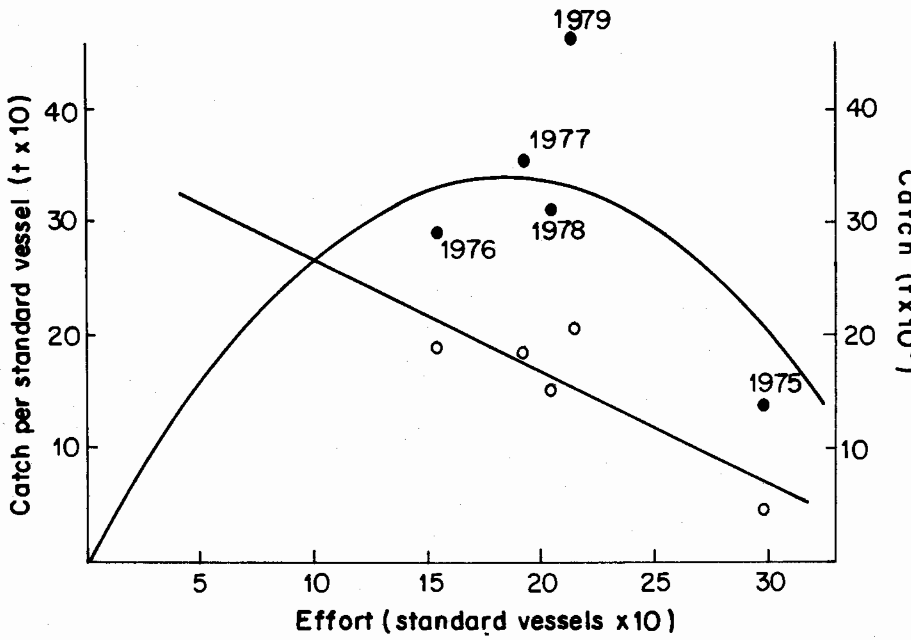

Fig. 2.17. South Java: Total catch, standard effort per unit of effort of demersal fish production by the demersal gear in 1975-1979.

Mochtar and Sumadi (1973) reported on exploratory tuna longline fishing surveys conducted jointly by the MFRI and a private South Korean company. Average hook rates were 2.0 with yellowfin tuna predominating except in September 1977 where higher catch rates of southern blue of tuna were observed.

The JETINDOFISH project also conducted exploratory fishing along Java's south coast, generally with discouraging results (JETINDOFISH 1982).

It can be noted from Table 2.20 that large tunas are not a significant element of south coast Java's pelagic catch. However, in resource terms, this is misleading as the state fishing enterprise, P.T. Samudra Besar, is based in nearby Bali and some of its longlines operate in these waters. Production figures in Table 2.20 refer only to landings within the south Java coast area. In this are anchovies and eastern little tuna as the most important pelagic species, together accounting for 40%. Anchovies are caught primarily by liftnets in shallow coastal waters. Payang seines and drifting gill nets are used for eastern little tuna, mackerels and skipjack (Uktolseya and Barus 1975). The composition of species landed at Pelabuhan Ratu on West Java's south coast appears to differ from fishing grounds to the east, with skipjack accounting for 55% and eastern little tuna comprising 18% (Hutomo 1980). Both drifting gill nets and payang seines are used for these species. Hutomo (1980) analyzed monthly catch statistics for the period 1967-1977 and found peak production to be during June-September, with the onset of the season clearly associated with upwelling along the coast.

Catch-and-effort data on pelagic fisheries in this area and corresponding yield curve are shown in Fig. 2.16.

The ribbon fish (Trichiurus) occurs in large quantities around the beginning of the southeast monsoon through the coastal waters of the Sunda Strait and is caught by payang seine from September to December, about 2,500 t/yr.

Tuna and tuna-line fish are also caught principally with payang seine and gill nets. Payang catches are frigate mackerel (81%) Euthynnus (little tuna) (8%), yellowfin (6%) and skipjack (5%). Catches by gill nets, on the other hand, include 88% skipjack, 8.3% yellowfin and 1.2% Euthynnus (Unar 1982).

Bali-Nusa Tenggara-Timor

This coastal area covers the island province of Bali and the chain of small islands stretching to the east between the Flores and Banda Seas and the Indian Ocean. Most fishing grounds in this area are characterized by deep water except around the islands themselves where coral and rocky outcrops exist. Catches with demersal gear during 1975-1979 averaged 30% of total landings (Table 2.21) with hook and line, set gill net, beach seines and simple coast nets accounting for the bulk of the catch (Table 2.22). Slipmouths, rays and squids are the most important demersal groups by volume, but high valued snappers, baramundi breams and groupers are economically significant. Penaeid shrimp production averaged only 230 t/yr, 2% of the demersal total (Table 2.21).

Pelagic species are dominated by oil sardines, anchovies, fringe scale sardines and eastern little tuna, which together comprise 65% of the total (Table 2.22). Payang seines, purse seines, drifting gill nets, mobile liftnets and troll lines are the most productive pelagic gear types. Troll lines are used for eastern little tuna and liftnets primarily exploit anchovies. Large payang seines and purse seines for scads and small payang are used for sardines with purse seines gaining preeminence in the Bali Straits oil sardine fishery.

Fisheries research in the Bali-Nusa Tenggara-Timor area has been confined to the Bali Straits and the oil sardine. Fishermen from Bali and East Java both operate in the

Tabel 2.21. Bali-Nusa Tenggara-Timor: Hasil tangkapan dengan alat penangkap demersal dan pelagis (tonnes), 1975-1979.[a]
Table 2.21. Bali-Nusa Tenggara-Timor: Catch by demersal and pelagic gears in tonnes, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	22,476	20,985	16,136	15,987	19,398	18,996.2
Udang penaeid Penaeid shrimp	297	105	194	159	393	229.6
Udang lain Other shrimp	21	25	64	76	140	65.2
Ikan demersal Demersal fish	22,158	20,855	15,878	15,752	18,865	18,701.6
Pelagis Pelagic						
Jumlah produksi Total catch	28,091	40,926	51,450	46,173	50,729	43,473.8
Tuna	1,210	1,585	2,373	2,640	2,255	2,012.6
Cakalang Skipjack tuna	1,702	2,083	1,904	1,331	1,347	1,673.4
Ikan pelagis kecil Small pelagic fish	25,179	37,258	47,173	42,202	47,127	39,787.8
(Lemuru) (Oil sardine)	4,583	8,513	14,762	12,088	12,014	10,392.0

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Tabel 2.22. Bali-Nusa Tenggara-Timor: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.22. Bali-Nusa Tenggara-Timor: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Pancing/Hook and line	4,704.8	24.8	Peperek/Slipmouths	1,931.0	17.0
	Jaring insang tetap/Set gill net	3,816.6	20.0	Cucut/Sharks	1,780.4	16.0
	Pukat pantai/Beach seine	3,659.0	19.3	Cumi-cumi/Squid	1,461.6	13.0
	Jala/Cast net	2,841.4	14.9	Ikan merah/Red snapper	832.6	7.4
	Dogol/Danish seine	979.4	5.1	Kakap/Baramundi	762.8	6.7
	Sero/Guiding barriers	770.4	4.0	Pari/Rays	734.4	6.5
	Jaring klitik/Shrimp gill net	696.8	3.6	Ekor kuning/Yellowtail fusilier	578.4	5.0
	Bubu/Portable traps	629.8	3.3	Kerapu/Groupers	540.0	4.8
	Perangkap lain/Other traps	550.6	2.9	Gulamah/Croakers	369.8	3.3
	Muroami	155.6	0.8	Ikan gerot-gerot/Grunts	365.4	3.2
Pelagis Pelagic						
	Payang	7,998.6	18.4	Lemuru/Oil sardine	10,392.0	23.0
	Pukat cincin/Purse seine	7,895.4	18.2	Teri/Anchovies	6,958.6	15.7
	Jaring insang hanyut/Drift gill net	7,646.2	17.6	Tembang/Fringe scale sardine	6,537.4	14.7
				Tongkol/Eastern little tuna	5,019.6	11.3
	Bagan perahu/Rakit boat/ Raft liftnet	7,572.8	17.4	Selar/Yellow striped trevally	2,106.8	4.7
				Kembung/Indo-Pacific mackerel	2,038.0	4.6
	Pancing tonda/Troll lines	4,920.8	11.3			
	Bagan tancap/Stationary liftnet	3,049.6	7.0	Tuna	2,012.6	4.5
				Julung-julung/Garfish, half-beak	1,793.6	4.0
	Rawai tuna/Tuna longline	1,732.2	4.0			
	Jaring angkat lain/Other liftnets	1,199.8	2.7	Cakalang/Skipjack tuna	1,673.4	3.8
				Tenggiri/Spanish mackerel	905.4	2.0
	Rawai hanyut/Drift longline	1,076.6	2.4			

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Bali Straits. Over the past decade, oil sardine landings in East Java have averaged 16,000 t/yr (Bandie 1982). Landings in Bali averaged 10,400 t/yr during 1975-1979 (Table 2.21).

Several studies on the oil sardine have been published, including a synopsis on biology by Seorjodinoto (1960), growth rate (Dwiponggo 1974) and population dynamics (Ritterbush 1975). Ritterbush concluded that by 1974 the oil sardine was being exploited at or near MSY. Sujastani and Norhakim (1982) estimated MSY to be 36,000-38,000 t/yr and that excess effort was being applied resulting in reduced profits and catches. However, according to catch and effort data (1975-1979) the MSY of pelagic fisheries is estimated at 47,000-49,000 t, indicating that the pelagic fisheries are moderately to fully exploited.

One reason the oil sardine of the Bali Straits has attracted the attention of researchers is that this is the only true single-species fishery in Indonesia. It is also a seasonal fishery, with peak catches occurring during September-March. Strong upwelling from the Indian Ocean is associated with the concentration of the oil sardine, and variations in upwelling and other environmental factors result in fluctuating production levels (Dwiponggo 1982). It is also interesting to note that the oil sardines in Indonesia are limited to the Bali Straits and during the off season, to waters immediately to the south. An exploratory survey using various gear was conducted along islands east of Bali and failed to locate any sizeable stock of this species (Dwiponggo and Uktolseya 1974).

It appears that the oil sardine migrates to deeper waters (40-60 m) south of the Bali Straits in April. Merta (1972), Dwiponggo et al. (1972) and Amin et al. (1974) reported dense pelagic biomasses located by acoustic devices south of Bali Straits. In one case, a deepwater trawl was used for sampling and, though the results are not conclusive, oil sardines dominated the sample catch (Dwiponggo et al. 1972). Based on their acoustic survey, Amin et al. (1974) estimated the unidentified stock south of Bali Straits to be 55,000 t. A more recent (1982) survey using more sophisticated equipment estimated pelagic biomass to be 46,000 t + 2,000 t, though samples were not taken and species composition is unknown (Sujastani, pers. comm.).

It is also worth noting that a tuna longline fishery is based in Bali, P.T. Samodra Besar. This state enterprise has capitalized on exploratory longline fishing surveys and used its own experience to increase production to over 2,800 t in 1980 with exports valued at over US$3 million (P.T. Samodra Besar 1981). The fleet consists of 17 longliners of 111 GT plus three larger boats (180-300 GT). Yellowfin tuna comprise 60-70% of the total catch. The weight for all species caught ranges between 80 and 160 kg.

It is interesting to note that fishermen of Lembata Island, a small island east of Flores, have been observed capturing whales in the Savu Sea, including sperm, killer and pilot whales (Barnes et al. 1980; Hembree 1980). Hand thrown harpoons are used. The meat is used for local consumption in coastal communities and as an item of barter trade with communities in the interior and on neighboring islands.

South coast of Sulawesi

Fishing grounds in this coastal area are generally in waters in excess of 200 m depth. Along the west coast of South Sulawesi Province, the continental shelf is extremely narrow except in the west and south off of Ujung Pandang where extensive coral formations may be found. Other relatively shallow waters are located in parts of Bone Bay and around the islands at the southern extremity of Southeast Sulawesi Province. Despite the limited extent of shallow waters, which usually are associated with productive fishing grounds, production from this coastal area was 181,000 t in 1979, the third highest in Indonesia and 14% of the national total (Table 2.1). Nearly 118,000 fishermen operate in this area, 13% of all those employed in this sector (Table 1.2). During 1975-1979, the annual growth rate of marine fisheries production exceeded 10%, far above the national average of less than 6%. Increased production in this area is attributed to a rapid expansion in the use of motorized vessels among small-scale fishermen and the use of more effective fishing gear (Dinas Perikanan Sulawesi Selatan 1980). There is believed to be potential for further production increases although stock assessment research on this coastal area is at present limited to one resource type, the flying fish.

Given the nature of the fishing grounds, it is not surprising that demersal gear accounted for only 22% of this area's production between 1975-1979 (Table 2.23). Hook and line dominate demersal production (42%), followed by other simple small-scale gear (Table 2.24). Medium-scale trawlers and large-scale double-rigged shrimp trawlers ranked sixth and seventh, respectively, in demersal production.

The MSY of the demersal fish was estimated to be 34,000-42,000 t, which indicates that coastal waters of southern Sulawesi have been fully exploited.

Slipmouths and penaeid shrimps dominate total landings of demersal species, followed by a number of high valued species associated with coral reef hook and line fisheries (Table 2.24). Slipmouths and penaeid shrimps are commonly found together and are landed both by trawlers and fishermen using guiding barriers and beach seines.

Tabel 2.23. Selatan Sulawesi: hasil tangkapan dengan alat penangkap demersal dan pelagis (tonnes), 1975-1979.[a]
Table 2.23. South Sulawesi: Catch by demersal and pelagic gears in tonnes, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	13,841	28,986	35,565	31,125	46,365	31,156.4
Udang penaeid Penaeid shrimp	2,313	2,936	3,375	4,749	4,738	3,622.2
Udang lain Other shrimp	214	265	612	410	304	361.0
Ikan demersal Demersal fish	11,314	25,785	31,578	25,966	41,323	27,193.2
Pelagis Pelagic						
Jumlah produksi Total catch	108,808	106,705	105,778	110,566	134,173	113,206.0
Tuna	6,041	919	1,844	2,333	6,164	3,460.2
Cakalang Skipjack tuna	5,961	4,895	6,898	6,977	9,691	6,884.4
Ikan pelagis kecil Small pelagic fish	96,806	100,891	97,036	101,256	118,318	102,861.4
(Ikan terbang) (Flying fish)	11,865	14,342	10,361	5,331	9,711	10,322.0

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Small-scale gear dominate pelagic fisheries, with the payang seine, drifting gill net and liftnet (both stationary and mobile) accounting for over half of all landings (Table 2.24). Anchovies, fringe scale sardines, scads, Indo-Pacific mackerel and flying fish comprise 61% of pelagic production (Table 2.24).

Flying fish (*Cypsilurus* spp.) account for only 10% of pelagic production but are economically more significant than this figure suggests. Like the oil sardine fishery of the Bali Straits, the unique features of this fishery have attracted considerable attention among researchers. In this fishery, both the fish and especially the roe are of economic value. The roe are processed locally and exported to Japan.

Flying fish are caught in the Makassar Strait during May-August using batteries of floating traps. Delsman and Hardenberg (1934) noted that this coincided with the spawning season. The trap is covered with seaweed, providing a bed on which the flying fish lay their eggs. Nessa et al. (1977) noted that 10,000 fishermen are involved in this seasonal fishery and that in 1973 gill nets were used in addition to floating traps.

In 1982, the South Sulawesi provincial government sponsored a workshop on flying fish. Dwiponggo et al. (1982) and Dwiponggo (1983) estimated the potential for this species to be 16,000-17,000 t/yr. Average production during 1975-1979 was 10,000 t, indicating some potential for increased exploitation. They suggested that any increase in effort be gradual, however. They estimated annual roe production could be sustained at

Tabel 2.24. Selatan Sulawesi: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.24. South Sulawesi: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Pancing/Hook and line	13,023.6	42.0	Peperek/Slipmouths	5,392.0	20.0
	Sero/Guiding barriers	4,135.6	13.0	Udang penaeid/Penaeid shrimp	3,622.2	13.3
	Jaring klitik/Shrimp gill net	3,424.0	11.0	Lencam/Emperors	3,311.6	12.2
	Pukat pantai/Beach seine	3,267.0	10.4	Ikan merah/Red snapper	2,177.0	7.9
	Jala/Cast net	1,771.0	5.7	Kuro/Senangin-Threadfins	1,356.0	5.0
	Otter trawl	1,746.0	5.6	Kerapu/Groupers	1,313.4	4.8
	Trawl udang ganda/Double-rigged trawl	670.3	2.1	Cucut/Sharks	1,303.0	4.7
				Ekor kuning/Yellowtail fus.	966.6	3.5
	Perangkap lain/Other traps	500.0	1.6	Cumi-cumi/Squid	929.8	3.4
	Dogol/Danish seine	390.0	1.2	Ikan gerot-gerot/Grunts	879.0	3.2
	Jermal/Stow nets	294.0	0.9			
Pelagis Pelagic						
	Payang	23,902.8	21.0	Teri/Anchovies	16,578.4	15.8
	Jaring insang hanyut/Drift gill net	18,101.0	16.0	Tembang/Fringe scale sardine	14,611.0	13.9
				Layang/Scads	11,971.4	11.4
	Bagan tancap/Stationary liftnet	17,303.8	15.0	Kembung/Indo-Pacific mackerel	10,774.6	10.2
	Bagan perahu/rakit-Boat/raft liftnet	12,436.0	11.0	Ikan terbang/Flying fish	10,322.0	9.8
				Cakalang/Skipjack tuna	6,884.4	6.5
	Bubu/Portable traps	9,732.0	8.6	Tongkol/Eastern little tuna	6,454.6	6.1
	Jaring insang tetap/Set gill net	9,572.8	8.5	Lemuru/Oil sardine	4,935.0	4.7
				Selar/Yellow striped trevally	4,556.6	4.3
	Pancing tonda/Troll lines	7,657.0	6.8	Tuna	3,460.0	3.3
	Jaring insang lingkar/Encircling gill net	5,529.0	4.9			
	Pukat cincin/Purse seine	4,153.5	3.7			
	Rawai hanyut/Drift longline	3,205.2	2.8			

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

150 t. During 1970-1979, the export of flying fish roe increased from 85 t/yr to 120 t/yr. Export earnings for this commodity increased significantly over this period, from US$4,273 in 1970 to US$4.1 million in 1979.

Recommendations from the workshop included research on the migratory habits of flying fish and improvement of statistical data (Dwiponggo et al. in press). It was noted that, since the most valuable product from the fishery was the roe, the use of gill nets should be limited and gradual increase in floating traps should be encouraged. Catch-and-effort data from 1975 to 1979 indicate that pelagic fisheries generally are fully exploited and that management of the flying fish fishery needs to be considered (Fig. 2.18 and 2.19).

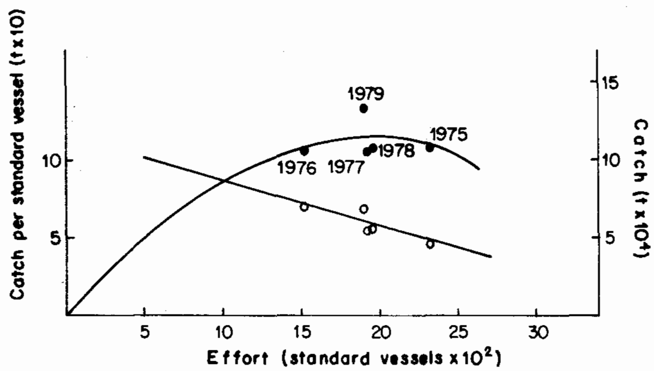

Fig. 2.18. South Sulawesi: Total catch, standard effort (st. purse seine), catch per unit of effort of pelagic fish production by the pelagic gear (excluding the skipjack pole and line) in 1975-1979.

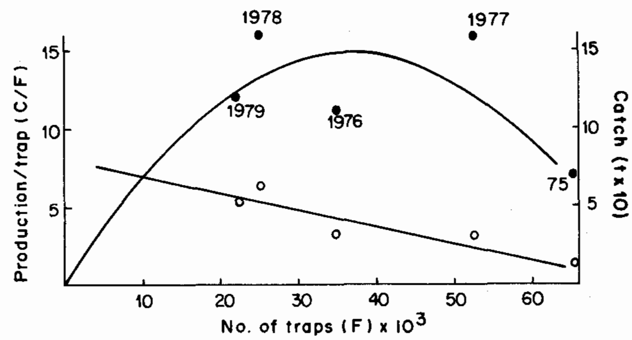

Fig. 2.19. South Sulawesi: Total production (export), number of traps (E) and production per trap (C/F) of flying fish roe production by the trap fishery in 1975-1979.

North coast of Sulawesi

This coastal fishery area includes the provinces of North and Central Sulawesi. The continental shelf in this area is extremely limited and this is the only one of the 12 coastal areas where no trawlers were recorded in 1979 (DGF 1981a). North coast Sulawesi is bordered by the Makassar Straits to the west, the Sulawesi (Celebes) Sea to the north, and the Moluccas Sea to the east. Particularly during the northern monsoon season, the seas in this area are rough, with Tomini Bay the only sheltered fishing ground.

Production by demersal gear between 1975 and 1979 averaged 22% of total marine fisheries production (Table 2.25), with beach seines accounting for half of the demersal total, followed by other typical small-scale gear such as set gill nets and cast nets (Table 2.26). Coral reef species dominate the demersal catch.

The most important pelagic gear are hook and line, mobile liftnet, purse seine, and pole and line, which together account for two-thirds of pelagic production (Table 2.26). Anchovies (landed primarily by mobile liftnets), skipjack (caught by hook and line, pole and line and troll gear) and trevallies and scads (captured by purse seines and payang seines) are the most important pelagic species (Table 2.26).

Skipjack tuna is the most economically important species in this area with pole and line playing a major production role. Most pole and liners are between 30 and 40 GT and operate within a radius of 40-50 km from the port, the most important of which is Bitung on the northern tip of Sulawesi Island. This is home port for a government fishing company, P.N. Perikani Sulawesi Utara Tengah, which operates 30 pole and liners out of a total of 69 recorded by DGF in 1979 (DGF 1981a). Production by this company was 3,900 t in 1979, a significant increase over 1978 production of only 266 t (P.T. Samodra Besar 1981). Production was constrained by inadequate supply of anchovies used as bait for chumming due to competition from private pole and line operators (Skillman 1980). This problem was overcome by P.N. Perikani by purchasing bait at attractive prices from small-scale fishermen using mobile liftnets. Officers of P.N. Perikani are confident that skipjack resources will support continued increases in articles.

Fisheries research in this coastal area includes a 1968 survey of potential anchovy fishing grounds (Subani 1973) and stock assessment of pelagic and demersal resources during the period December 1978-December 1980 (Amin et al. 1980). The anchovy survey was aimed at identifying unexploited sources of bait for pole and line operations as bait supply was recognized as a potential constraint. Subani reported that the distribution of anchovy fishing grounds has been mapped.

Tabel 2.25. Utara Sulawesi: hasil tangkapan dengan alat penangkap demersal dan pelagis (tonnes), 1975-1979.[a]
Table 2.25. North Sulawesi: Catch by demersal and pelagic gears in tonnes, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	12,746	9,282	10,146	11,660	10,925	10,951.8
Udang penaeid Penaeid shrimp	508	244	170	32	72	205.2
Udang lain Other shrimp	147	86	2	69	22	65.2
Ikan demersal Demersal fish	12,091	8,952	9,974	11,559	10,831	10,681.4
Pelagis Pelagic						
Jumlah produksi Total catch	24,822	39,179	42,902	43,427	43,427	39,928.2
Tuna	1,762	3,534	3,544	2,637	2,934	2,882.2
Cakalang Skipjack tuna	4,674	7,293	5,500	5,623	8,532	6,324.4
Ikan pelagis kecil Small pelagic fish	18,386	28,352	33,858	35,167	31,961	29,544.8

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Results of the 1978-1980 stock assessment surveys reported by Amin et al. are summarized in Table 2.27. Acoustic equipment was used during the survey cruises. However, research in the Sulawesi Sea and the Makassar Straits, where significantly higher stock densities are reported, was accomplished with the aid of more sophisticated equipment (i.e., an echo integrator), resulting in problems of comparability. Further research using standardized equipment and during different seasons has been suggested (BPPL 1981).

Other fisheries researches in this area include that of Uktolseya et al. (1981), who indicated that skipjack probably spawn in the protected waters of Tomini and Tolo Bays, and an acoustic survey conducted in June 1982 around Sangihe and Talaud Islands north of Sulawesi Island (Sujastani, pers. comm.). During this survey,only few echo traces were recorded.

Moluccas

The Moluccas, legendary islands of spice, lie between Sulawesi and Irian Jaya. Approximately 1,000 small islands make up this group. Fishing grounds include the Moluccas Sea to the west, the Banda Sea to the south and the Pacific Ocean to the north, and waters off Irian Jaya to the east. With the exception of the wide continental shelf bordering Irian Jaya, the waters in this area are characteristically deep, and pelagic gear

Tabel 2.26. Utara Sulawesi: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.26. North Sulawesi: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Pukat pantai/Beach seine	5,572.0	50.9	Ekor kuning/Yellowtail fusilier	1,038.8	23.0
	Jaring insang tetap/Set gill net	1,672.5	15.3	Ikan merah/Red snapper	645.0	14.3
	Jala/Cast net	1,419.0	13.0	Cucut/Sharks	459.6	10.2
	Sero/Guiding barriers	885.8	8.1	Kerapu/Groupers	440.8	9.8
	Perangkap lain/Other traps	603.0	5.5	Kakap/Baramundi	380.0	8.4
	Muroami	543.0	5.0	Lencam/Emperors	290.0	6.4
	Bubu/Portable traps	379.0	3.5	Biji nangka/Goatfish	254.4	5.6
				Cumi-cumi/Squid	217.0	4.8
				Udang penaeid/Penaeid shrimp	205.0	4.5
				Peperek/Slipmouths	112.8	2.5
Pelagis Pelagic						
	Pancing/Hook and line	12,221.0	31.0	Teri/Anchovies	6,601.0	16.0
	Bagan perahu/Rakit-boat /raft liftnet	5,640.0	14.0	Cakalang/Skipjack tuna	6,324.0	15.0
	Pukat cincin/Purse seine	4,296.6	10.8	Selar/Yellow striped trevally	5,800.8	13.7
	Huhate/Skipjack pole and line	4,002.0	10.0	Layang/Scads	5,397.8	12.7
	Payang	3,574.0	9.0	Tongkol/Eastern little tuna	3,802.0	8.9
	Jaring insang hanyut/Drift gill net	3,661.0	9.0	Tuna	2,882.0	6.8
	Pancing tonda/Troll lines	2,955.0	7.4	Julung-julung/Garfish, halfbeak	2,464.0	5.8
	Serok/Scoop net	2,096.0	5.0	Tembang/Fringe scale sardine	1,878.0	4.4
	Rawai hanyut/Drift longline	760.0	2.0	Kembung/Indo-Pacific mackerel	1,873.0	4.4
				Kuwe/Jacks, trevally	1,330.0	3.1

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

account for 72% of total catch (Table 2.28). Pole and line, purse seine and troll line dominate pelagic production (Table 2.29). The most important pelagic species are skipjack and halfbeaks (Table 2.29). Large schools of garfish (Hemiramphus spp.) found in the Moluccas are unique in Indonesia (DGF 1974). They landed by a small-scale purse seine locally known as giob. Large garfish (Belone spp.) are caught by fishermen using hook and line suspended from kites (Delsman et al. 1934). (Capt. L. Moody of the M/V Java Tide reported fishermen along the north coast of West Java using a similar technique in 1982; pers. comm.).

Catch-and-effort data (1971-1979) analysis shows that the state of exploitation of pelagic resources indicates the possibility of further expansion of net fisheries in this area (Fig. 2.20).

From Table 2.29, it can be seen that increased production during the period 1975-1979 is attributable to expanding catches of small pelagic species. Much of this increase is due to the motorization of small-scale fishing boats and gear improvements.

Most of the purse seine and troll lines in this area appear to be operated from small-scale boats powered by outboard engines. However, over 97% of the boats in the Moluccas are without engines and 78% are dugout canoes (DGF 1981a). Thus, the majority of fishermen in this area continue to use traditional gear types in nearshore waters.

Table 2.27. Area, distribution of stock density and estimated potential yield from acoustic survey in northern Sulawesi.[a]

	Area km^2	Density t/km^2	Potential yield (t)	Period of survey
Pelagic stock				
East of Sulawesi (Tolo Bay)	59,555	1.6	95,287	Dec 78-Feb 79
Tomini Bay	56,413	3.4	194,130	Jan-Feb 80
Sulawesi Sea and Makassar Strait	37,523	4.5	169,166	Oct-Dec 80
Total	153,491		183,433	
Demersal stock				
East of Sulawesi	10,700	1.8	18,807	Dec 78-Feb 79

[a]Sumber/Source: Amin et al. (1980).

Tabel 2.28. Maluku: hasil tangkapan dengan alat penangkap demersal dan pelagis, 1975-1979.[a]
Table 2.28. Moluccas: Catch by demersal and pelagic gears, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	18,220	14,644	10,925	15,018	16,598	15,984.2
Udang penaeid Penaeid shrimp	4,692	4,861	3,387	3,955	3,754	4,129.8
Udang lain Other shrimp	86	603	879	1,889	1,368	965.0
Ikan demersal Demersal fish	15,008	9,180	6,659	9,174	11,476	10,299.4
Pelagis Pelagic						
Jumlah produksi Total catch	31,851	36,537	39,197	39,966	46,227	38,755.6
Tuna	1,686	1,245	1,712	2,126	2,081	1,770.0
Cakalang Skipjack tuna	9,158	7,589	8,650	8,665	9,995	8,811.4
Ikan pelagis kecil Small pelagic fish	21,007	27,703	28,835	29,175	34,151	28,174.2

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Tabel 2.29. Maluku: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang penting, 1975-1979.[a]

Table 2.29. Moluccas: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan	Jenis alat tangkapan	Rata-rata produksi (t) 1975-1979	Rata-rata persentasi produksi 1975-1979	Jenis ikan/udang	Rata-rata produksi (t) 1975-1979	Rata-rata persentasi produksi 1975-1979
		Average production			Average production	
Fishery	Type of gear	(t)	(%)	Species of fish/shrimp	(t)	(%)
Demersal						
	Pukat pantai/Beach seine	5,936.8	37.1	Udang penaeid/Penaeid shrimp	4,129.8	32.0
	Trawl udang ganda/Double-rigged trawl	4,484.4	28.1	Lencam/Emperors	2,122.0	16.4
				Kakap/Baramundi	1,199.8	9.2
	Sero/Guiding barriers	2,207.0	13.8	Ekor kuning/Yellowtail fusilier	968.8	7.5
	Jala/Cast net	1,889.2	11.8	Udang lain/Other shrimp	965.0	7.4
	Rawai tetap/Set longline	655.2	4.1	Kerapu/Groupers	748.6	5.7
	Muroami	653.4	4.1	Biji nangka/Goatfish	414.8	3.0
	Bubu/Portable traps	332.6	2.1	Cucut/Sharks	387.8	2.9
				Pari/Rays	201.4	1.5
				Kurisi/Threadfin bream	174.0	1.3
Pelagis Pelagic						
	Huhate/Skipjack pole and line	8,313.6	21.5	Cakalang/Skipjack tuna	8,811.4	22.3
	Pukat cincin/Purse seine	8,263.2	21.3	Julung-julung/Garfish, half-beak	7,067.6	18.0
	Pancing tonda/Troll lines	6,004.6	15.5			
	Pancing/Hook and line	3,530.6	9.1	Tongkol/Eastern little tuna	3,500.6	8.8
	Jaring insang tetap/Set gill net	3,493.6	9.0	Selar/Yellow striped trevally	2,941.0	7.4
				Layang/Scads	2,458.2	6.2
	Jaring insang hanyut/Drift gill net	2,812.2	7.3	Tembang/Fringe scale sardine	2,068.2	5.2
				Kembung/Indo-Pacific mackerel	2,046.8	5.2
	Rawai hanyut/Drift longline	2,440.6	6.3			
	Jaring insang lingkar/Encircling gill net	1,879.0	4.9	Tuna	1,770.0	4.2
				Kuwe/Jacks, trevally	1,593.8	4.0
	Jaring angkat lain/Other liftnets	1,051.8	2.7	Alu-alu/Barracudas	696.0	1.8
	Bagan perahu/rakit-Boat/raft liftnet	886.6	2.3			

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

Catch-and-effort data for 1975 to 1979 (Fig. 2.20) show that the pelagic fisheries have scope for expansion although catches are nearing MSY.

Landings of skipjack, the most important pelagic species, have varied in recent years (Table 2.29) but show no evidence of overexploitation despite the reported presence in 1979 of 453 pole and lines in the Moluccas, 79% of the national total (DGF 1981a). Since in that year the total number of medium- and large-scale boats (i.e., those with inboard engines) was only 138 (DGF 1981a), it must be assumed that the majority of all pole and liners in this area are small-scale operation, probably including some fishermen using non-powered boats. (Pole and line were excluded from consideration in Fig. 2.20).

There are, however, some medium- and large-scale pole and line operations, the latter represented by Perum Perikanan Maluku, a state enterprise which operates 10 pole and liners of 30 GT and 2 of 100 GT. The smaller boats make day trips in waters near the

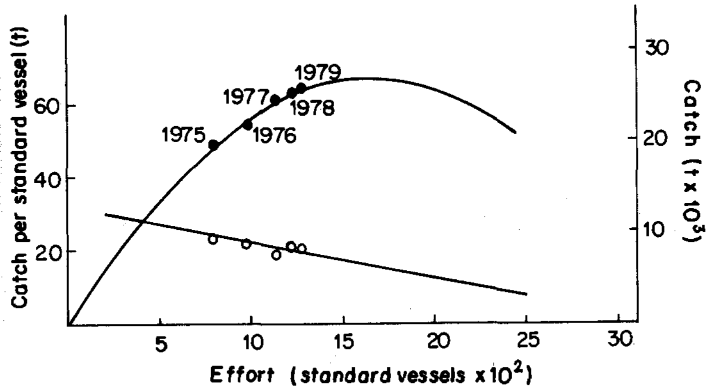

Fig. 2.20. Moluccas: Total catch, standard effort (st. purse seine) and catch per unit of effort of pelagic fish production by the pelagic gear (excluding pole and line) in 1975-1979.

company's base at Ambon while the larger boats operate for extended periods in less heavily exploited waters in the Moluccas Sea. This company buys bait fish from local small-scale fishermen and helps market the skipjack catch of other fishermen for both domestic and export markets.

Available catch-and-effort data from the Moluccas and a yield curve suggesting an MSY of around 27,000 t/annum of pelagic species are shown in Fig. 2.20.

Demersal production is dominated by such small-scale gear as beach seines, hook and line, set gill nets, guiding barriers and cast nets. Large-scale fisheries also are important, however, with double-rigged shrimp trawlers operated by joint venture companies landing 20% of the demersal catch (Table 2.29). However, these trawlers actually are deployed in the Arafura Sea off Irian Jaya and use Ambon for their shore facilities. In 1979, 60 double-rigged shrimp trawlers were recorded in the Moluccas (DGF 1981a). During the period 1975-1979, average penaeid shrimp landings were over 4,000 t/yr, though production declined between 1977 and 1979 (Table 2.29). Penaeid shrimps constituted on average 32% of total demersal landings, but local production was dominated by coral reef species (Table 2.29).

Pattimura University at Ambon is being developed into a major center for marine research for eastern Indonesia. To date, however, demersal and pelagic research on local fisheries is largely lacking.

The Aru Islands fishing grounds are estimated to cover an area of 13,000 t. Fishing takes place at 5-50 m depth. Fishing grounds of these islands are characterized by capture of tiger shrimp (Penaeus monodon) by trawl. The tiger shrimp catch increased from 1,025 t in 1972 to 1,500 t in 1978. The MSY is estimated at between 1,070 and 1,270 t/yr which requires an annual average fishing effort of between 93,150 and 100,000 hauls, equal to 61 to 66 double-rigged tankers.

Irian Jaya

Irian Jaya is the largest province in Indonesia, with 22% of the nation's land area. The population is less than 200,000, the lowest of any province. Marine fisheries production in 1979 was 18,000 t, the lowest for any coastal fishing area (Table 2.1). However, the importance of this area's fisheries lie not in total production but in export earnings from shrimp and skipjack, which dominate demersal and pelagic landings (Tables 2.30 and 2.31).

Tabel 2.30. Irian Jaya: Hasil tangkapan dengan alat penangkap demersal dan pelagis (tonnes), 1975-1979.[a]
Table 2.30. Irian Jaya: Catch by demersal and pelagic gears in tonnes, 1975-1979.[a]

Jenis alat dan hasil tengkapan Gear type and catch	1975	1976	1977	1978	1979	Rata-rata Average
Demersal						
Jumlah produksi Total catch	7,773	4,057	4,336	6,634	7,203	5,980.8
Udang penaeid Penaeid shrimp	4,507	701	2,777	4,493	4,457	3,387.0
Udang lain Other shrimp	17	2,093	306	521	425	672.4
Ikan demersal Demersal fish	3,249	1,263	1,544	1,620	2,321	1,999.4
Pelagis Pelagic						
Jumlah produksi Total catch	4,397	7,519	7,794	12,551	11,039	8,660.0
Tuna	99	279	276	183	635	294.4
Cakalang Skipjack tuna	324	1,619	2,273	5,521	4,052	2,757.8
Ikan pelagis kecil Small pelagic fish	3,974	5,621	5,245	6,847	6,352	5,607.8

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

As is the case elsewhere in Indonesia, small-scale fishermen account for a large majority of all fishermen which in 1979 were reported to be nearly 20,000 (DGF 1981a). From Table 2.31, however, it is clear that large-scale gear dominate both demersal and pelagic production. Double-rigged shrimp trawlers operated by joint venture companies (by definition, large scale), accounted for over half of average demersal production during 1975-1979, and if those based in the Moluccas which operate within the Arafura Sea were included, the proportion is larger still (see Table 2.29). During 1975-1979, pole and line operations produced 29.7% of pelagic landings. P.T. Usaha Mina, a state fishery enterprise based in Sorong, operates 27 pole and lines of 30 GT and one each displacing 100 GT and 300 GT. There appear to be no private pole and line operations in Irian Jaya as the DGF reported only 28 such units in 1979 (DGF 1981a). Skipjack landings increased from 324 t in 1975 to over 5,500 t in 1978, declining to 4,100 t in 1979 (Table 2.30) and increasing slightly to 4,200 t in 1980 (P.T. Samudra Besar 1981). Skipjack comprise 90-95% of the catch from pole and liners (Supanto and Sujastani 1978). Potential yields for skipjack or other pelagic species have not fully been investigated in Irian Jaya's waters.

Prior to 1963, when Indonesia assumed control over Irian Jaya from the Dutch, no fisheries research in this area had been conducted. In 1964, an Indonesian research vessel reported finding rich shrimping grounds in the Arafura Sea; these results were confirmed by a subsequent (Baruma) survey in 1967. In 1969, two joint venture companies were established, one based in Ambon and the other in Sorong (Unar 1972). In that year, nine

Tabel 2.31. Irian Jaya: Rata-rata produksi dan persentasi jumlah produksi per tahun untuk beberapa jenis alat tangkap dan jenis ikan/udang yang panting, 1975-1979.[a]
Table 2.31. Irian Jaya: Average annual production and percentage of total production of important gear types and species of fish/shrimp, 1975-1979.[a]

Perikanan / Fishery	Jenis alat tangkapan / Type of gear	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)	Jenis ikan/udang / Species of fish/shrimp	Rata-rata produksi (t) 1975-1979 / Average production (t)	Rata-rata persentasi produksi 1975-1979 / Average production (%)
Demersal						
	Trawl udang ganda/Double-rigged trawl	4,188.6	52.0	Udang penaeid/Penaeid shrimp	3,387.0	63.5
				Udang lain/Other shrimp	672.4	12.6
	Pancing/Hook and line	1,982.0	25.0	Kakap/Baramundi	393.4	7.3
	Jala/Cast net	557.2	7.0	Cucut/Sharks	200.0	3.7
	Pukat pantai/Beach seine	548.2	6.8	Ikan merah/Red snapper	70.8	1.3
	Jaring insang tetap/Set gill net	429.8	5.3			
	Sero/Guiding barriers	172.0	2.0			
Pelagis / Pelagic						
	Huhate/Skipjack pole and line	2,570.2	29.7	Cakalang/Skipjack tuna	2,757.8	38.4
	Bagan perahu/Rakit-boat/raft liftnet	2,360.0	27.3	Teri/Anchovies	1,841.4	25.7
				Kembung/Indo-Pacific mackerel	522.8	7.3
	Pancing/Hook and line	1,982.0	22.9	Tenggiri/Spanish mackerel	317.0	4.4
	Pancing tonda/Troll lines	837.7	9.8	Tuna	294.0	4.0
	Jaring insang hanyut/Drift gill net	595.6	6.9	Belanak/Mullets	275.0	3.8
				Julung-julung/Garfish, halfbeak	278.2	3.9
	Jaring insang lingkar/Encircling gill net	83.8	1.0	Layang/Scads	202.6	2.8
				Tembang/Fringe scale sardine	147.0	2.0
	Pukat cincin/Purse seine	80.0	0.9	Kuwe/Jacks, trevally	141.0	2.0
	Payang	48.5	0.6			

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a).

vessels commenced exploratory fishing; by 1971, the total had increased to 17, 70% of which were 100 GT and the remainder 300 GT. Naamin and Saifan Noer (1980) reported that by 1978, there were 120 trawlers owned by 17 joint venture companies active in the Arafura Sea. These trawlers ranged in size from 90 to 594 GT, with 55 using engines less than 500 hp; 58 using engines between 500 and 1,000 hp; and seven with engines over 1,000 hp.

Gulland (1973), looking at the Arafura Sea shrimp fishery at its earliest stages of development, noted that declines in catch per unit effort were setting in as a virtually virgin resource came under fishing pressure, but that total production was increasing. He recommended a limit of 90 double-rigged shrimp trawlers pending further investigation.

Uktolseja (1978) estimated the MSY for shrimp in the Arafura Sea to be 5,200 t/yr. She reported that by 1974, this resource was overexploited and catch per trip declined between 1974 and 1976.

Naamin and Saifan Noer (1980) estimated MSY of the shrimp fishery of the Arafura Sea to be between 6,000 and 6,170 t/yr. They also provided information on levels of exploitation and catch per unit effort on sub-areas and by species, noting that MSY for some areas and species has been exceeded but that potential for increased production exists elsewhere.

Catch-and-effort data from Irian Jaya during the period 1975-1979 and a yield curve for demersal fish and shrimp (combined) are given in Fig. 2.21.

Assessing Indonesia's Marine Fishery Resources

In the preceding section, basic descriptive information on each of Indonesia's 12 coastal fishing areas was discussed, together with estimates from various sources of MSY. Yield curves based on the Schaefer model were provided for a number of fisheries (Fig. 2.5-2.21). The figures were derived from the application of regression analysis to data on catch per unit of standard effort against total standard effort. For purposes of this Review, demersal gear were standardized with trawlers equal to one unit of fishing effort. Pelagic gear were standardized with purse seiners as one unit of fishing power. All other gear were assigned values depending on their relative efficiency, i.e., fishing power.

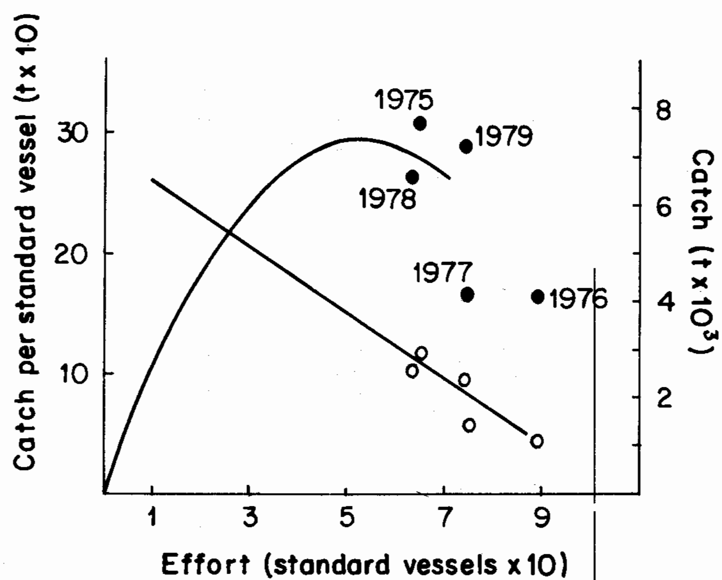

Fig. 2.21. Irian Jaya: Total catch, standard effort and catch per unit of effort of demersal fish and shrimp production by the shrimp trawler and demersal gear in 1975-1979.

Use of these stock assessment models provides a practical means of estimating MSY and describing the level of exploitation of the various fisheries. However, their effective use is constrained in many cases by the absence of reliable time series data, particularly for the period prior to 1975, when improved methods of collection and presentation of fisheries statistics were adopted. Even for years subsequent to 1975, serious problems hamper assessment of stocks, notably accuracy in identifying species composition of the catch and area in which the catch was boarded as distinct from where it was landed. Questions may also be raised regarding the accuracy of production statistics as a whole, since they depend in part on estimation of catch by small-scale fishermen in isolated coastal communities. Despite these caveats, Indonesia's fisheries statistics since 1975 are reasonably accurate and sufficient for approximations of MSY and level of fishing effort presented in Table 2.32.

Table 2.32 summarizes for each of the 12 coastal areas the status of Indonesia's marine fisheries resources in 1979, including catch, total standard fishing effort, Tabel 2.32. Ringkasan dari status pengusahaan beberapa sumberdaya perikanan di Indonesia.

Table 2.32. Summary of the status of exploitation of Indonesian marine fisheries resources based on landings data for the period 1975-1979. The levels of exploitation are adapted from FAO (1974).

Sub-area	1979 Production (x 10^3 t)	Total standard effort	MSY (x 10^3 t)	Optimum effort	Level of exploitation
1. Malacca Strait					
Demersal					
a. Demersal gear	152	2,571	167-188	1,438-2,092	Fully
b. Demersal fish	86	2,571	137-248	833-1,758	Fully
c. Penaeid shrimp	16	1,969	18	1,573-1,767	Fully
d. Other shrimp	50				
Pelagic					
a. Pelagic gear	84.6	963	70-90		Fully
2. East Coast of Sumatra					
Demersal					
a. Demersal gear	29.7	220	27-28	227-247	Moderate
b. Demersal fish	24.4	171	24-25	239-253	Moderate
c. Shrimp	5.3	152			
Pelagic					
a. Small pelagic	57.4				
3. North Coast of Java					
Demersal					
a. Demersal gear	116.9	1,642	124-170	833-367	Fully
b. Demersal fish	105.6	1,642	114-160		Fully
c. Penaeid shrimp	7.8	1,084	7-7	1,073-1,161	Fully
Pelagic					
a. Small pelagic	185.3	2,172	290-391	5,523-9,050	Lightly/ Moderate
b. Muroami Jakarta	0.9	16	1-1.1	17-20	Fully
4. South and West Coast of Kalimantan					
Demersal					
a. Demersal fish	37.2	1,709	34-35	1,636-2,053	Fully
b. Penaeid shrimp	5.4	1,665			
Pelagic					
a. Small pelagic	29.8				
5. East Coast of Kalimantan					
Demersal					
a. Demersal fish	32.8				Moderate
b. Penaeid shrimp	5.5		3.4		Fully
Pelagic					
a. Small pelagic	37				Moderate
6. West Coast of Sumatra					
Demersal					
a. Demersal gear	24.4	269	22-23	269-287	Fully
b. Demersal fish	23.1	241	20-21	261	Fully
c. Penaeid shrimp	1.3	188	1.5	209	Fully

Continued

Table 2.32. (continued)

Sub-area	1979 Production (x 10^3 t)	Total standard effort	MSY (x 10^3 t)	Optimum effort	Level of exploitation[a]
Pelagic					
a.	39				
b.	3.2				
c.	5.3				
7. South Coast of Java					
Demersal					
a. Demersal fish	19.9	276	20.9	268	Fully
b. Penaeid shrimp	4.9	157	4-6	106-119	Fully
Pelagic					
a. Small pelagic	16.4				
b. Tuna	0.09				
c. Skipjack	5.3				
8. Bali-Nusa Tenggara-Timor					
Demersal					
a. Demersal gear	19.4	612			
b. Penaeid shrimp	4.7	207			
Pelagic					
a. Small pelagic	48.7	464	47-49	494-582	Moderate/ Fully
b. Oil sardine	24		36-38	190	Fully
c. Tuna	2.3				
d. Skipjack	1.3				
9. South Coast of Sulawesi					
Demersal					
a. Demersal fish	46.3	203	34-42	102-187	Fully
b. Penaeid shrimp	4.7	207			
Pelagic					
a. Small pelagic	132.5	1,910	114.8-	1,972-	Moderate/ Fully
b. Flying fish roe	0.12	2,262 (Pakaja)	0.15	2,000-2,700 (Pakaja)	Moderate
10. North Coast of Sulawesi					
Demersal					
a. Demersal fish	10.8				
b. Penaeid shrimp	0.72				
Pelagic					
a. Small pelagic	34.2				
b. Tuna	2.9				
c. Skipjack	8.5				
11. Moluccas					
Demersal					
a. Demersal fish	16.6	207	18-18.2	344-421	Lightly/ Moderate
b. Penaeid shrimp	5.1	165	5.1-5.2	146-153	Fully

Continued

Table 2.32. (continued)

Sub-area	1979 Production ($x 10^3$ t)	Total standard effort	MSY ($x 10^3$ t)	Optimum effort	Level of exploitation[a]
Pelagic					
(a) Small pelagic	25.8	1,268	27-32	1,645-2,262	Moderate
(b) Tuna	2.1				
(c) Skipjack	10				
12. Irian Jaya					
Demersal					
a. Demersal gear	7.2	74	7-12	27-52	Fully
b. Penaeid shrimp	4.9	54	4.7	39	Fully
Pelagic					
a. Small pelagic	6.4				
b. Tuna	0.6				
c. Skipjack	4.1				

estimated MSY, optimum level of standard fishing effort and state of resource exploitation (see also Fig. 2.5-2.21). Catch-and-effort data were calculated for both demersal and pelagic species. Where significant production was recorded, demersal species were subdivided into finfish and shrimp and pelagic species disaggregated to small pelagics, skipjack and other tuna. Only those catch-and-effort data were used to estimate MSY that showed significant (P=0.05) correlation between catch per effort and effort.

Light exploited : current catches are a small fraction of the potential;

Moderately exploited : current catches are a sizeable fraction of the potential, but where appreciable increase in sustained catch can still be obtained by increased fishing

Fully exploited : current catches approach the potential of the resources, and increased fishing would not give appreciable increase in sustained catch. Some increase in catch would probably be achieved by suitable management measures

Overexploited : stocks have been reduced such that the current catches are less than the possible sustained catch.

Demersal resources

It can be seen from Table 2.32 that in Indonesia, demersal resources generally are more heavily exploited than pelagic resources. This situation reflects the high density of population and numbers of fishermen around major shallow-water fisheries such as the Malacca Straits and the Java Sea, especially along the north coast of Java. Most fishermen in these areas are small-scale operators limited to inshore waters by their boats and gear. Many of the species exploited by these fishermen are demersal and coastal pelagic fish, and accordingly these resources are under heavy pressure. Until 1980, the presence of large numbers of trawlers, whose target species were the shrimps that are most abundant in coastal waters, contributed significantly to fishing pressure on demersal resources.

Production data for demersal species subsequent to the trawl ban are just beginning to become available and the impact of this measure in terms of stock assessment of production cannot yet be assessed thoroughly. There are indications, confirmed by observations by the authors in the field, that at least shrimp production has declined (Naamin and Martosubroto 1984). However, the productivity of individual small-scale fishermen seems to have improved and the numbers of such fishermen appear to have increased (Martosubroto and Badrudin 1984).

Stock assessment analyses for demersal resources are relatively well-developed in Indonesia, and were reviewed in the preceding section. These studies have included results of survey cruises as well as statistical analysis of available catch-and-effort data, and have provided valuable data for the updated calculations presented in Table 2.32.

There are, however, extensive areas where assessment of demersal stocks is based not directly on research but on extrapolation. This is the case particularly for the west coast of Sumatra, the south coast of Java and south of the Lesser Sunda Islands. In these waters of the Indian Ocean, fishing effort applied to demersal resources is limited to narrow strips of continental shelf and catch-and-effort data provide no indication of potential production in deeper waters. Neither are there adequate data on standing stocks of these unexploited resources.

Research on coral reef fisheries also is inadequate for stock assessment purposes. Extrapolations from elsewhere may provide useful guides for estimating MSY for coral reefs. However, coral reefs in Indonesia have experienced considerable destruction caused by dynamite and poison fishing, and the mining of reefs for construction materials (Subani 1978; Soegiarto and Polunin, n.d.). It is reported that throughout Indonesia more isolated coral reefs are most affected, probably due to difficulties in enforcing existing conservation regulations (Rod Salm, World Wildlife Fund, pers. comm.). Destruction of coral reef habitats has a direct and negative impact on fisheries production.

Although demersal resources are heavily exploited in many parts of Indonesia, there appears to be scope for increased production in some areas as discussed below.

Pelagic resources

Estimations of pelagic resources are complicated by the migratory habits of many important pelagic species, several of which ignore international boundaries and represent shared stocks with neighboring countries.

In order to determine MSY and optimum levels of fishing effort, it is necessary to have information on both seasonal and spatial distribution of the fish. However, such information is not yet available and assessment of pelagic resources cannot be done with confidence in most areas. Often the best that can be done is to estimate the carrying capacity of waters where pelagic species exist or are thought to exist. A discussion of primary productivity and its relationship in the upper trophic levels (i.e., the fisheries) was presented earlier in this chapter.

Although only few resource surveys of pelagic stocks have been carried out, existing estimates based on tertiary production and biological studies of several important pelagic species suggest that there exists considerable scope for increased production. In the section which follows, the locations and magnitudes of this potential are discussed.

Areas of Potential for Expanded Marine Fisheries Production

To meet national goals of increased production from the marine fisheries sector requires the matching of resource potentials with appropriate levels of fishing effort. Several major fisheries have reached MSY while in other areas existing resources are

South China Sea

Indonesia's offshore fishing grounds within the South China Sea appear to be underexploited for both demersal and pelagic species.

Menasveta et al. (1973) estimated pelagic stock density in the South China Sea to be 1.3 t/km^2 or 325,000 t, with annual potential yield of 162,500 t. Average landings during 1975-1979 by pelagic gear based in the East Sumatra coastal area were only 49,500 t/yr, though it is likely that some fishermen based along the north coast of Java also operate in these waters. Nonetheless, the potential for expanded pelagic production exists for vessels and gear capable of sustained operations in this distant fishing ground.

Dwiponggo and Badrudin (1979) showed that demersal trawl catch rates (108 kg/hr) in the South China Sea were much the same as those for offshore coastal waters of the Java Sea. They estimated potential demersal resources to be 425,000 t and potential yield to be 212,500 t/yr. Average landings by demersal gear based in East Sumatra between 1975-1979 were less than 26,000 t/yr with exploitation limited primarily to inshore waters. If economically viable, demersal resources in the South China Sea will sustain significant increases in production. In this area, trawling is the most effective means of exploiting demersal stocks but the proposed extension of the trawl ban to all Indonesian waters may preclude this option.

Java Sea

Based on Cushing (1971), total stock density of the Java Sea is estimated to be 6.7 t/km^2 or 2,500,000 t. Demersal surveys show demersal standing stock to be 1,251,000 t (Losse and Dwiponggo 1976). It can be estimated that pelagic standing stock is approximately the same 1,250,000 t. If half of this total can be landed on a sustainable basis, potential yield would be 625,000 t/yr. Production by pelagic gear during the period 1975-1979 for the East Sumatra, North Java and Southwest Kalimantan coastal fishery areas averaged only 220,000 t/yr. Total production by pelagic gear in these areas in 1979 was 273,000 t. It appears that continued expansion is both possible and likely given increasing numbers of purse seiners, including converted trawlers. Here also the limited nature of current understanding suggests the need to monitor exploitation of pelagic resources.

Demersal resources in the Java Sea offer limited scope for increased production, with the notable exception of some fishing grounds in the offshore waters along the south coast of Kalimantan (Losse and Dwiponggo 1977; Dwiponggo and Badrudin 1978a). The recent trawl ban, however, is likely to have had a major impact on patterns of demersal resource exploitation, especially in coastal waters where fishing effort was excessive.

Indian Ocean

Both demersal and pelagic resources in the coastal fishery areas bordering the Indian Ocean (west coast Sumatra, south coast Java and Lesser Sunda Islands) appear to be underexploited. Cushing estimates tertiary production of the Indian Ocean to be 5.8 t/km^2, with between one-third and one-half harvestable by man. For the Indonesian portion of the Indian Ocean, total standing stock is estimated at between 500,000 and 750,000 t, divided between demersal and pelagic resources. Estimated standing stock and potential yield for demersal species is shown in Table 2.34. Figures in this table were calculated using the equation $MSY = 0.5 \times M \times$ virgin biomass, where M is the natural mortality coefficient equal to 0.5 (Gulland 1971). If the present relative contribution of the catch is the same as the relative potential production, then the potential production of demersal fish may be roughly estimated. Indian Ocean demersal resources are considered to be lightly fished, due to rough sea conditions. It is assumed here that the potential catch is four times as high as present catches.

Moluccas

Based on the tertiary production level of the East Arafura Sea, the standing stock of the fisheries resources in the Moluccas can be estimated at 1,365,000 t or an annual yield of 683,000 t. If the composition of fisheries in the Moluccas reflects the natural species composition of the resources, then 70% of the resources are pelagic.

Banda Sea

Estimate of standing stock in the Banda Sea and Moluccas Sea is 855,000 t (Cushing 1971) with 80% (680,000 t) composed of pelagic species. Potential yield for the pelagic resource is estimated to be 228,000 t/yr and for demersal species 87,000 t/yr. Determining actual production from the Banda Sea, the area of which is approximately 900,000 km^2, is extremely difficult. Some fishermen from the Moluccas, the eastern Lesser Sunda Islands and Sulawesi no doubt operate in parts of the Banda Sea. There are also unlicensed foreign purse seiners operating in the area whose catch is unreported. If nothing else, the presence of these foreign vessels, most of which appear to come from Japan, indicates potential for increasing production for Indonesia's fishing fleet.

Arafura Sea

The shallow waters of the Arafura Sea are highly productive. Shrimp resources appear to be fully exploited but it has been estimated that 80% of the catch of shrimp trawlers (30,000 t) is composed of demersal fish which are dumped at sea due to lack of space on board and the absence of market demand in the sparsely populated areas near the fishing grounds (Nuazat 1980; Sujastani 1982). For the Arafura Sea as a whole, stock density is estimated to be between 500,000 and 800,000 t (Cushing 1971). Liu et al. (1978) estimated demersal standing stock to be 330,000 t; the remainder is presumably pelagic. During 1975-1979, average annual production was less than 6,000 t for demersal gear and less than 9,000 t for pelagic gear. Potential increases in production seem to exist but development of the Arafura Sea fisheries is constrained by economic factors, principally marketing.

Potential for Expanded Production Among Small-Scale Fishermen

A notable feature of the areas in which potentials for increased marine fisheries production have been identified is that the underexploited resources generally lie in offshore waters at considerable distance from fishing grounds exploited by small-scale fishermen. This is the case in the South China Sea, the Java Sea, the Indian Ocean and the Flores, Banda and Arafura Seas. Only in the relatively narrow Malacca Straits are fishing grounds with potential for expanded production located near the coastal waters in which small-scale fishermen operate. Even in the Malacca Straits, exploitation of the pelagic stocks, which offer the best hope for increased landings, will require larger and more powerful boats than are commonly used by small-scale fishermen and improved gear types, such as the purse seine, to be effective. In short, for the Malacca Straits, increased production will depend on expansion of the medium-scale subsector.

For other areas identified in the preceding section, production increases will depend on both medium- and large-scale operations. With their small boats and gear of limited fishing power, small-scale fishermen are unable to exploit offshore areas due to long distances and rough seas.

Tabel 3.1. Jumlah perahu/kapal penangkap perikanan laut menurut katagori dan daerah perairan pantai, 1982.[a]
Table 3.1. Number of marine fishing boats by size and coastal area, 1982.[a]

Perairan pantai Coastal area	Jumlah Total	Perahu tanpa motor — Non-powered boat Sub jumlah Subtotal	Jukung Dugout boat	Perahu papan — Plank-built boats Kecil Small	Sedang Medium	Besar Large	Motor Tempel Inboard	Kapal motor — Boat with inboard engine Sub Jumlah Subtotal	<5 GT	5-10 GT	10-[illegible] GT	20-30 GT	30-50 GT	> 50 GT
Jumlah Total	300,549	215,466	102,454	70,683	36,096	6,263	55,265	29,818	22,265	4,584	1,6[illegible]	1,023	180	156
Barat Sumatra West Sumatra	16,062	12,346	5,833	4,292	1,592	629	2,138	1,578	724	455	3[illegible]	10	5	1
Selatan Jawa South Java	8,600	3,187	2,368	548	206	65	8,006	407	240	117		50	–	–
Selat Malaka Malacca Straits	36,265	20,294	213	13,542	6,033	506	1,911	14,060	11,553	1,767	3[illegible]	363	21	–
Timur Sumatra East Sumatra	12,395	6,869	540	4,157	1,958	214	1,344	4,182	4,182	3,902	2[illegible]	6	–	–
Utara Jawa North Java	57,741	34,110	4,357	16,253	11,520	1,980	21,661	1,970	426	544	5[illegible]	395	51	4
Bali-NTT-Timor Lesser Sunda Island	31,877	25,753	20,601	3,976	994	182	5,826	298	203	57		8	1	20
Sel/Barat Kalimantan Southwest Kalimantan	8,191	5,031	125	2,613	2,031	262	698	2,462	1,570	731	96	56	3	6
Timur Kalimantan East Kalimantan	12,916	5,258	504	2,398	2,251	105	3,724	3,934	3,330	460	105	10	20	9
Selatan Sulawesi South Sulawesi	42,406	35,182	15,558	12,087	5,774	1,763	6,682	542	310	155		20	8	–
Utara Sulawesi North Sulawesi	39,104	34,250	25,596	6,307	2,173	174	4,774	80	1	7		16	32	2
Maluku-Irian Moluccas-Irian	34,992	33,186	26,759	4,480	1,564	385	1,501	305	6	17		95	39	114

[a]Sumber/Source: DGF (1984).

of Japan (Rachman 1982). A total of 3,400 workers, all Indonesians, are employed by these State enterprises.

According to the Director General of Fisheries, the role of State enterprises is to "exploit the fisheries resources beyond the reach of the small-scale fisheries and at the same time to act as a stimulus for the development of the small-scale fisheries, particularly in the marketing of their catch" (Rachman 1982). These general goals which also apply to other large-scale fishing operations are limited to the exploitation of certain species in particular areas where competition with small-scale fishermen is minimized. The large-scale enterprises, and particularly those that are State-owned, are expected to fulfill a general development role in demonstrating advanced fisheries technologies and a more specific role in assisting small-scale fishermen market their catch by providing cold storage facilities and marketing channels for exportable species.

Large-scale fishing operations have made a major contribution to foreign exchange earnings. Between 1969 and 1980, joint venture and domestic enterprises exported US$626 million worth of fisheries products, with shrimp accounting for 97% of this total (Rachman 1982). In 1980 alone, exports from these companies were valued at US$107 million, 91% being shrimp exports. Between 1973 and 1981, State enterprises exported skipjack and tuna worth US$43 million (Rachman 1982), with US$11 million earned in 1980 (P.T. Samodra Besar 1981) and US$16 million in 1981 (Rachman 1982). Combined export earnings from Indonesia's large-scale fisheries subsector in 1980 were US$128 million, 56% of total fisheries export earnings which totalled US$230 million in that year (DGF 1981b).

Indonesia's large-scale fishery operates in relative isolation from the medium- and small-scale subsectors due to a strong export orientation which limits competition in local markets and to the location of fishing operations. The clearest example of this is shrimp trawling in the Arafura Sea and the tuna longline operations of P.T. Samodra Besar, a State enterprise which operates primarily in deep waters of the Indian Ocean and the Banda Sea. Three other State enterprises which exploit skipjack with pole and line do operate in competition with local medium- and small-scale fishermen using the same or similar gear types to exploit the same species. It is assumed, however, that skipjack tuna resources in those areas are underexploited and can support increased fishing effort (P.T. Samodra Besar 1981). Moreover, these State enterprises act as purchasing agents for export quality fish landed by local fishermen, purchase bait fish from small-scale fishermen and provide small- and medium-scale fishermen access to cold storage facilities during periods when catches are high. In 1981, State enterprises purchased over 7,000 t of fish (excluding bait fish) from other fishermen (Rachman 1982).

The three most important gear types used by the large-scale subsector are double-rigged shrimp trawl, tuna longline and pole and line. Pole and line gear is also used by medium-scale fishermen, whose boats are of the same size (30 GT) and configuration as those of the large-scale subsector (Fig. 3.2). Small-scale fishermen also use pole and line gear for capturing skipjack tuna but operate smaller boats. Double-rigged shrimp trawls and tuna longlines, however, are exclusively large-scale gear.

The double-rigged shrimp trawl was introduced in the early 1970s by joint venture companies to exploit shrimp resources in the Arafura Sea. Fishing vessels employing this gear vary in size from 90 GT to 600 GT and half are powered by engines in the 500-1,000 hp range (Naamin and Noer 1980). As the name implies, each trawler pulls two nets (see Fig. 3.1).

The commercial use of tuna longline in Indonesia began in 1962, though experimental fishing with this gear began as early as 1954 (P.T. Samodra Besar 1981). Further trials sponsored by the Japanese Overseas Technical Cooperation Agency were made in 1970 and resulted in a loan from the Japanese government in 1973 for the creation of P.T. Samodra Besar. By 1980, the tuna longline fleet of P.T. Samodra Besar consisted of 17 boats of 111 GT each. Baited hooks on several kilometers of lines suspended in midwater are used to capture yellow fin, big eye and albacore tuna as well as billfish and sharks. The fish are immediately cleaned and frozen and then stored on board for the duration of the cruise, which normally lasts 30-40 days.

Based on observations in the field by this Review team, it appears, that many, if not most, of the medium-scale skipjack pole and liners in these two areas are comparable in size and crew composition with those of the large-scale subsector. A typical 30 GT pole and liner is depicted in Fig. 3.2. Small-scale fishermen using pole and line for skipjack operate smaller boats some of which are not equipped with engines. Even with engines, small-scale pole and liners have a more limited operating range and are less able to follow the migratory skipjack. It is likely that these small-scale fishermen employ different gear types when skipjack are not present in local waters. Medium- and large-scale pole and liners, however, are used exclusively for skipjack fishing.

Medium-scale subsector

Medium-scale fisheries enterprises are distinguished from those of the large-scale subsector by lower investment levels. All are Indonesian owned but, unlike the privately owned domestic large-scale fishing enterprises, are not regulated by the Domestic Capital Investment Law of 1968. Owners of medium-scale fishing boats have relatively little or no investment in shore-based facilities such as ice plants, cold stores or workshops, which characterize the large-scale subsector. Investment levels for typical medium-scale fishing units (boats and gear) are commonly in the range of Rp 5-20 million (roughly US$5,000-20,000) (at the 1982 exchange rate of Rp 615 = US$1.00), and individual owners may have one or perhaps a few fishing units. In contrast, investment levels within the large-scale subsector may total several million dollars.

The medium- and small-scale subsectors are differentiated on the basis of mode of propulsion. Boats powered by inboard engines are considered to be medium-scale, while boats powered by paddle, sail or outboard engines are classified as small-scale. All boats powered by inboard engines, whether operated by medium- or large-scale enterprises, are classified by tonnage as shown in Table 3.1.

Several types of gear are used by the medium-scale subsector, including skipjack pole and line, purse seines, gill nets and (until they were banned during the period 1981 to 1983) otter trawls. Medium-scale fisheries in Indonesia cannot be differentiated from other subsectors on the basis of gear type.

As can be seen in Table 3.1, in 1982 there were nearly 30,000 inboard powered boats operating in Indonesian waters, 75% of which displaced less than 5 GT; 99% displaced 30 GT or less. Most if not all of the boats displacing over 30 GT are those of the large-scale subsector and are based in the Moluccas and Irian Jaya. From Table 3.2, it can be seen that the number of inboard powered boats increased steadily since 1960, but by 1982 these still represented less than 10% of Indonesia's total fishing fleet. In 1982, 47% of all inboard powered boats operated in the Malacca Straits and these represented 39% of the entire fishing fleet in that area (Table 3.1). In contrast, inboard powered boats comprised only 3% of the fleet operating off the north coast of Java.

Otter trawls. Indonesia's medium-scale fisheries are of recent origin, having been firmly established only during the mid- to late 1960s with the development of demersal trawling. During the 1950s, the DGF conducted experimental trawl fishing in the Madura Straits and the Java Sea. The trials were targeted at finfish and regarded as successful, but local fishermen did not respond, among other reasons, due to the difficulty in obtaining engines and spare parts during a turbulent period in Indonesia's economic history. During the late 1960s and early 1970s, however, many of the structural difficulties in Indonesia's broader economy gradually were overcame. Transportation facilities (and consequently marketing opportunities) began to improve; inflation was gradually brought under control; and the value of the rupiah stabilized. But what really sparked the rapid expansion of trawling was strong international demand for shrimp.

These conditions provided the necessary basis for motorization of fishing boats, and the profitable operations of Malaysia's trawler fleet provided the technical inspiration for

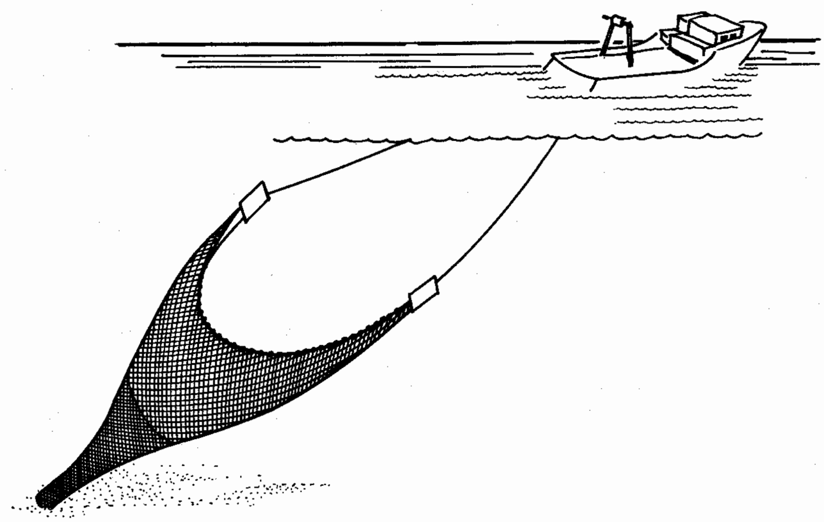

Fig. 3.3. Otter trawling.

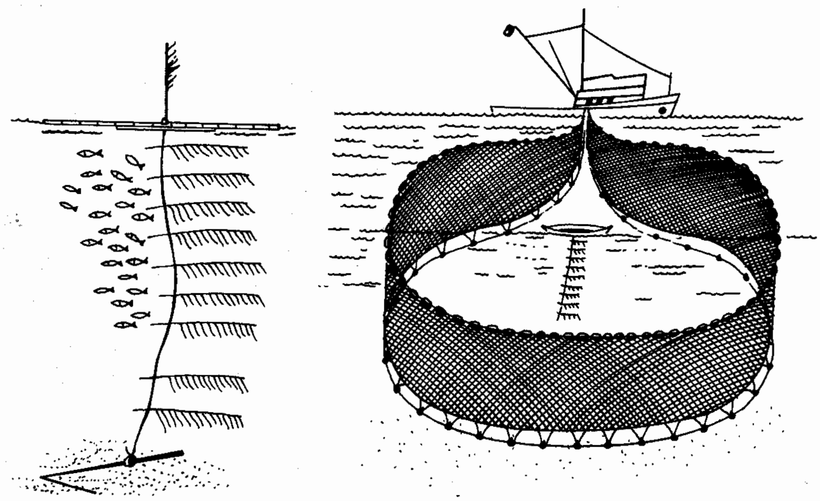

Fig. 3.4. Purse seining.

device designed to exclude finfish, turtles and other unwanted bycatch. This modified gear has been renamed the "shrimp net" (pukat udang).

Purse seines. Since the ban on trawlers, purse seiners have come to dominate medium-scale landings. This gear was introduced in 1968 by the MFRI to fishermen in the area of Pekalongan, along Java's north coast. Between 1975 and 1982, landings by purse seiners more than tripled (Table 3.3) and the numbers of purse seiners more than quadrupled (Table 3.4). In 1982, purse seiners operating along the north coast of Java and the Malacca Straits accounted for 56% of the total fleet and 60% of the purse seine catch (DGF 1984). Other major centers of purse seine activity are the provinces of North Sulawesi, the Moluccas and South Sulawesi, which combined accounted for 34% of all purse seiners in 1980 but only 19% of total landings by this gear. Based on observations by this Review team in each of these areas, it is apparent that these purse seines are

Tabel 3.4. Nombor dan jenis alat tangkap perikanan laut di Indonesia, tahun 1975-1980.[a]
Table 3.4. Number and type of Indonesian fishing gear, 1975-1980.[a]

Jenis alat tangkap Type of fishing gear	Nombor alat tangkap per tahun/Number of gear by year 1975	1976	1977	1978	1979	1980	1981	1982
Jumlah alat tangkap Total number of fishing gear	416,068	354,617	347,070	341,745	325,651	358,100	380,171	404,259
Trawl								
Trawl udang ganda/Double-rigged trawl	134	154	15	133	142	167	134	188
Otter trawl	2,202	2,691	3,266	2,511	2,570	2,476	666	453
Trawl lain/Other trawls	163	135	63	289	165	466	377	177
Pukat kantong/Seines								
Payang	15,542	11,808	14,305	15,132	14,026	14,269	12,962	13,133
Dogol/Danish seine	2,203	3,124	5,355	3,260	3,119	2,884	3,386	2,837
Pukat pantai/Beach seine	13,140	8,176	7,903	7,283	7,200	6,731	7,548	7,202
Pukat cincin/Purse seine	1,144	1,481	1,706	2,137	2,828	3,700	3,572	4,933
Jaring insang/Gill net								
Jaring insang hanyut/Drift gill net	36,037	37,178	47,565	49,097	47,715	58,521	59,518	65,749
Jaring insang lingkar/Encircling gill net	4,950	3,323	5,323	4,674	4,131	4,438	5,611	5,836
Jaring klitik/Shrimp gill net	4,403	16,990	20,420	17,961	23,181	24,803	30,844	31,567
Jaring insang tatap/Set gill net	25,315	17,320	18,874	23,569	23,436	26,610	27,638	29,880
Jaring angkat/Liftnet								
Bagan perahu/rakit-Boat/Raft liftnet	4,252	4,693	8,924	6,500	4,871	6,056	6,936	6,493
Bagan tancap/Stationary liftnet	12,289	9,584	11,177	12,869	13,657	13,082	13,259	12,536
Serok/Scoopnet	9,445	7,263	9,083	6,851	7,030	8,125	6,654	6,274
Jaring angkat lain/Other liftnets	22,559	11,147	9,671	9,021	6,766	6,906	7,997	8,442
Pancing/Hook and line								
Rawai tuna/Tuna longline	33	20	18	18	19	372	20	73
Rawai hanyut lain/Other drift longlines	8,264	5,322	6,889	5,072	4,298	5,108	4,827	3,485
Rawai tetap/Set longline	10,388	3,933	5,090	5,211	6,024	5,963	7,082	7,701
Huhate/Skipjack pole and line	1,688	293	513	1,166	575	673	1,257	541
Pancing/Hook and line	142,411	97,350	78,840	77,173	70,619	79,184	89,752	98,641
Pancing tonda/Troll line	27,323	30,186	32,538	39,170	34,992	31,588	31,732	39,214
Perangkap/Trap								
Sero/Guiding barrier	10,365	9,259	8,841	7,483	6,718	6,596	6,724	8,494
Jermal/Stow net	2,207	2,303	2,062	2,123	2,914	4,525	4,679	3,732
Bubu/Portable trap	15,296	8,083	10,819	9,564	7,405	5,947	7,935	6,610
Perangkap lain/Other traps	14,851	10,781	7,369	7,883	6,682	7,897	8,612	11,046
Alat-alat lain/Other gear								
Alat pengumpul kerang/Shellfish collection	917	2,254	3,292	3,634	4,051	4,419	6,343	4,840
Alat pengumpul rumput laut/Seaweed collection	1,400	2,692	3,223	4,031	3,891	3,335	2,463	2,593
Muroami	56	53	267	225	200	421	679	324
Jala, tombak, dan lain-lain/Cast net, harpoon and others	27,285	47,021	23,912	17,705	16,426	22,868	20,964	21,271

[a]Sumber/Source: DGF (1984).

boat. A majority, however, are modified gasoline or diesel generators mounted along the side with a long trailing propeller shaft (Fig. 3.6). These are cheaper and hence more popular than standard outboard engines but may generate as little as 2 hp.

Given the difficulty of determining scale on the basis of gear employed, the system of categorization used by the DGF has the merit of being easily applied. The primary criterion for this system of classification is size of investment and is justified by the direct correlation between investment and both per unit landings of individual fishing units and incomes which are earned by fishermen (Yamamoto 1978a), two key variables for development planning. Generally speaking, investments in small-scale fishing units are less than Rp 5 million for those using boats powered by outboard engines and well under this figure for those using sail powered boats and such relatively inexpensive gear as simple hand lines, the most numerous gear type in Indonesia (Table 3.4).

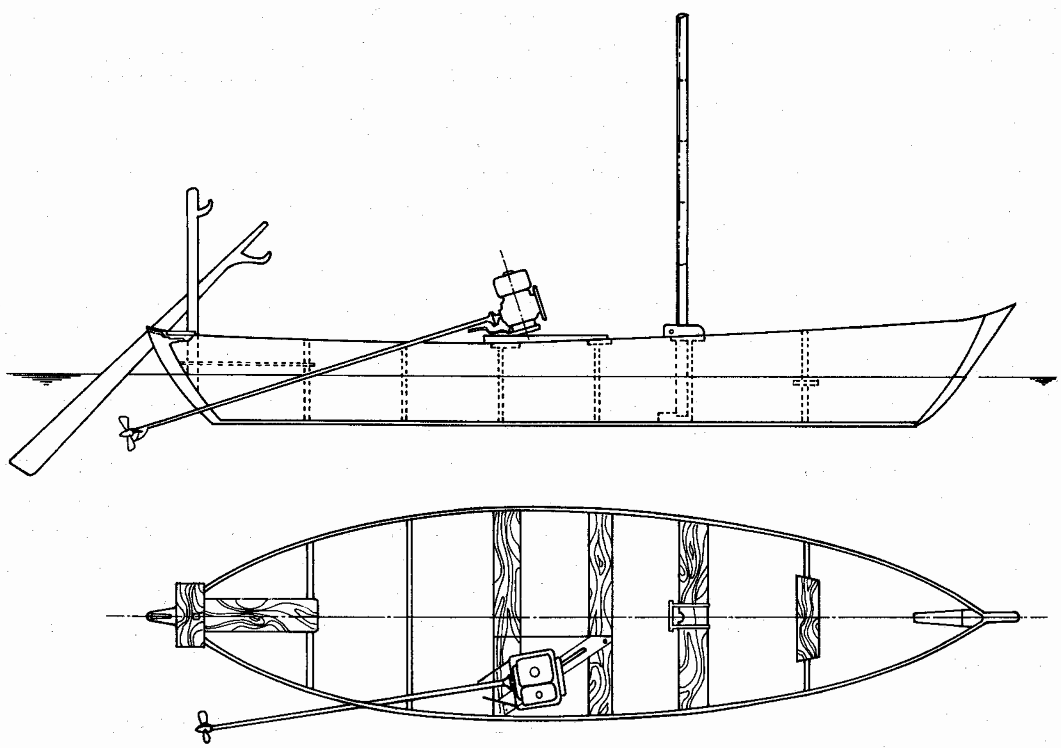

Fig. 3.6. Typical small-scale boat with inboard motor and long propeller shaft.

During the 1960s, the dominance of the small-scale subsector in Indonesian fisheries was almost complete: 98-99% of all fishing boats operated without engines during this decade (Table 3.2). During the 1970s, increasing numbers of inboard and outboard powered boats entered Indonesia's marine fisheries sector, though by 1982 sail powered boats still comprised 72% of the total fishing fleet. The use of outboard engines increased greatly in recent years, more than doubling between 1978 and 1980 and again doubling between 1980 and 1982. By 1982, outboard powered boats accounted for two-thirds of all boats with engines and 18% of the national fishing fleet.

Small-scale fishermen in Indonesia use gear similar to those found in other countries of Southeast Asia, including seines, gill nets, fish traps, liftnets, guiding barriers and hand lines. Illustrations of fishing gear used in the Philippines and also common in Indonesia may be found in Smith et al. (1980). Fishing gear types and the manner of their operation in Indonesia have been described by Subani (1972) and Ayodhyoa (1981). The DGF (1975)

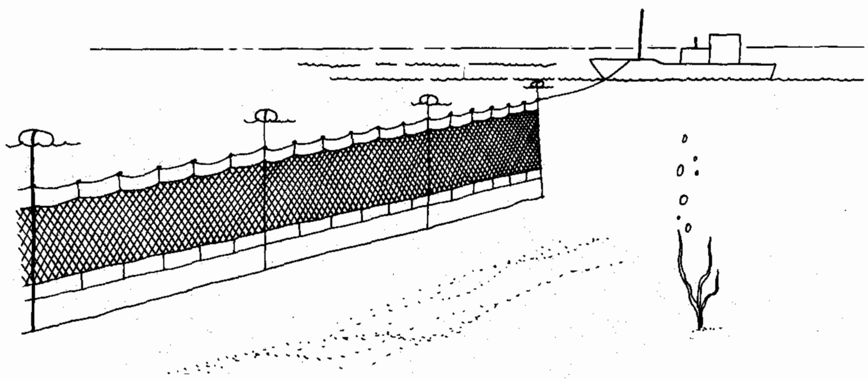

Fig. 3.7. Drifting gill net.

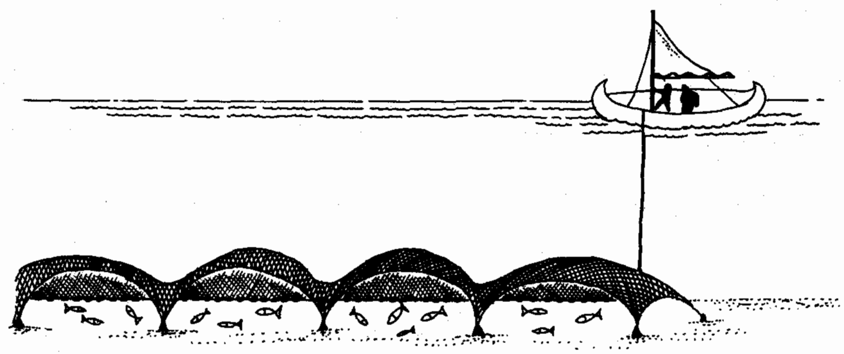

Fig. 3.8. Trammel nets.

Liftnets. The most important type of liftnet found in Indonesia is a stationary platform built on pilings in shallow water and used at night to capture anchovies or other small schooling pelagic species which are attracted over the net with light from powerful kerosene pressure lamps. The most common type of stationary liftnet is illustrated in Fig. 3.9. A variant form known as the kelong (Fig. 3.10) relies on guiding barriers rather than lights to aggregate fish. The DGF combines these two types of stationary liftnets in its annual reports. Stationary liftnets are widely distributed throughout Indonesia except in the Moluccas, Irian Jaya, the Lesser Sunda Islands and along the Indian Ocean coast of both Java and Sumatra, where seasonally rough seas make this gear impractical.

The second most important gear of this type is the mobile liftnet. There are two kinds: those mounted on twin hulled boats resembling a catamaran and those mounted on rafts of bamboo or other material lashed together (Fig. 3.11). The latter more closely resemble the stationary liftnets shown in Fig. 3.9. The boat liftnet became popular in the 1970s as the use of outboard engines became more common. These engines are less frequently used with the less maneuverable raft liftnets, which commonly operated in protected inshore waters. More than 40% of all mobile liftnets in Indonesia are reported to operate in the south Sulawesi coastal area.

A third category of liftnets for which the DGF provides landings data is the scoop net, which is widely distributed throughout Indonesia. Two distinctly different types of scoop nets are included under this category of pelagic gear. When operated from sail powered boats, these take the form of a simple dip net on a bamboo pole and are used with a fine-meshed gill net set in a circle next to the boat. Schooling fish swimming near the surface within the enclosed space are then scooped out with the dip net. The second type of scoop net is depicted in Fig. 3.12. Operated from a motorized boat, this more active type of scoop net is functionally similar to a pelagic trawl and is particularly effective in exploiting small pelagic species.

The fourth category of liftnets reported upon by the DGF as "others" includes small versions of stationary lift nets or push nets operated by fishermen wading in shallow waters. The latter are employed to capture milkfish fry or juvenile shrimp for sale to brackishwater pond operators.

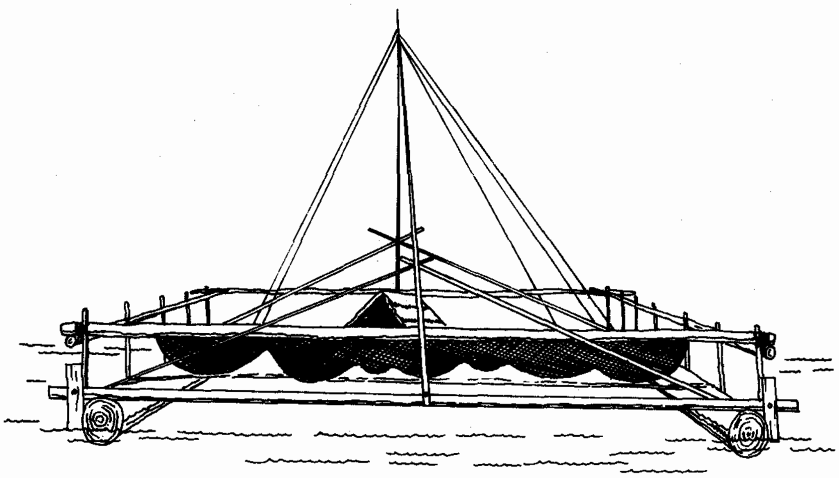

Fig. 3.11. Mobile liftnet.

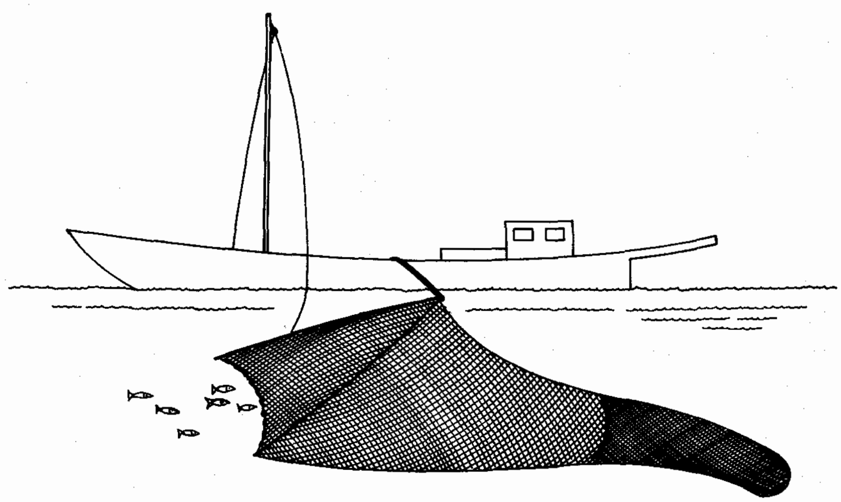

Fig. 3.12. Motorized scoop net.

Hook and line. Included under this general category of the DGF are longlines, skipjack pole and lines, trolls and "other pole and lines." Skipjack pole and lines were described in the previous section on large-scale gear.

Three types of longlines are covered by the DGF in its annual reports: tuna longlines, "other" drifting longlines and set longlines. "Other" drifting longlines consist of strings of they are extracted by dip nets or small seines (Fig. 3.14). These barriers are used primarily to capture demersal finfish and shrimp and require shallow protected waters. Like their pelagic counterpart, the stationary lift net, guiding barriers are widely distributed throughout Indonesia except along the west coast of Sumatra and the south coast of Java.

Similar conditions are required for operation of stow nets (also fixed to the bottom and sometimes known as filter nets). Sergestid shrimp (rebon), used for making shrimp paste (a popular condiment in Indonesian cuisine), are the primary target species of this gear, which requires a coastal current sufficiently strong to carry the shrimp into the net. The stow net illustrated in Fig. 3.15 uses barriers to direct the shrimp to the net. A variant form involves a battery of similar nets without barriers. Stow nets are reversible to take advantage of shifting currents or tides. In 1982, 89% of all stow nets in Indonesia were reported in the Malacca Straits and the eastern coastal areas of Sumatra and Kalimantan.

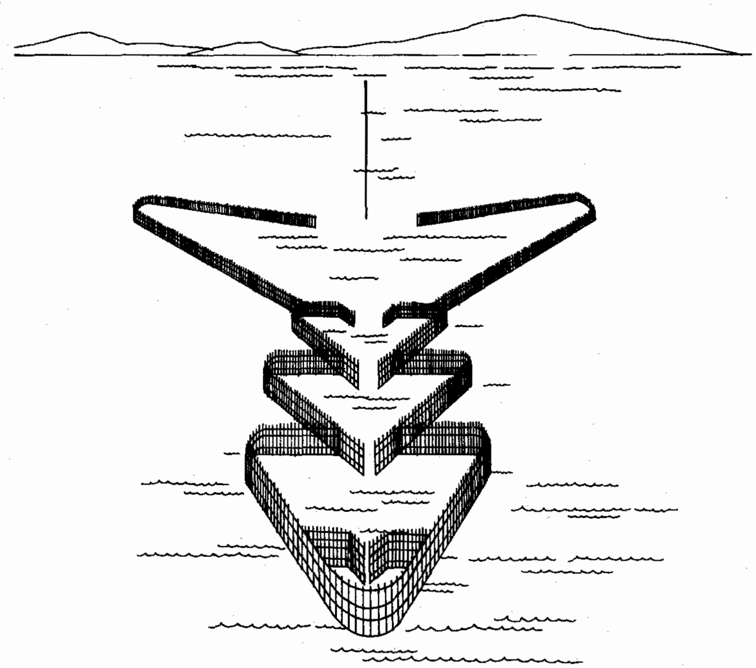

Fig. 3.14. Guiding barriers.

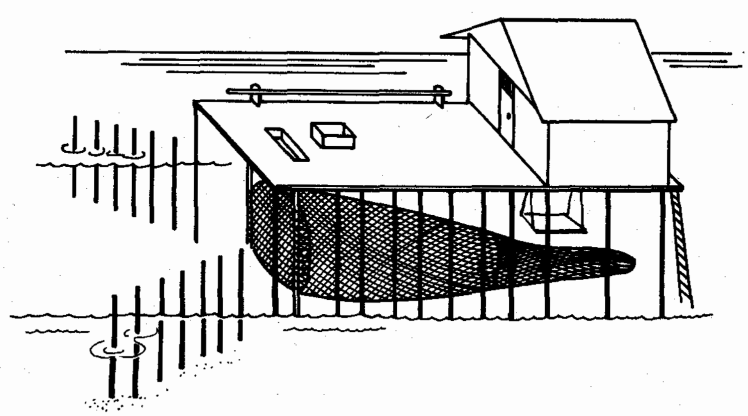

Fig. 3.15. Stow net for shrimp showing barriers.

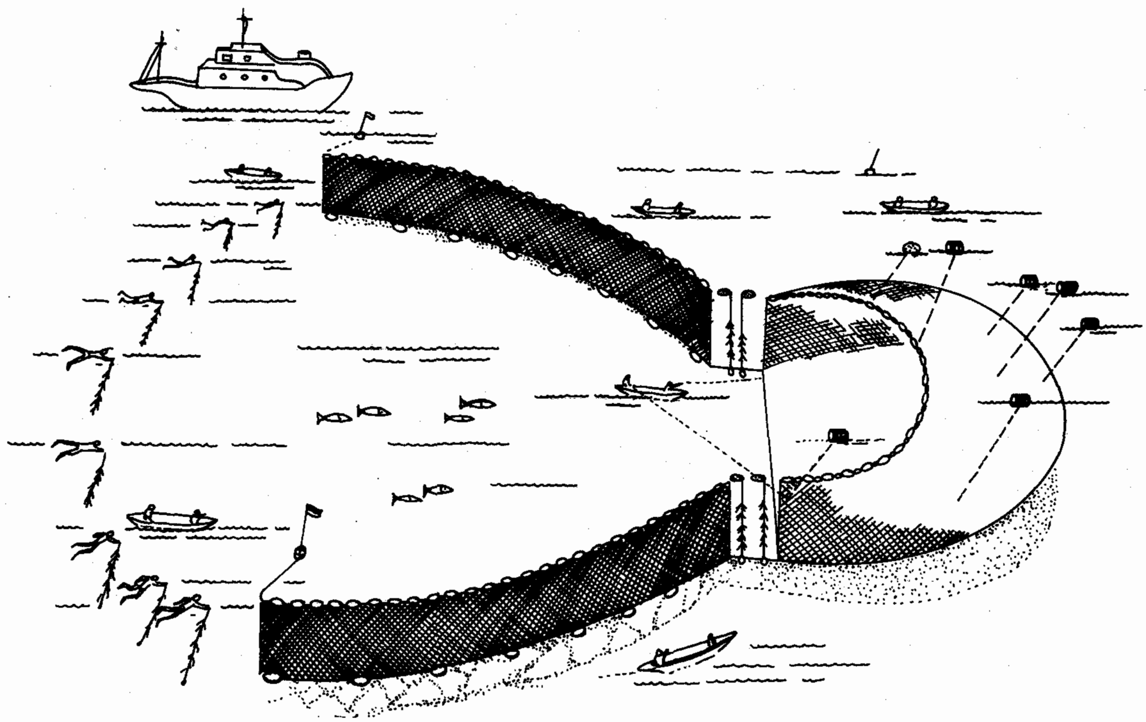

Fig. 3.17. Muroami fishing.

The large number of "other gear" fishing units (approximately 21,000 in 1982) and the relatively low catch per unit (0.8 t; see Table 3.5) suggest that relatively few are used for whaling! Probably most are simple cast nets, inexpensive gear well-suited for fishermen with limited capital.

The two remaining gear categories in Table 3.4 are not, strictly speaking, fishing units but rather simple implements used to harvest seaweed and shellfish from the natural environment. In 1982, nearly 70% of all shellfish "gear" were reported to be in the Malacca Straits. Seaweed collection is concentrated in the Lesser Sunda Islands, the south coast of East Java Province and the Moluccas.

<u>Diversity of the small-scale subsector</u>. The foregoing discussion underscores the diversity of small-scale gear types in Indonesia and the wide range of conditions in which they are operated. Even this portrayal does not fully illustrate the complex multigear nature of small-scale fisheries in Indonesia. During the course of a single year, it is common for fishermen to use more than one gear type due to seasonal variations in the availability of certain species. An indication of this practice is shown in comparing the total number of fishing boats (300,000; Table 3.3) and the total number of gear units (404,000; Table 3.4).

Small-scale fishermen are more likely to operate a mix of gear types than those from the medium- and large-scale subsectors. Medium-scale purse seiners and otter trawlers and all large-scale fishing units are more highly specialized in design and equipment needed to operate specific gear. The larger boats in these latter two categories also are less affected by rough seas and their engines allow them to exploit a wider area. Medium-scale purse seiners from Java, for example, are reported to operate as far as South Sulawesi.

The limited operational range of small-scale boats, including those powered by small outboard engines and the vagaries of weather and species availability, dictates flexibility for many who wish to continue fishing beyond a certain season. This is especially true for those small-scale fishermen whose primary gear is targeted on migratory pelagic species or who operate in areas exposed to seasonally rough seas.

used by large-, medium- and small-scale fishermen. The 71 boats using this gear owned by State enterprises averaged 126.5 t per unit in 1980 (P.T. Samodra Besar 1981), nearly three times the average of 38.1 t for that year (DGF 1982d). The remaining eight large-scale skipjack pole and liners probably enjoyed similar catch levels. Many medium-scale boats using this gear are comparable in size and probable fishing power. The average for this gear was brought down by the more numerous but less effective small-scale pole and liners.

Similarly, average per unit landings by purse seiners on the north coast of Java in 1982 were 57 t compared to the national average of 39 t and 10 t for small-scale purse seiners from northern Sulawesi (DGF 1984).

Average landings by all gear in 1982 are estimated to have been 3.7 t, with a range of 0.8 to 68.1 t. Twelve gear types used primarily by small-scale fishermen and representing 81% of all gear units had annual per unit landings of 3 t or less; five (42% of all gear units) averaged 2 t or less. Such low levels of productivity are a major factor in explaining poverty among many small-scale fishermen in Indonesia. It is, however, simplistic to say that low productivity is a result of technological inefficiency; high levels of resource exploitation and competition between fishermen for a scarce resource may be equally significant.

Landings by Subsector

During the 1970s, Indonesia's marine fisheries sector underwent considerable change. In 1970, small-scale fishing boats comprised 99% of the nation's total fishing fleet (Table 3.2). By 1982, this figure had declined to 90% as increasing numbers of inboard powered boats came into operation. Indonesia's marine fisheries sector remains primarily small-scale in nature, but it is clear that the growth of the large- and particularly the medium-scale subsectors played a major role in increased landings during the 1970s and early 1980s (Table 1.1).

Large-scale fisheries

In 1980, the 17 tuna longliners owned by P.T. Samodra Besar landed 2,239 t, and the 71 skipjack pole and liners operated by other State enterprises landed 8,982 t (P.T. Samodra Besar 1981). It can be assumed that the remaining eight large-scale skipjack pole and liners have comparable catch rates (126.5 t), thereby contributing a further 1,012 t. In 1980, double-rigged shrimp trawlers landed 11,103 t. Total landings by these large scale fishing units totalled 23,336 t, 1.7% of total marine landings in 1980.

Medium-scale fisheries

Estimating the contribution of medium-scale fisheries is far more difficult given problems in identifying fishing gear by subsector. Virtually all otter trawlers were medium-scale boats, and many but not all purse seiners are part of this subsector. For present purposes, it is assumed that the 2,753 purse-seiners on the north coast of Java and the Malacca Straits are medium-scale fishing units. Purse seiners in these two areas landed nearly 115,420 t in 1982, 8% of total marine landings and 60% of all purse seine landings in Indonesia (DGF 1984).

In 1982, otter trawl landings were approximately 11,000 t (Table 3.5), a dramatic decline compared with the 174,400 t of 1980 (DGF 1982d), the last year in which trawlers were permitted to operate in waters off Java and Sumatra. In 1982, there were only 453 otter trawlers in Indonesia, compared with 2,476 in 1980 (DGF 1982d). However, balanced against this decline has been an increase from roughly 18,000 to 30,000 in the number of

Average crew sizes in the medium-scale subsector probably are not much higher. In 1982, three-quarters of all inboard powered boats displaced less than 5 GT (Table 3.1). Many of these relatively small boats used drifting gill nets or other relatively simple gear for which a crew of two or three men would be sufficient. Purse seiners and pole and liners, however, typically use crews of 15 to 20 men. Average crew sizes within the medium-scale subsector can be estimated to be five men, with the larger crew sizes of purse seiners and pole and liners counterbalanced by fewer fishermen employed on the large number of boats displacing less than 5 GT.

Fishing boats in the large-scale subsector appear to employ greater numbers of crewmen than the other two categories. Average crew size among State enterprises is 25 men (Rachman 1982) and averages for this subsector are probably much the same. With a total fleet size of 304 (Rachman 1982), total numbers of fishermen can be estimated (not counting shore-based workers) to be 7,600.

In 1982, small-scale fishing boats comprised 90% of the national total (Table 3.1). Despite fewer crewmen per boat in this subsector, the proportion of small-scale fishermen to the total employed in Indonesia's marine fisheries sector is not much less, and a figure of 90% in that year seems a reasonable estimate.

The DGF reports total numbers of marine fishermen in 1982 to have been nearly 1,171,000 (Table 3.6). Using the figure 90%, we can estimate that there are over 1 million small-scale marine fishermen in Indonesia. By adding the 7,600 fishermen who operate large-scale fishing boats and considering those employed in the medium-scale subsector a residual category, a figure of 109,500, or 9.4% of total employment in this sector is derived. This estimate, when divided by the number of medium-scale boats (approximately 29,500; see Table 3.1), gives an estimated average crew size of 3.7.

Tabel 3.6. Jumlah nelayan dan estimasi nombor dan proporsi yang bekerja di kapal motor (skala sedang dan besar) dibandingkan dengan yang bekerja di sub-sektor skala kecil, 1975-1980.[a]

Table 3.6. Total number of fishermen and estimated numbers and proportions of those employed on inboard powered boats (medium- and large-scale) compared to the small-scale subsector, 1975-1980.[a]

Year		1975	1976	1977	1978	1979	1980
Jumlah nelayan Total fishermen		n.a.	811,512	815,947	831,965	833,997	970,731
Kapal motor Inboard boats	Fleet	8,160	9,735	10,715	12,766	14,758	18,467
	Employed	42,840	51,109	56,254	67,022	77,480	96,952
	Percent	n.a.	6.3	6.9	8.1	8.8	10.0
Skala kecil Small-scale	Fleet	248,992	235,990	237,829	235,347	243,147	253,389
	Employed	n.a.	760,403	759,693	764,943	806,517	873,779
	Percent	n.a.	93.7	93.1	91.9	91.2	90.0

[a]Sumber/Source: DGF (1977, 1978a, 1979, 1980, 1981a and 1982d).

CHAPTER 4

MARINE FISHERIES MANAGEMENT AND DEVELOPMENT: POLICIES AND PROGRAMS

C. Bailey

Abstract

From the colonial era to the present, the protection of inshore fisheries resources and maintenance of access to these resources by small-scale fishermen have been primary concerns of policymakers. These concerns reached a peak of intensity during the 1970s when a series of regulations designed to restrict medium-scale trawlers from operating in coastal waters were issued. The physical and institutional difficulties involved in enforcing these regulations are discussed. The subsequent total ban on all trawlers from Sumatra, Java and Bali imposed by Presidential Decree 39 of 1980 has been effectively enforced and was extended throughout Indonesia at the beginning of 1983.

Fisheries development programs have emphasized upgrading of small-scale fishing technologies through government loan programs. Relatively few fishermen have benefitted from these programs and those who have frequently are from areas where levels of fishing effort already were high. However, national planners are giving increased attention to fisheries development in areas where resources are underutilized. This is being done by extending credit and technical assistance to local fishermen and by encouraging Javanese fishermen to transmigrate to other islands.

Introduction

Throughout Southeast Asia, marine fisheries provide the single most important source of high-quality animal protein and contribute substantially to export earnings (Floyd 1984). Large numbers of people are employed directly or indirectly in the fisheries of this region, the majority of whom are small-scale fishermen (Smith 1979). Fisheries development programs during the 1950s and 1960s typically emphasized gear and vessel improvements as the primary means of increasing marine landings and improving incomes among this group.

In recent years, however, there has been a fundamental shift in thinking and emphasis in fisheries development throughout the region. Fisheries development planners have become increasingly aware that such technical programs have tended to benefit relatively few fishermen and in some cases have exacerbated tensions and increased inequalities

During the Dutch colonial era, customary rights of local fishermen to exploit their traditional fishing grounds were protected by an ordinance established in 1916 concerning exploitation of oyster, mother of pearl, pearl and coral reef fisheries. Regulations dating from 1920 prohibited use of poisons and explosives to capture fish or collect coral. The Coastal Fisheries Law of 1927 reserved all marine fisheries to local citizens (warga negara) and prohibited fishing operations by foreigners without special permission from the Minister of Agriculture.

In 1939, the Territorial Waters and Maritime Environment ordinance was enacted which further specified that exploitation of marine fisheries could only be carried out by indigenous residents (penduduk bumiputra) of Indonesia, excluding immigrant Chinese and other "foreigners" except in special instances where approval was obtained from the Naval Chief of Staff. This Ordinance also prohibited oceanographic or other marine research by foreign vessels. The involvement of the Navy in enforcing this regulation suggests it was enacted due to considerations of security in the years immediately preceding the Pacific War.

As the struggle for independence began in 1945, a constitution was drafted which remains today the basic law of the land. The 1945 Constitution, in particular Article 33, Sub-Article 3, provides the legal basis for State control over Indonesia's lands and waters and the natural resources contained therein, and stipulates that the government is to manage these resources in the manner which best benefits all Indonesians. Since independence, fisheries regulations established during the Dutch colonial period remained largely unchanged until the early 1970s.

Prior to 1966, marine fisheries in Indonesia were almost exclusively small-scale in nature, depending on gear of limited efficiency to exploit nearshore waters (Chapter 3). The expansion of medium-scale fisheries, and particularly the adoption of trawl gear, introduced new concerns regarding the sustainability of yields and the allocation of access to these resources among competing groups of fishermen. As a result, a number of new fisheries regulations were introduced during the mid-1970s designed to protect both fisheries resources and the rights of small-scale fishermen to their traditional fishing grounds.

Medium-scale trawlers contributed significantly to increased landings of fish for domestic consumers and shrimp for export markets. The expanded use of trawlers during the 1970s led to significant increases in fishing pressure on inshore demersal resources, especially in the Malacca Straits and along the north coast of Java (Chapter 2). Export quality shrimp commanding premium prices were the target species of these trawlers, which tended to operate in shallow coastal waters where shrimp stocks were most abundant. These same waters serve as the nursery grounds of many commercially important species. A high proportion of the trawler catch appears to have been "trash" fish, much of which consisted of undersized individuals of commercially valuable finfish and shrimp species destined for conversion to animal feed. Surprisingly, no study of trawler bycatch species composition appears to have been conducted in Indonesia; however, Azhar (1980) examined the bycatch of trawlers on the Malaysian side of the Malacca Straits and reported that two-thirds of total landings were "trash" fish.

By the early 1970s, per unit trawler landings in the Malacca Straits had declined and some trawler owners shifted their base of operations to new fishing grounds off Java as well as to other parts of Sumatra (Unar 1972). Policymakers became increasingly concerned that this expansion of trawler activity, unless controlled, would result in overexploitation of important coastal fisheries resources and competition with large numbers of small-scale fishermen on these two islands. These concerns no doubt were increased by events on the Malaysian side of the Malacca Straits, where during the early 1970s, this competition resulted in violent conflict between small-scale and trawler fishermen (Gibbons 1976; Smith 1979). By the mid-1970s, similar violence was reported in the Indonesian portion of the Malacca Straits and on both the north and south coasts of Java (LaPorta 1978; Collier et al. 1979; Naamin 1982).

The first evidence of official concern came in 1973 when the Minister of Agriculture issued Decree 561 calling for the "rational" exploitation of fisheries resources. This

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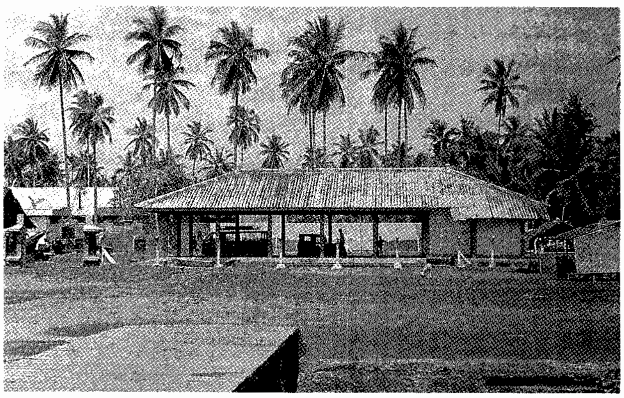

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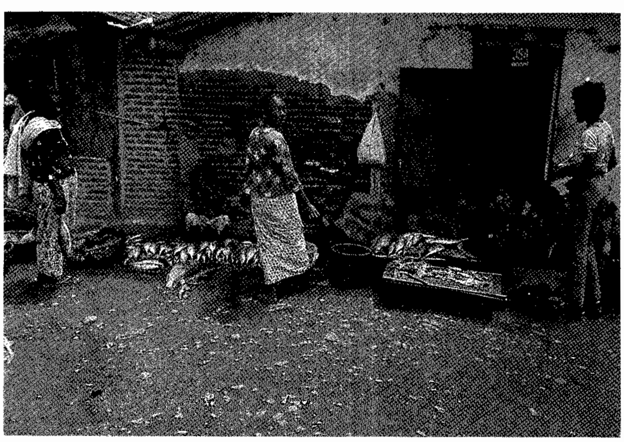

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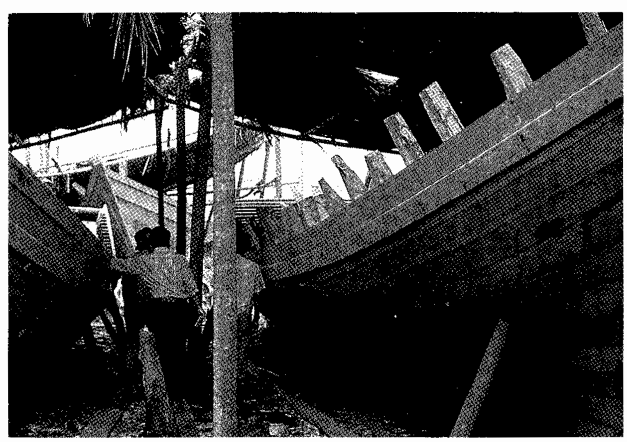

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1. Rough handling and lack of ice lower value of fish distributed to local markets. This photo shows skipjack being packed in North Sulawesi. 2. A typical TPI (fish auction hall) with a small jetty. This one is located on the southwest coast of Bali. 3. Retail distribution of fish is dominated by small traders, often women. These sellers bought fish at the TPI near Cirebon. Note the absence of ice and general conditions at the various stages of distribution. 4. Prow of Balinese small-scale boat. Note fine-meshed nylon gill net drying in the sun. 5. Auctioning the catch of a purse seine at a TPI near Cirebon, West Java. 6. Purse seiners under construction in Aceh funded by government loans.

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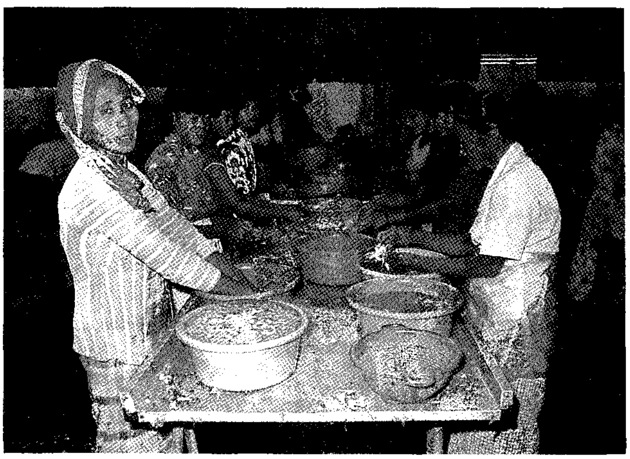

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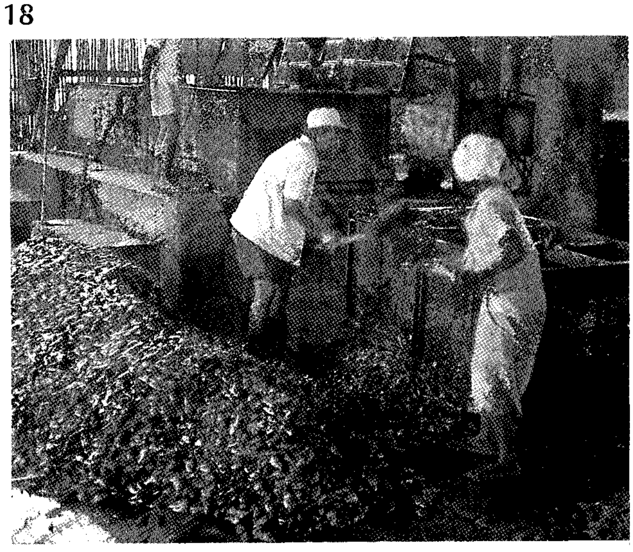

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14. Collecting payments after a sale. 15. Sorting and cleaning shrimp for export near Medan, North Sumatra. 16. Drying fish meal at Muncar, East Java. 17. The catch of a particular purse seiner at Tegal, identified by pink slips of paper, prior to auction. 18. A fisherman, his boat, his family and home along a river in North Sumatra. 19. Preparing fish meal using byproduct of oil sardine cannery in Muncar, East Java.

Presidential Decree 39 was clearly, in Sardjono's words (1980), a "political decision" which was justified primarily in terms of protecting the interests of artisanal fishermen:

> "/Every sudden change in policies or regulations by a Government might indeed upset certain established systems or investment, but compared with the aim of reaching social peace and stability, by way of providing better protection to the poor traditional fishermen masses, the disadvantages become very minor."

Unlike previous efforts to control trawler operations through ministerial decrees and regulations issued by the DGF, Presidential Decree 39 has been effectively enforced. By

Tabel 4.1. Daerah operasi kapal penangkap ikan yang ditetapkan oleh Keputusan Mentri Pertanian 607 di 1976.
Table 4.1. Zones of operation for fishing boats established by the Minister of Agriculture's Decree 607 in 1976.

Jalur Zone	Jauhnya dari pantai Distance from shore	Tertutup bagi Closed to
I	0-3 mil	1. Kapal penangkap iken bermesin dalam berukuran atas 5 GT; 2. Kapal penangkap ikan bermesin dalam dengan motor lebih dari 10 DK; 3. Semua jenis jaring trawl; 4. Jaring cincin; 5. Jaring lingkar dan jaring hanyut tongkol; 6. Jaring payang panjangnya di atas 120 m.
	0-3 nautical miles	1. Boats with inboard engines displacing over 5 GT; 2. Boats with inboard engines over 10 hp; 3. All types of trawl gear; 4. All purse seines; 5. Encircling gill nets and drifting gill nets for tuna; 6. Seine nets longer than 120 m.
II	3-7 mil	1. Kapal penangkap ikan bermesin dalam berukuran atas 25 GT; 2. Kapal penangkap ikan bermesin dalam dengan motor lebih dari 50 DK; 3. Otter trawl dengan tali ris atas/bawahnya di atas 12 m; 4. Jaring trawl malayang dan pair (yang ditarik dengan dua kapal); 5. Jaring cincin panjangnya di atas 300 m.
	3-7 nautical miles	1. Boats with inboard engines displacing over 25 GT; 2. Boats with inboard engines over 50 hp; 3. Otter trawls with head ropes longer than 12 m; 4. Midwater trawls and pair trawls; 5. Purse seines longer than 300 m.
III	7-12 mil	1. Kapal penangkap ikan bermesin dalam berukuran atas 100 GT; 2. Kapal penangkap ikan bermesin dalam dengan motor lebih dari 200 DK; 3. Otter trawl dasar dan melayang dengan tali ris atas/bawahnya di atas 20 m; 4. Pair trawl; 5. Jaring cincin panjangnya di atas 600 m.
	7-12 nautical miles	1. Boats with inboard engines displacing over 100 GT; 2. Boats with inboard engines over 200 hp; 3. Demersal and midwater trawls using otter boards equipped with headropes over 20 m in length; 4. Pair trawls; 5. Purse seines longer than 600 m.
IV	Lebih 12 mil	1. Pair trawl, terkecuali boleh beroperasi di perairan Samodera Indonesia.
	Over 12 nautical miles	1. Pair trawl, except in the Indian Ocean where they are permitted.

The 1980 trawler ban and to a lesser extent, its 1983 extension probably resulted in declining shrimp exports. In 1980, over 31,900 t of shrimp were exported with total value of US$181 million (Floyd 1984). In 1981, shrimp exports declined to 25,900 t and US$170 million (Floyd 1984). In 1982, export volume was held constant but value increased to the level of 1980 (BPS 1984).

To encourage small-scale fishermen to increase landings of fish for domestic consumers and shrimp for export markets, the Indonesian government expanded credit programs to upgrade boats and gear. Loan programs also were expanded for extensification and intensification of brackishwater pond culture of penaeid shrimp. A special credit program was established to encourage trawler owners to refit their vessels for use with other gear, most notably purse seines.

Fisheries Development Programs

The broad goals of marine fisheries development programs in Indonesia are to increase overall fisheries production in a manner compatible with resource sustainability, and to improve the productivity, incomes and standards of living of those employed in this sector, especially small-scale fishermen. The DGF is the government agency primarily responsible for both management and development activities. Viewed from the perspective of staff and financial resources committed, however, it is clear the primary business of the DGF is the administration of development activities. During REPELITA IV, two-thirds of the DGF's total expenditures (Rp 520.6 billion, approximately US$490 million) are to be spent on efforts to increase marine and inland fisheries landings and aquaculture production; less than 3% is targeted for fisheries resource management and environmental protection (DGF 1983b).

Extension of new fisheries technologies is a primary development function of the DGF. The DGF recognizes that existing extension efforts have serious failings. In part, this is due to difficulty in reaching numerous small coastal fishing communities, which often are not served by roads or regular public transport. Limited technical competence and low motivation of the typically young and poorly paid extension staff further limit the effectiveness of government extension services. Moreover, extension staff are involved in many other activities, including development of Village Unit Cooperatives (Koperasi Unit Desa or KUD), gathering statistical information for annual reports, processing credit applications, establishing repayment schedules and assisting government banks to obtain timely payments on outstanding loans.

A joint DGF-FAO Small-Scale Fisheries Extension Services Project originally based in Semarang but in 1984 shifted to Menado is attempting to develop appropriate extension methods by providing adequate logistical and technical support to specially trained field workers who live in the communities for which they are responsible.

In addition to the DGF, a number of other government agencies are directly or indirectly involved in programs of fisheries development, including government banks which provide credit for upgrading fishing boats and gear and the National Development Planning Agency (BAPPENAS), which serves at the central planning body for development activities in all sectors. The DGF also works closely with the Directorate General of Cooperatives, the Directorate General of Transmigration and other administrative organs of the government.

These national agencies have their counterparts, as does the DGF, at the provincial and district levels. Provincial governments exert considerable influence over local Fisheries Service offices both by providing supplemental funding for specific projects and by playing a coordinating role in the activities of the various government agencies within their jurisdictions. Thus, the administration of development projects is to some extent decentralized, with local officials able to modify national programs to fit local circumstances (Wilmovsky 1978). Given the diversity of conditions found in Indonesia, this decentralization of administrative authority has obvious advantages. Decentralization loan, fishermen are provided with gear only suitable for operating in nearshore waters. A prime example of this is the trammel net, a gear commonly associated with loans to small-scale fishermen along Java's north coast and the Malacca Straits. Use of this gear is expanding with official encouragement as a means of exploiting shrimp resources after the banning of trawlers along these coasts (Tables 3.3 and 3.4). Small-scale fishermen using motorized boats in association with this and other gear operate more days each year, but frequently continue to focus their fishing effort on nearshore waters (DGF 1982b).

Fisheries Credit

Prior to 1973, there were no institutional sources of credit to small-scale fishermen in Indonesia. Fishermen requiring loans for purchase of boats and gear, operating expenses or domestic consumption needs, relied on local sources, often fish buyers within their own community. These local entrepreneurs provided, and continue to provide, a flexible source of readily available funds, a point of importance to fishermen needing to repair boats and nets or faced with a family emergency. As local residents, these lenders are in a position to assess the relative risks in providing loans to individual fishermen based on personal judgements of character and past success in fishing.

The willingness of local fish buyers to provide loans to fishermen is based on their need to secure a regular supply of fish for their trading activities. Fishermen receiving loans are obligated to sell their catch to their creditor and receive a price typically 10% lower than that obtained by fishermen who do not have such ties (Nessa 1981; Utzurrum 1982). Repayments to the outstanding principal of the loan are made irregularly, depending on the success of a particular day's fishing operations. During periods when the catch is small, no payments are made as the buyer recognizes that fishermen require some cash to meet domestic needs and operational expenses for the next day of fishing.

Whether or not these informal credit arrangements are exploitative is unclear (see Chapter 7). It is clear, however, that the Indonesian government believes that fish buyers exert a depressing effect on prices paid to fishermen, that the relationship is an unequal one and that the credit ties between fishermen and fish buyers are an important cause of poverty among small-scale fishermen. A number of Indonesian observers also have justified government involvement in providing credit and alternative marketing outlets for small-scale fishermen by citing the negative effect of informal credit arrangements on fishermen's incomes (Sallatang et al. 1977; Universitas Sumatra Utara 1980; Santoso 1981; Universitas Brawijaya 1981b). This impression has been supported by several outside observers, including Steina (1973) and Hotta (1982), FAO experts who have advised the Indonesian government on the establishment and implementation of formal institutional credit schemes. In one elementary school book (Halian 1962), fish buyers are referred to as "lintah darat" (literally "land leeches").

The Indonesian government began providing institutional sources of credit to small-scale fishermen in 1974, with the Bank Rakyat Indonesia (People's Bank of Indonesia or BRI) as the primary conduit of funds coming from Bank Indonesia. Both banks are owned by the government. Over the years, a number of different loan programs have been established.

KIK and KMKP

The KIK (Kredit Investasi Kecil or small investment credit) program often takes the form of a package including engines and gear and construction of a new hull. The maximum loan is Rp 10 million (roughly US$10,000 at mid-1985 exchange rates) with an interest rate of 10.5% per year, well below the commercial bank rate reported by Hotta (1982) of 24 to 36% per year for loans of this size and relative risk. The repayment period is 10 years with a four-year grace period. In 1979, Rp6.63 billion (US$10.6 million in that similar problems have been noted regarding the type of gear provided under this loan program (Comitini and Dibbs 1978). Fishermen receiving KIK credits have little control over the type of net they will receive and often are unable to supervise the construction of their boat if the authorized builder is not located nearby (Comitini and Dibbs 1978).

In contrast, fishermen obtaining loans from local fish buyers are able to obtain immediate credit, supervise the construction of their new boat, purchase their own gear and are more quickly able to begin operations. Often, such informal loans are made only for the purchase of new gear to be used with existing boats. In such cases, fishermen are able to benefit from their loan in a matter of a few days.

A further advantage of informal loans compared to the KIK and KMKP programs is that the former do not require any form of collateral. Both government loan programs require collateral of 100% of the value of the loan. The fishing unit itself may be considered as collateral, but such decisions are left to branch offices of the BRI and apparently it is common for additional collateral such as land or other assets to be required (Hotta 1982). Few fishermen have clear title to land or other assets of value acceptable to the BRI.

The BIMAS fisheries loan programs appear to have overcome some but not all of these problems. Hotta (1982) noted that credit applications have been acted upon in a matter of weeks rather than months for KIK and KMKP loans. However, fishermen still have little control over what types of gear they will receive.

Other factors also discourage fishermen from applying for government loans. Recipients are required to sell their catch at government auction halls, where 15% of the proceeds of the sale is automatically deducted for loan repayment. An additional 8% of the sale price is deducted as auction fees and local taxes. Of this, fishermen directly pay 5% and the remaining 3% is paid by buyers who may be presumed to consider this cost in calculating profit margins and the prices they are willing to pay. Half of these total deductions are supposed to benefit fishermen as enforced savings and funds for emergency needs and social purposes. The other half is divided between operating costs of the auction and taxes to support local and provincial fisheries development.

Loan repayments and auction fees/taxes combined account for 23% of the total catch value. This acts as a strong incentive for fishermen to sell part of their catch before arrival at the auction hall (Comitini and Dibbs 1978). Wilimovsky (1978) reported that the auction charges alone discourage fishermen from selling their catch at government-run auction halls. This, in turn, has a serious effect on the reliability of landings data as those recorded at the auction hall are used to estimate landings elsewhere (see also Mantjoro 1980).

Joint ownership for fishing boats and gear purchased with government loan funds may present serious problems affecting the maintenance of the fishing unit, management of the enterprise and repayment of the loan. During field visits by members of this Review team in the Bali Straits area, KUD officials reported that jointly owned purse seine units were successful both in fishing and in repaying their loans. A report from Aceh Province published in Kompas (1981), however, suggests that in that area, joint ownership of ex-trawlers was less successful partly due to ineffective management.

This report also noted a number of other problems: provision of inappropriate gear and boats that were too old and not suitable for continued fishing operations. Moreover, the engines in these ex-trawlers were too large for the operation of gill nets and fish traps which had been provided, resulting in excessively high operating costs. The report stated that of the 69 ex-trawlers converted in 1981 through BIMAS loans totalling Rp 1.3 billion, nine of these boats had since sunk and most of the rest were not in operation due to accumulated losses. The local BRI branch was reported to have ceased giving BIMAS loans pending further study of these problems.

It also was noted in this Kompas report that the cost of fishing gear provided under the BIMAS loan program was higher than the prevailing market price. During a visit to Sumatra by this Review team, local fishermen reported that the cost of engines and gear provided through government loan programs was as much as 30% higher than those available in local stores. Hotta (1982), however, reported the cost to fishermen is lower however, are quite distinct. Farmers may have to adapt to new crops and new soil or other conditions, but their tools will be the same. The primary products of transmigrated farmers (rice, rubber, coconuts, etc.) tend to be relatively non-perishable, presenting relatively minor marketing problems compared with fish, which is a highly perishable commodity. Transmigrated fishermen also need to adapt to new seasons, different tidal and current systems; learn the behavioral characteristics of new species of fish; and often learn how to operate new types of gear.

Transmigration programs in Indonesia are the responsibility of the Directorate General of Transmigration (DGT), which works in cooperation with the Ministry of Agriculture, including the Department of Agriculture, the various research institutes of the AARD and the DGF. These agencies provide technical support for programs coordinated by the DGT. Both the DGT and the DGF have sponsored studies on the feasibility of transmigration programs for Javanese fishermen.

The first such study was commissioned by the DGT, conducted by Universitas Gajah Mada (1978), and was aimed at measuring the degree of willingness of Javanese fishermen who live along the north coast and the Bali Straits to move elsewhere. The results of this study indicate that only 10% of all crewmen but a somewhat higher percentage of boat owners (especially those who are not actively engaged in fishing) were receptive to the idea of leaving Java. The primary reason fishermen were unwilling to move was reluctance to be separated from their families and their place of birth. The authors reported that there was no correlation between willingness to transmigrate and age, educational level, density of population in their current community, or (subjectively measured) relative wealth or poverty of their home community. Nonetheless, despite the low percentage of fishermen willing to leave Java, in absolute terms the authors estimate that there were over 22,000 fishermen from Java's north coast willing to move to a different island, nearly 10% of the total in 1978 (DGF 1980). This is a substantial number and, with household members, would involve the movement of approximately 100,000 people.

Two separate studies by the Bogor Agricultural Institute (Institut Pertanian Bogor or IPB) examined a total of 16 separate possible transmigration sites within 12 different provinces. Published results of these two studies are contained in a total of eight volumes.

The first study was commissioned by the DGF and examined issues related to marketing in 12 potential transmigration sites on 10 provinces in Sumatra, Kalimantan, Sulawesi and the Moluccas (IPB 1981a). This study was based on the reasonable premise that for transmigration programs to succeed, special attention must be given to marketing of the fishermen's catch. As could be expected with such a wide sample, a considerable diversity of marketing problems was found, the most serious and common of which was isolation from centers of consumer demand. The provision of carrier boats was recommended but the economic feasibility of providing carrier boats to relatively small and isolated communities was not examined.

The second IPB study, commissioned by the DGT, provides a detailed analysis of the feasibility of establishing transmigration centers for fishermen in East Kalimantan, Southeast Sulawesi, Moluccas and Irian Jaya Provinces (IPB 1981b). Estimates were made of maximum sustainable yields from each area and, based on these, the number of Javanese fishermen who could be supported in these areas without seriously threatening the resource base were calculated. It was recommended that a total of 1,600 transmigrant fishermen from Java be sent to these areas. Costs of this program were estimated, including those of transfer, the purchase and clearing of land for house sites and garden plots (0.5 ha), the construction of houses, the provision of a subsistence allowance until the transmigrants could be expected to be self-supporting, the supplying of agricultural implements and planting materials and the provision of fishing gear appropriate for each place. It was assumed that boats and gear would be jointly owned and operated by groups of fishermen. The total cost was estimated at Rp 3.53 billion, or an average of Rp 2.21 million per household. If fishing boats and gear were provided on credit and fully repaid, the total cost to the government for establishing 1,600

CHAPTER 5

THE ECONOMICS OF MARINE FISHERIES: COSTS AND EARNINGS

C. Bailey and F. Marahudin

Abstract

Economic aspects of Indonesia's marine fisheries are of critical importance in determining the feasibility of national programs of fisheries development. However, only a limited number of studies have been conducted on the economics of marine fisheries in Indonesia.

Here, relevant data from the few available costs-and-earnings studies are analyzed and compared with data from two extensive socioeconomic surveys. The purpose is to assess the economic performance of various medium- and small-scale fishing units.

Generally, as a function of investment level, the profitability of small-scale fishing units tends to be higher than in the medium-scale subsector. On the other hand, absolute profits are higher in the latter due to higher productivity. There is considerable variability in economic performance between and within subsectors and even for the same type of gear in different parts of the country.

Introduction

Broadly defined, fishing in Indonesia may be regarded as a commercial, profit-oriented activity. Fish or other marine species are sold in order to purchase such daily necessities as rice or to meet other household expenses. A portion of the catch is commonly retained for home consumption, but very few households are sufficiently isolated from the broader market economy that the term "subsistence fisherman" may be applied with accuracy. That many fishing households in Indonesia live near the margin of subsistence is not due to isolation from the cash economy but rather reflects generally low incomes.

The effectiveness of Indonesia's marine fisheries development and management programs depends on the identification of economically viable production systems. These programs, reviewed in Chapter 4, are designed to improve productivity within the marine sector and increase levels of income, especially among small-scale fishermen.

In this chapter, the economic performance of various types of small- and medium-scale fishing units is measured on the basis of costs-and-earnings data. Analysis of these data provides insights into the diversity of Indonesia's marine fisheries sector and the nature of relationships between owners and non-owning crewmen.

Tabel 5.1. Analisa biaya dan pendapatan rata-rata per bulan, pukat cincin dan pukat trawl, Pekalongan dan Semarang, 1978. Satuan: rupiah.[a]
Table 5.1. Analysis of average monthly costs and earnings, purse seiners and trawlers, in rupiah, Pekalongan and Semarang, 1978.[a]

					Biaya tetap/Fixed costs			Biaya tidak tetap/Variable costs								
Jenis alat	Sumber data	Jumlah sampel	Penerimaan kotor	Jumlah biaya operasi	Penyusutan	Bunga	Lain-lain	Biaya operasi	Biaya tenaga kerja	Pemeli-haraan	Lain-lain	Biaya pele-langan	Keuntungan bersih	Investasi	Tingkat keuntungan bulan (%)	Tingkat keuntungan per tahun (%)
Type of gear	Data source	Number in sample	Gross receipts	Total operating costs	Depreciation	Interest	Others	Running costs	Labor costs	Mainte-nance	Others	Auction charge	Net profit	Investment	Monthly profit-ability (%)	Annual profit-ability (%)
Puket cincin	Domingo[b]	10	3,236,580	2,388,009	242,240	119,692	6,374	1,049,150	760,212	17,042	30,828	162,471	848,571	12,005,400	7.1	85.2
				(100.0)	(10.2)	(5.0)	(0.3)	(43.9)	(31.8)	(0.7)	(1.3)	(6.8)				
Purse seiners	Baum[b]	160	1,760,000	1,583,875	309,625	177,500	–	293,500	630,000	83,500	2,000	87,750	176,125	17,750,000	1.0	12.0
				(100.0)	(19.5)	(11.2)	–	(18.5)	(39.8)	(5.3)	(0.1)	(5.5)				
Trawlers	Domingo[b]	7	1,785,628	1,376,567	110,190	79,868	7,416	678,570	366,389	16,456	28,368	89,310	409,061	7,985,700	5.1	61.2
				(100.0)	(8.0)	(5.8)	(0.5)	(49.3)	(26.6)	(1.2)	(2.1)	(6.5)				
	Baum[b]	120	1,234,915	1,137,260	213,020	101,000	–	314,943	306,500	83,472	31,883	86,444	97,653	10,100,000	1.0	12.0
				(100.0)	(18.7)	(8.9)	–	(27.7)	(27.0)	(7.3)	(2.8)	(7.6)				

[a]Sumber/Source: Domingo (1978) dan Baum (1978a, 1978b).
Domingo (1978) and Baum (1978a, 1978b).
[b]Sampel-sampel semue dari Pekalongan.
All samples from Pekalongan.
[c]Sampel-sampel semua dari Semarang.
All samples from Semarang.

Both Domingo and Baum reported that labor costs for purse seiners, which require crews of 28 to 30 men, are more than double those of trawlers, the crews of which consist of 10 to 11 men. Reported labor costs exclude the costs of household labor, but it can be assumed that such labor is employed primarily in shore-based management and not in operations at sea. Baum provided no information on sharing systems. The sharing systems reported by Domingo for purse seiners and trawlers are illustrated in Fig. 5.1 and 5.2.

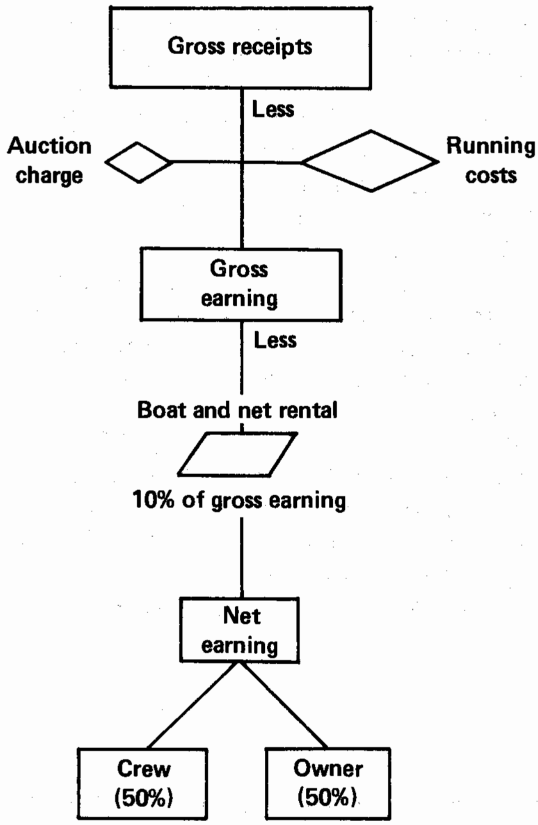

Fig. 5.1. Sharing system for purse seiners, Pekalongan, 1978 (Domingo 1978).

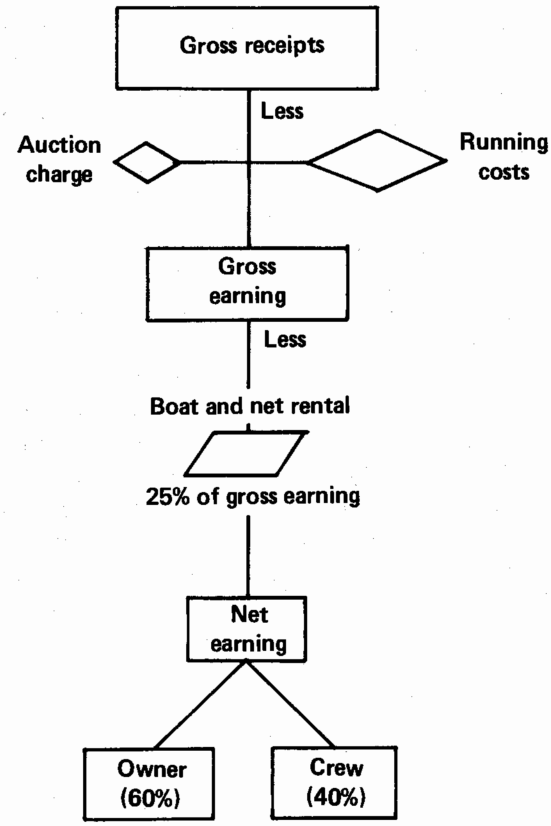

Fig. 5.2. Sharing system for trawlers, Pekalongan, 1978 (Domingo 1978).

A notable feature of both sharing systems is payment of a separate "rent" for the fishing unit charged to gross earnings and paid directly to the owner. This rental is 25% in the case of purse seiners and 10% for trawlers. Owners and crew of purse seiners divide the remainder (i.e., net earnings) on a 50-50 basis. Trawler owners, however, take 60% of net earnings. The end result is roughly the same: purse seine owners obtain 62.5% of gross earnings and trawler owners receive 64%. The remainder is divided among crewmen, with extra shares given to captains, machinists (mechanics) and, in the case of purse seiners, master fishermen.

Domingo reported that 35 shares are divided among a total purse seiner crew of 30, with 25 crewmen each receiving one share. For trawlers, he reported 12.5 shares being divided among 10 men, with each of eight ordinary crewmen paid one share. Using Domingo's labor costs and crew sizes, the average monthly value of a single share for purse seine fishermen is Rp21,720 and that for trawler fishermen is Rp29,311.

Baum based his calculations for labor costs and individual crewman's earnings for purse seiners on a similar sharing system to that reported by Domingo, with 34 shares divided among 28 men, 23 of whom receive one share each valued at Rp18,529. For

Tabel 5.3. Analisa biaya dan pendapatan rata-rata per tahun kapal motor dalam dengan motor 22 pk dan 33 pk yang mengunakan jaring insang hanyut, pantai utara Jawa, 1981, dalam rupiah.[a]
Table 5.3. Analysis of average annual costs and earnings of inboard powered boats with 22-hp and 33-hp engines using drifting gill nets, north coast of Java, 1981, in rupiah.[a]

			Biaya tetap/Fixed costs			Biaya tidak tetap/Variable costs						
Jenis perahu	Penerimaan kotor	Jumlah biaya operasi	Penyusutan	Bunga[b]	Lain-lain	Biaya operasi	Biaya tenaga kerja	Pemeliharaan	Lain-lain	Keuntungan bersih	Investasi	Tingkat keuntungan per tahun (%)
Type of boat	Gross receipts	Total operating costs	Depreciation	Interest[b]	Others	Running costs	Labor costs	Maintenance	Others	Net profit	Investment	Annual profitability (%)
Kapal motor 22 pk / Inboard powered boat, 22 hp	7,644,753	6,388,046	777,500	796,800	2,000	1,974,000	2,055,508	400,000	382,238	1,256,707	6,640,000	18.9
		(100.0)	(12.2)	(12.5)	(0.1)	(30.9)	(32.2)	(6.3)	(6.0)			
Kapal motor dalam, 33 pk / Inboard powered boat, 33 hp	9,243,842	7,604,315	917,500	994,800	2,000	2,191,500	2,623,825	412,500	462,190	1,639,527	8,290,000	19.8
		(100.0)	(12.1)	(13.1)	(0.1)	(28.8)	(34.5)	(5.4)	(6.1)			

[a]Sumber/Source: Indriati (1981).
[b]Biaya bunga modal 12 persen per tahun.
Interest costs calculated at 12%/year.

Tabel 5.4. Analisa biaya dan pendapatan rata-rata per tahun untuk beberapa jenis alat tangkap ikan skala kecil di Sulawesi Selatan, Mei 1979 sampai April 1980 (satuan: rupiah).[a]
Table 5.4. Average annual costs and earnings of several small-scale gear types in South Sulawesi, May 1979 to April 1980, in rupiah.[a]

				Biaya tetap (Fixed costs)			Biaya tidak tetap (Variable costs)						
Jenis alat	Jumlah sampel	Penerimaan kotor	Jumlah biaya operasi	Penyusutan	Bunga	Pajak	Biaya operasi	Biaya tenaga kerja	Pajak penjualan	Pemeliharaan	Keuntungan bersih	Investasi	Tingkat keuntungan (%)
Type of gear	Number of samples	Gross receipts	Total operating costs	Depreciation	Interest[b]	Tax	Running costs	Labor costs	Tax on sales[c]	Maintenance	Net profit	Investment	Profitability (%)
Bagan tancap	15	677,010	919,515	142,200	32,992	2,500	128,420	568,343		45,060	(242,505)	274,935	(88.2)
Stationary liftnet			(100.0)	(15.5)	(3.6)	(0.3)	(14.0)	(61.8)	nil	(4.9)			
Bagan perahu	15	937,675	871,850	149,920	68,648	2,365	179,335	431,532		40,050	65,825	572,065	11.5
Mobile liftnet			(100.0)	(17.2)	(7.9)	(0.3)	(20.6)	(49.5)	nil	(4.6)			
Jaring insang udang	15	342,145	290,990	79,000	40,103	2,835	43,245	104,177		21,630	51,155	334,190	15.3
Shrimp trammel net			(100.0)	(27.1)	(13.8)	(0.9)	(14.9)	(35.8)	nil	(7.4)			
Jaring insang tuna	7	2,853,325	1,997,640	296,090	239,939	3,100	323,990	750,531	285,340	98,650	855,685	1,999,490	42.8
Tuna gill net			(100.0)	(14.8)	(12.0)	(0.2)	(16.2)	(37.6)	(14.3)	(4.9)			
Jaring insang layang	15	1,316,450	1,277,453	423,440	129,574	2,850	304,445	372,334		44,810	38,997	1,079,780	3.6
Scad gill net			(100.0)	(33.1)	(10.1)	(0.2)	(23.8)	(29.1)	nil	(3.5)			
Pancing karang	15	459,200	362,078	29,705	9,888	2,500	87,855	191,475		40,655	97,122	82,400	117.9
Coral reef hand line			(100.0)	(8.2)	(2.7)	(0.7)	(24.3)	(52.9)	nil	(11.2)			
Pancing rompong	15	946,250	776,132	121,175	48,159	2,500	265,980	284,288		54,030	170,118	401,325	42.4
Rompong hand line			(100.0)	(15.6)	(6.2)	(0.3)	(34.3)	(36.6)	nil	(7.0)			
Payang	4	1,630,530	1,596,127	362,145	114,675	2,500	237,400	802,532		75,875	34,403	955,625	3.6
Payang seine			(100.0)	(22.7)	(7.2)	(0.2)	(14.9)	(50.3)	nil	(4.8)			

[a]Sumber/Source: Nessa (1981).
[b]Biaya bunga tidak dikalkulasi oleh Nessa. Untul tabel ini 12% per tahun dari biaya investasi diguna untuk biaya bunga.
Interest costs were not calculated by Nessa. For this table, 12% of investment costs was used for calculating interest costs.
[c]Pajak penjualan diatas hasil jaring insang tuna 10%. Pajak penjualan alat tangkap lain tidak ada.
Tax on sales from tuna gill nets is 10%. Sales taxes are not applied to other gear types.

Tabel 5.5. Analisa biaya dan pendapatan rata-rata per tahun untuk bebarapa jenis alat tangkap ikan skala kecil di Sulawesi Selatan, tidak termasuk biaya tenaga kerja dari rumah tangga pemilik, Mei 1979 sampai April 1980.[a]

Table 5.5. Average annual costs and earnings of several small-scale fishing gear types in South Sulawesi, in rupiah, excluding labor costs from owners' household, May 1979 to April 1980.[a]

Jenis alat / Gear type	Penerimaan kotor / Gross receipts	Jumlah biaya operasi / Total operating costs	Biaya tenaga kerja bukan rumah tangga / Non-household labor cost	Persentasi jumlah biaya tenaga kerja[b] / Percentage of total labor costs[b]	Keuntungan operasi bersih / Net operating profits	Investasi / Investment	Tingkat keuntungan (%) / Profitability (%)
Bagan tancap Stationary liftnet	677,010	456,012	104,840	18.4	220,998	274,935	80.4
Bagan perahu Mobile liftnet	937,675	703,863	263,545	61.1	233,812	572,065	40.9
Jaring insang udang Shrimp trammel net	342,145	201,123	14,310	13.7	141,022	334,190	42.2
Jaring insang tuna Tuna gill net	2,853,325	1,800,509	553,400	73.7	1,052,816	1,999,490	52.3
Jaring insang layang Scad gill net	1,316,450	1,120,879	215,760	57.9	195,571	1,079,780	18.1
Pancing karang Coral reef hand line	459,200	202,803	32,200	16.8	256,397	82,400	311.2
Pancing rompong Rompong hand line	946,250	587,484	95,640	33.6	358,766	401,325	89.4
Payang Payang seine	1,630,530	1,506,255	712,660	88.8	124,275	955,625	13.0

[a]Sumber/Source: Nessa (1981).
[b]Lihat Tabel 5.4 untuk jumlah biaya tenaga kerja.
See Table 5.4 for total labor costs.

Nessa's examination of the sharing system provides further insights into the balance between labor and capital in small-scale fishing communities. His study also provides the most complete detail available on the role of local fish buyers who also serve as financiers. In Sulawesi, these individuals are known as ponggawa.

Table 5.6 provides data on net receipts, numbers of shares into which net receipts are divided and the number and monetary value of shares received by owners, ponggawa and crewmen. Also indicated are total numbers of shares and the annual value of these shares accruing to the owners and ponggawa (grouped) and to crewmen both as a whole and as individuals. No distinction is made between crewmen who are household members and those who are not.

For purposes of Table 5.6, owners and ponggawa are grouped together. In many cases, these are the same individuals, with the ponggawa acting either directly as owners of the fishing unit or indirectly as the source of funds with which boats and gear are purchased.

Most ponggawa act both as financiers of fishing operations and as buyers of fish. In their role as financiers, ponggawa provide investment and operating capital and require the recipients of such loans to sell their catch to them, giving the ponggawa a steady source of supply and a certain control over the price paid.

For three gear types (scad gill net, rompong hand line and payang seine), the role of ponggawa is explicitly recognized in the sharing system (Table 5.6). In each of these three cases, the ponggawa's role is to provide the rompong, an expensive and highly depreciable item.

No special share is provided for ponggawa in the sharing systems used for tuna gill nets or shrimp trammel nets primarily because they often (and in the case of tuna gill nets always) act as direct owners of boats and gear. Ponggawa play a less important role in ownership of coral reef hand lines or the two types of liftnets, at least in Nessa's study area,[1] but are still involved in financing the construction and operations of these gear. Both owners and ponggawa represent investors of capital, and since it is not possible to differentiate between them on the basis of Nessa's data, it is necessary to group them together.

For each of the gear studied by Nessa, no distinction is made in number of shares given to ordinary crewmen and captains or other crewmen performing specialized tasks. However, Nessa noted that in some cases, captains are given an extra payment if they operate a boat owned by another individual. These extra payments are not reflected in Tables 5.5 and 5.6.

Table 5.7 is derived from data in Tables 5.4 and 5.6 and presents a third measure of profitability for the gear studied by Nessa. From the total value of all owner and ponggawa shares (Table 5.6), fixed costs (depreciation, interest and taxes) and maintenance costs (Table 5.4) were subtracted to determine net receipts, which were then divided by investment costs to determine annual rates of return on investment capital.

As a measure of return to capital investment, this third approach is particularly appropriate for more capital-intensive fishing units where the value of household labor is relatively small. Nessa's data indicate that tuna gill net, scad gill net, payang seine and mobile gill net require the highest levels of investment but are the four least dependent on household labor for their operation (Tables 5.4 and 5.5). Owners (including ponggawa) of these types of fishing unit are more likely to base their investment decisions on expected rate of return to capital than are those who also are interested in creating employment opportunities for household members, a concern which appears to guide investment decisions for less expensive gear types.

The profitability figures in Tables 5.4 and 5.7 for the four most expensive fishing units are roughly consistent. For the less expensive units, however, profitability figures shown in Tables 5.4 and 5.7 are inconsistent. The return to capital for stationary liftnets and coral reef hand lines shown in Table 5.7 is higher than that of Table 5.4, while for shrimp trammel nets and rompong hand lines, it is lower.

One possible explanation of these differences is that a higher proportion of total shares is given to owners and ponggawa of stationary liftnets (5 of 7) and coral reef hand lines (4 of 6) compared to shrimp trammel nets (3 of 6) and rompong hand lines (3 of 7).

Nessa's study contains the most complete set of published costs-and-earnings data available to date. The detail and quality of this data benefitted from the author's residence in the study community over a four-month period. The most serious drawback of this study is that the data are available only for these months.

Community study: South Sumatra and Central Kalimantan

Collier (1980) conducted a comparative study of fishing communities in South Sumatra and Central Kalimantan Provinces which includes costs-and-earnings data (Table

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[1] The authors of this Review visited the community studied by Nessa as well as a number of other areas in South Sulawesi. Our impression is that this community is less dependent on ponggawa than most others in this Province. This is especially so for stationary and mobile liftnets.

Tabel 5.8. Analisa biaya dan pendapatan per tahun beberapa alat tangkap skala kecil di Sumatra Selatan dan Kalimantan Tengah, 1979. Satuan: rupiah.[a]
Table 5.8. Analysis of annual costs and earnings of several small-scale gear in South Sumatra and Central Kalimantan, in rupiah, 1979.[a]

				Biaya tetap / Fixed costs		Biaya tidak tetap / Variable costs					
Provinsi / Province	Jenis alat[b] / Type of gear[b]	Penerimaan kotor / Gross receipts	Jumlah biaya operasi / Total operating costs	Penyusutan / Depreciation	Bunga[c] / Interest[c]	Biaya operasi / Running costs	Biaya tenaga kerja / Labor costs	Pemeliharaan / Maintenance	Keuntungan operasi bersih / Net operating profit	Investasi / Investment	Tingkat keuntungan (%) / Profitability (%)
Sumatra Selatan / South Sumatra	Bagan tancap / Stationary liftnet	3,300,000	2,081,340	867,000	266,340	530,000	360,000	58,000	1,218,660	2,219,500	54.9
			(100.0)	(41.7)	(12.8)	(25.4)	(17.3)	(2.8)			
	Jaring insang udang / Shrimp gill net	1,035,000	591,550	43,750	46,800	396,000	nil	105,000	443,450	390,000	113.7
			(100.0)	(7.4)	(7.9)	(66.9)		(17.7)			
	Jaring insang lingkar / Encircling gill net	3,990,000	3,282,500	258,600	132,000	1,541,900	1,190,000	160,000	707,500	1,100,000	64.3
			(100.0)	(7.9)	(4.0)	(47.0)	(36.3)	(4.9)			
Kalimantan Tengah / Central Kalimantan	Jaring insang hanyut dan jaring insang udang / Drift gill net and shrimp gill net	2,430,000	1,590,648	308,420	132,648	373,500	590,080	186,000	839,352	1,105,400	75.9
			(100.0)	(19.4)	(8.3)	(23.5)	(37.1)	(11.7)			
	Jaring insang tetap / Bottom gill net	1,215,000	177,070	51,670	17,400	nil	nil	108,000	1,037,930	145,000	715.8
				(29.2)	(9.8)			(61.0)			

[a] Sumber/Source: Collier (1980).

[b] Istilah alat-alat tangkap ikan dalam studi Collier istilah tempatan yang diubah untuk Tabel ini menurut istilah yang di gunakan Direktorat Jenderal Perikanan. Untuk Kalimantan Tengah nampaknya dari informasi dalam Collier jaring insang hanyut dan jaring insang udang merupakan alat-alat yang di gunakan satu kapal dalam musim tiga bulang yang sama.

Terms for fishing gear used in Collier's study are local terms which have been changed in this table to those used by the DGF. For Central Kalimantan, it appears from information in Collier that drift gill nets and shrimp gill nets are used by a single fishing boat during the same three-month season.

[c] Dalam studi Collier biaya bunga tidak termasuk jumlah biaya operasi. Untuk Tabel ini biaya bunga di kalkulasikan dengan 12 persen per tahun.

In Collier's study, interest costs were not included in total operating expenses. For this table, interest costs are calculated at 12%/year.

from their home community. Gross receipts, total operating costs and net operating profits are all higher for the kelong, but, as a result of lower investment costs of the South Sulawesi stationary liftnets, profitability ratio of the latter is somewhat higher.

For each gear studied by Collier, there was a negative correlation between investment costs and profitability. This pattern was somewhat less well-defined for the gear studied by Nessa. Data from Collier's study indicate that in absolute (i.e., rupiah) terms, levels of net operating profits in general were related to level of investment. Among the gear types studied by Nessa, only tuna gill nets and mobile liftnets maintain the same order ranked by net operating profit as by level of investment (first and fourth, respectively). Payang seines (ranked third in investment and eighth in profits), coral reef hand lines (eighth and third, respectively), rompong hand lines (fifth and second, respectively) and scad gill nets (second and sixth, respectively) show the most significant variation. Nessa's data suggest that the relationship among level of investment, rate of return on investment and operational profit is not necessarily linear in the small-scale subsector.

Costs-and-Earnings Data from Extensive Surveys

The representativeness of the community level studies by Nessa and Collier may be gauged by comparing their findings to those of three extensive surveys conducted by government agencies. In 1973, the Central Bureau of Statistics (Biro Pusat Statistik or BPS) and the DGF conducted a Marine Fishery Census which covered all of Java, Sumatra and Bali (BPS and DGF 1979). In 1975, the DGF conducted a socioeconomic survey along Java's north coast (DGF 1976).

Neither the 1973 Census nor the 1975 Survey provided information on total investment costs, though costs of hulls and engines were included (but not gear) in the former. As a result, the costs-and-earnings data presented in these sources included only variable costs with no estimates of depreciation, interest or other fixed costs, which are included in the analysis of Nessa's and Collier's data.

In addition to the lack of usable data on investment and fixed costs, other problems exist in interpreting data from the 1973 Census and the 1975 Survey. No information was provided on sharing systems used or extent to which household labor contributes to total labor, precluding the alternative calculations of profitability made from Nessa's data. Moreover, there is reported to be a tendency to understate gross receipts and overstate expenses as respondents were reluctant to provide accurate information for fear that such information might lead to increased tax liabilities. This is especially the case for medium-scale operators (BPS and DGF 1979), but a similar pattern was reported among small-scale fishermen covered by the 1975 Survey (DGF 1976). Additional problems of reliability are posed by the survey methodology itself: respondents were asked to recall costs-and-earnings data for 12 months of fishing during a single interview.

Another problem in interpreting the costs-and-earnings data from these two sources is that such data are presented by "owning establishment" (i.e., households and companies) rather than by fishing unit. This is not a major problem in regard to small-scale fisheries but is significant for medium-scale fisheries. Among those small-scale fishing households which own boats, the 1973 Census and the 1975 Survey reported an average of only 1.07 and 1.02 boats, respectively. (The 1980 Survey reported this average to be 1.1; DGF 1982e). Costs and earnings of household and of fishing unit, thus, were nearly the same. This was not true, however, within the medium-scale subsector where concentration of ownership was somewhat greater. For the 1973 Census, costs and earnings for this subsector were reported on the basis of total tonnage of boats owned and not by individual fishing unit (Yamamoto 1980). The 1973 Census reported an average of 1.7 boats per medium-scale fishing establishment.

The 1973 Census provides costs-and-earnings data only by category of boat. The 1975 Survey, which covered only the small-scale subsector, provides data on costs and earnings

Tabel 5.9. Analisa biaya dan pendapatan operasi rata-rata per tahun untuk beberapa jenis alat tangkap ikan skala kecil, pantai utara Jawa, 1975. Satuan: rupiah x 1,000.[a]
Table 5.9. Analysis of average annual operational costs and earnings of several small-scale gear types, north coast of Java, 1975, in rupiah x 1,000.[a]

Jenis alat	Jumlah sampel	Penerima an kotor	Biaya tidak tetap (Variable cost)					Keuntungan operasi	Tingkat keuntungan (%)
			Sub total	Bahan bakat	Es	Lain-lain[c]	Upah buruh		
Type of gear	Number of samples	Gross receipts	Subtotal	Fuel	Ice	Others[c]	Labor costs	Operational profit	Profitability (%)
Payang[b]	231	554.3	263.3	67.2	13.8	25.1	157.2	291.0	52.4
Payang seine[b]			(100.0)	(25.5)	(5.2)	(9.5)	(59.7)		
Dogol	24	229.1	91.1	–	–	38.6	52.5	138.0	60.2
Danish seine			(100.0)			(42.4)	(57.6)		
Jaring klitik	175	382.7	161.0	1.4	10.3	50.0	99.3	221.7	57.9
Shrimp gill net			(100.0)	(0.8)	(6.4)	(31.1)	(61.7)		
Jaring insang tetap	241	347.2	118.5	4.2	1.1	28.5	84.7	228.7	65.9
Bottom gill net			(100.0)	(3.5)	(0.9)	(24.1)	(71.5)		
Bagan tancap	111	445.2	186.9	46.4	0.3	42.0	98.2	258.3	58.0
Stationary liftnet			(100.0)	(24.8)	(0.2)	(22.5)	(52.5)		
Serok	88	112.6	18.8	2.1	0.7	6.3	9.7	93.8	83.3
Scoop net			(100.0)	(11.2)	(3.7)	(33.5)	(51.6)		
Pancing	84	171.0	66.3	0.3	0.1	15.4	50.5	104.7	61.2
Hand line			(100.0)	(0.5)	(0.2)	(23.2)	(76.2)		
Sero	62	263.9	26.3	4.2	–	7.3	14.8	237.6	90.0
Guiding barrier			(100.0)	(16.0)		(27.8)	(56.3)		

[a]Sumber/Source: DGF (1978b).

[b]Lima buah unit payang dari sampel mengunakan kapal mesin dalam dan sebenarnya harus dikirakan sebagai unit skala sedang. Data dari 5 unit itu tidak termasuk dalam data di Tabel 5.8. Unit-unit lain dalam Tabel ini semuanya skala kecil.

Five payang seine units from this sample used boats powered by inboard engines and should be classified as medium scale. Data from these five units are excluded from Table 5.8. All other gear in this table are small scale.

[c]Mungkin ini biaya pemeliharaan; lihat teks.

This is probably maintenance costs; see text.

The 1973 Census

In Table 5.11, data on operational costs and earnings derived from the 1973 Census are presented. However, comparisons among data in Tables 5.9, 5.10 and 5.11 are necessarily indirect, as information in Table 5.11 is restricted to type of boat regardless of gear, whereas Tables 5.9 and 5.10 provide operational costs-and-earnings data by gear type. The only direct comparison that can be made between the 1973 Census and the 1975 Survey is for operational costs and earnings of various types of small-scale boats along the north coast of Java (Table 5.12).

Tabel 5.11. Analisa biaya dan pendapatan operasi rata-rata per tahun menurut jenis perahu skala kecil di Jawa, Sumatra dan Bali, 1973. Satuan: rupiah x 1,000.[a]
Table 5.11. Analysis of average annual operational costs and earnings by type of small-scale boat in Java, Sumatra and Bali, 1973, in rupiah x 1,000.[a]

Pulau / Island	Daerah / Area	Jenis perahu[b] / Type of boat[b]	Penerimaan kotor / Gross receipts	Biaya operasi / Operating costs	Keuntungan operasi / Operational profit	Tingkat keuntungan (%) / Profitability (%)
Jawa Sumatra Bali	Seluruh tiga pulau / All three islands	Kecil/Small	162.0	39.9	122.1	75.3
		Sedang/Medium	236.5	84.6	151.9	64.2
		Besar/Large	431.4	176.2	255.2	59.2
		Motor tempel/Outboard	2,037.6	1,055.6	982.0	48.1
Jawa	Seluruh pulau Jawa / All of Java	Kecil/Small	169.5	47.7	121.8	25.9
		Sedang/Medium	253.8	100.5	153.3	60.4
		Besar/Large	491.3	197.8	293.5	59.7
		Motor tempel/Outboard	3,196.0	2,237.9	958.1	29.9
	Pantai utara Jawa / North coast Java	Kecil/Small	177.6	48.5	129.1	72.6
		Sedang/Medium	262.1	104.7	157.4	60.0
		Besar/Large	510.8	207.1	303.7	59.4
		Motor tempel/Outboard	2,160.3	1,891.4	268.9	12.4
Sumatra	Seluruh pulau Sumatra / All of Sumatra	Kecil/Small	162.8	28.5	132.3	82.2
		Sedang/Medium	228.5	64.5	164.0	71.7
		Besar/Large	255.0	108.6	146.4	57.4
		Motor tempel/Outboard	1,524.8	532.6	992.2	65.0
	Selat Malaka / Malacca Straits	Kecil/Small	170.5	31.1	139.4	81.7
		Sedang/Medium	241.3	72.4	168.9	69.9
		Besar/Large	268.4	119.8	148.6	55.3
		Motor tempel/Outboard	1,376.9	242.3	1,134.4	82.3
Bali	Seluruh Bali / All of Bali	Kecil/Small	83.3	16.8	66.5	79.8
		Sedang/Medium	89.8	32.6	57.2	63.6
		Besar/Large	157.1	55.8	101.3	64.4
		Motor tempel/Outboard	1,120.1	189.7	930.4	83.0

[a]Sumber/Source: BPS and DGF (1979).

[b]Ukuran perahu kecil, sedang, dan besar yang tidak bermotor dalam Sensus 1973 berbeda dari yang digunakan sekarang yang berdasarkan panjangnya perahu (lihat Bab Tiga). Perubahan ini tidak sangat berpengaruh. Untuk Sensus 1973 luas dalamnya digunakan untuk perahu tidak bermotor. Ukuran ini dikirakan libih sulit daripada ukuran panjangnya perahu, dan kerana itu perubahan dilakukan. Untuk perahu motor tempel besarnya perahu tidak dikirakan.

The measurement of small, medium and large non-motored boats used in the 1973 Census differs from current standards which are based on length (see Chapter 3). These changes have little effect on the data themselves. For the 1973 Census, displaced volume of non-motorized boats was used. This measurement was considered to be more difficult to apply than length of boat, resulting in the change in manner of classification. For boats powered by outboard engines, no distinction is made by size of boat.

Collier were compared with the only other available sources of information, the 1973 Census and the 1975 Survey.

The broad compatibility of (or ability to explain differences between) costs-and-earnings data between these four sources suggests that some of Nessa's and Collier's findings can be extrapolated beyond their study communities. However, it is not possible to use Nessa's findings from South Sulawesi or Collier's from Central Kalimantan and South Sumatra as a basis for programs of fisheries development in areas where there is more limited potential for expanded fisheries production, as appears to be the case for the north coast of Java and the Malacca Straits.

What can be applied, however, are the research methodologies employed by Nessa and Collier. Nessa's more intensive study is not likely to be replicated by others in more than a few communities elsewhere in Indonesia within the forseeable future due to the length of time required for such an effort. Collier's quicker approach, though providing less reliable costs-and-earnings data, could be adopted for use in gathering such information on a wider range of fishing communities.

These two types of studies also allow the inclusion of descriptive details on fishing gear, mode of operation, sharing systems employed and other more qualitative features of life in communities of fishermen. As such, studies of this type provide not only a check on the reliability of costs-and-earnings data from more extensive surveys but a basis for understanding significant variations between different areas. Such information is of critical importance to the design and implementation of credit or other fisheries development programs.

international markets were established. Export- oriented fisheries in North Sulawesi, the Moluccas and Irian Jaya have been established with shore-based facilities for handling the catch and carrier boats with refrigerated holds. No parallel infrastructure exists to support domestic inter-island fish trade, yet without redistributing supply to meet demand, it will not be possible either to increase fish supply on Java or to encourage fishing in areas where fisheries resources are lightly exploited.

Supply and Demand

Table 6.1 summarizes data on total fisheries harvests and human population by island and by province for 1982. The fisheries data include all harvests from capture and culture fisheries, marine and freshwater (see Table 1.1). Population data are projections based upon the 1980 Census. These calculations ignore imports, exports and inter-island trade in fisheries products, and as such more accurately reflect production rather than net supply per capita.

Based on Table 6.1, average annual per capita fish supply in Indonesia during 1982 was 12.9 kg. In that year, Indonesian exports of fisheries products totalled 88,100 t. The most recent data available on fisheries imports are for 1981 (DGF n.d.), when nearly 59,000 t worth US$ 37 million entered Indonesia. However, all but 8.7 t and US$ 5.5 million of these totals were for fish meal used as animal feed and unfit for human consumption (DGF 1982d). The net supply of fisheries products within Indonesia, exclusive of imported fish meal used for livestock, was 12.35 kg/capita in 1982.

The DGF calculates average annual per capita fish supply in this manner (DGF 1982d). The Central Bureau of Statistics (BPS 1982a), however, goes one step further in estimating supply by calculating a wastage factor of 15% of net supply to represent inedible parts and losses in processing, handling and marketing. Applying this wastage factor to the net fisheries supply figures for 1982 reduces annual per capita consumption to 10.5 kg.

Differences in the DGF's and the BPS' per capita fish supply estimates reflect the differing purposes of these two institutions. The DGF, responsible for fisheries management and development, is interested primarily in production data necessary for project planning and stock assessment purposes. The BPS, however, is concerned primarily with reporting the availability of protein to Indonesian consumers.

During the period 1971-1982, total fisheries harvests increased at an average annual rate of 4.2%; between 1975 and 1982, this accelerated to nearly 6% (Table 1.1). The annual population growth rate during the period 1971-1980 was 2.3% (BPS 1981). Fisheries harvests have increased at a faster rate than the population.

By the year 2001, Indonesia's population is projected to be 210 million (BPS 1980). To maintain current levels of per capita fish supply will require harvests of 2.6 million t, compared with 2.0 million t in 1982. As much as 2 million t of this may need to come from the marine sector if trends established over the past 15 years continue (Fig. 1.2). This is well below estimated maximum sustainable yields for marine capture fisheries (4.5 million t), but many of these resources may not be economically exploitable (see Chapter 2). Increases in production of this magnitude are possible only if marine resources not yet under heavy fishing pressure are more fully exploited.

Fish supply by island and inter-island trade

Table 6.1 indicates substantial variation in supply of fisheries products between islands (or island groups) and provinces. Per capita fish production on Java in 1982 was 6.3 kg, less than half of the national average of 12.9 kg.

Java's large population and low per capita supply, as measured by harvests, strongly influence the national average. If fisheries supply and population figures for Java were probably overstates the volume of inter-island trade and suggests that half of all fish landed outside of Java in 1971 were shipped to that island. In 1975, the first year for which reliable landings data are available, total landings on Sumatra and Kalimantan combined totalled only 510,000 t (DGF 1977). Landings in 1971 are likely to have been even less, and it can be assumed that people on those two islands ate much if not most of the fish harvested in local waters.

In a second FAO (1975) study, it was reported that a total of 529,000 t of fish (mostly salted and sun-dried) was shipped to Java during 1974. Shipments from Riau to West Java alone were listed as 174,000 t, compared to total harvests (including all capture and culture fisheries) in Riau Province of 165,000 t during 1975. Similarly, 180,000 t of fish reportedly were shipped from Central Kalimantan to Central Java in 1974, compared with total 1975 fish harvests of 52,000 t in Central Kalimantan and 212,000 t for all of Kalimantan (DGF 1977).

These FAO reports lack precise data but do accurately indicate the general pattern of fish trade. Virtually all inter-island fish trade in Indonesia is directed towards Java, and more than half of this is to West Java. The most common product form is salted sun-dried fish. Riau Province probably is the single most important shipper of fish to the West Java market. Approximately one-third of all fish shipped to Java is destined for Central Java Province. Much of this comes from Kalimantan and enters through the port of Surabaya where it is loaded onto trucks for further transhipment.

Riau Province has well-established trade relations with nearby Malaysia and Singapore and fish is a major commodity in this exchange. It is not known what proportion of this trade is carried out formally or "informally," and hence recorded as international trade. It is widely believed that unrecorded trade directly by fishermen or through middlemen using smaller vessels also takes place, with transfers effected at sea. No data on the volume of this informal international trade exist.

Hanafiah and Unar (1976) examined salted fish shipments unloaded at three major ports on Java during 1969-1975 and reported the average annual volume to be approximately 55,000 t. This figure is well below the FAO estimates for 1971 and 1974 and probably closer to the quantities of fish involved.

Hanafiah (1978) reported that in 1975 a total of 24,000 t of salted fish was shipped to Java from Bagan Siapiapi, the single most important fishing port in Riau Province. He traced the decline in salted fish shipment to Jakarta during the period 1969-1975 from a peak of nearly 30,000 t in 1970 to less than 6,000 t in 1975, which he noted was caused by increased shipments to Cirebon, another West Java port.

Hanafiah (1978) also reported that the Jakarta fisheries office records show that 95% of the dried salted fish entering that port in 1975 came from Sumatra, two-thirds of which came from Bagan Siapiapi. The remaining 5% was recorded as coming from ports on Kalimantan.

It is possible that shipments of dried salted fish from Kalimantan to Jakarta were not accurately represented by these figures. Horridge (1981), who studied the large sail-powered boats which play an important role in inter-island trade between Java, Kalimantan and Sulawesi, suggested -- as do personal observations by the authors of this Review -- the important role of these boats in bringing from Kalimantan and Sulawesi dried salted fish to Jakarta and other Javanese ports (see also FAO 1973b). On any given day, literally hundreds of these sailing boats can be seen at the Jakarta port of Sunda Kelapa. The traders who travel on these boats purchase manufactured or other goods in Jakarta for resale in Kalimantan and Sulawesi, and return to Java with cargos of various raw materials, including lumber and dried salted fish. It is possible that these shipments of fish are not as closely monitored as those from Sumatra, which arrive in Jakarta primarily on small coastal freighters.

Horridge (1981) provided no data on the volume of fish trade, and the two FAO (1973b, 1975) reports did not cite their sources of information. Data from local and provincial fisheries offices and from harbormasters, the primary sources cited in the studies by Hanafiah and Unar (1976) and Hanafiah (1978), are full of inconsistencies. Further work is needed on this important inter-island fish trade.

Tabel 6.2. Konsumsi ikan per kapita per tahun menurut golongan pengeluaran rumah tangga per bulan, 1978.[a]
Table 6.2. Annual per capita fish consumption ranked by monthly household expenditures, 1978.[a]

Kategori pengeluaran per bulan Monthly expenditure category	Konsumsi ikan per tahun (kg) Annual per capita fish consumption
< Rp 2,000	2.08
Rp 2,000 – 2,999	6.00
Rp 3,000 – 3,999	6.60
Rp 4,000 – 4,999	11.96
Rp 5,000 – 5,999	13.52
Rp 6,000 – 7,999	17.68
Rp 8,000 – 9,999	21.32
Rp 10,000 – 14,999	26.52
≥ Rp 15,000	28.08
Rata-rata/Average	11.44

[a]Sumber/Source: DGF (1983b).

consumption for nearly half the national population was barely half the national average. Over 90% of this low income group were said to reside in rural areas.

These data indicate that if the development of Indonesia's economy results in increasing rural income levels, there will be a corresponding increase in demand for fish. Most of this increase will have to come from the marine fisheries sector, which has been responsible for virtually all of the increased supply of fish over the past 15 years (Fig. 1.2).

Supply and Demand for Fresh versus Processed Fish: Two Generations

Fish provide the single most important source of animal protein available to Indonesian consumers and are eaten either fresh or in a number of processed forms. Hanafiah and Unar (1976) estimate that over half of all marine fisheries landings are processed using salt in conjunction with either sun-drying or cooking to preserve the catch until it reaches the consumer. However, there has been a gradual trend to increase consumption of fresh fish due to improved transportation facilities, particularly on Java, which allow broader distribution of this highly perishable commodity. Even on Java, however, processed fish still provide a significant proportion of available fish supply, and outside Java, processing is a necessary element in marketing and distributing the catch.

The proportion of the catch destined for marketing as fresh or processed fish varies greatly with physical location of the landing points in relation to consumer markets. This relationship can be summarized as follows:

* A variable but generally high proportion of the catch landed outside Java is processed before it enters the marketing and distribution system, while on Java the bulk of the catch is sold as fresh or fresh iced product (BPS and DGF 1979).

demand (DGF and Universitas Gajah Mada 1979). In inland cities on Java, only relatively wealthy consumers are able to purchase fresh fish on a regular basis, although even for them the presence of alternatives and the often dubious quality of fresh fish arriving from the coast limit their willingness to pay high prices.

A lower proportion of fresh fish is marketed on much of Java's south coast due to rough terrain, low population densities and limited road access. Conditions along this coast often more nearly approximate those on other islands rather than conditions on Java's north coast.

Marketing and Distribution Patterns

The complex marketing and distribution patterns for fresh and processed fish in Indonesia are outlined in Fig. 6.1. Except in those cases where members of the fisherman's family sell the catch directly to local consumers, both fresh and processed fish typically change hands several times between landing site and point of retail sale. A variable number of persons are involved in buying and distributing fresh fish. Each of the various processed fish products tend to follow separate specialized distribution networks from processor to retailer. Consumers receive fish in a variety of forms from retailers who typically specialize in selling one type of product.

From the perspective of the individual fisherman, reality often is far less complex than Fig. 6.1. Rarely do fishermen have access to a wide range of possible buyers. Fish auction halls, for example, exist in only 134 of the thousands of fishing communities in Indonesia (DGF 1982d), and brokers associated with these auctions are present in some of them only. Direct access to wholesalers who distribute fresh fish to urban markets is restricted to fishermen based at or near major fishing ports where the wholesalers are located. Direct sale of the catch to consumers by members of the fisherman's family is a common marketing strategy but is not always possible due either to limited local demand

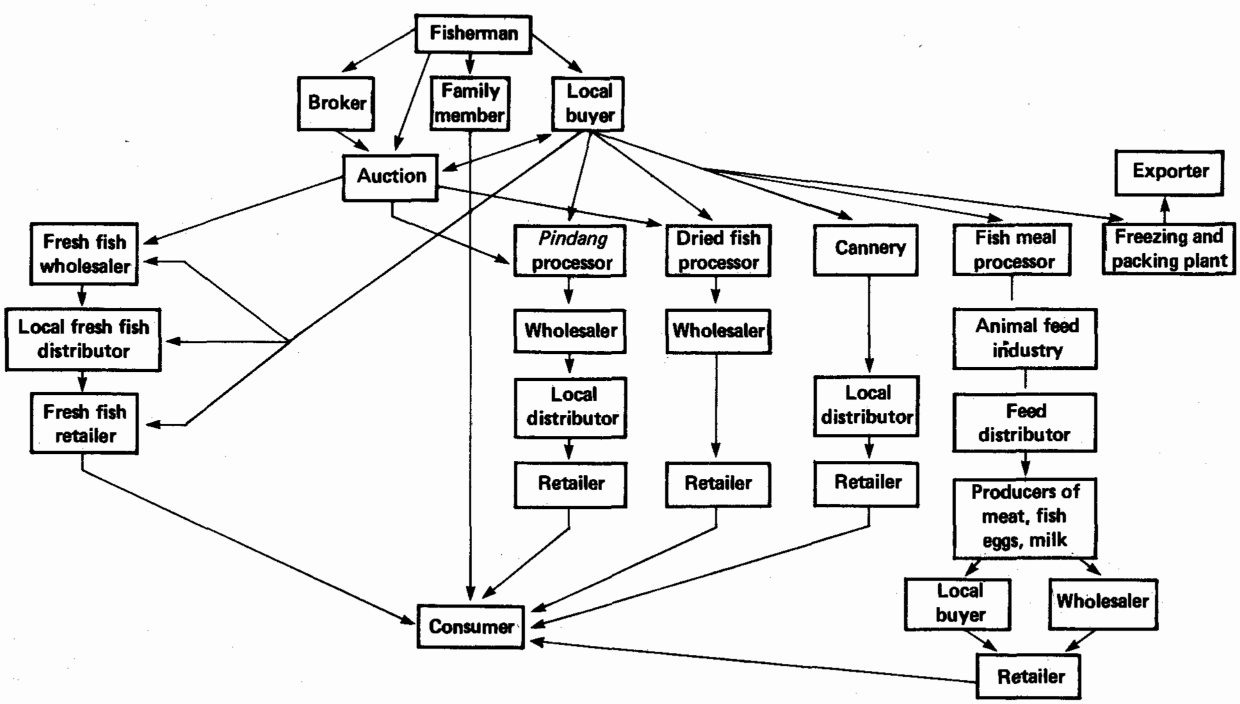

Fig. 6.1. Structure of fish marketing and distribution in Indonesia. (Adapted from the Directorate General of Fisheries and Universitas Gajah Mada 1979).

Fish auction halls typically are little more than a concrete slab covered by a roof, without walls. The staff which manage the TPI usually are housed in the local KUD office located nearby. Only at auction halls located in major urban ports are ice plants and cold storage facilities available. In the majority of cases, what ice is available is brought by individual buyers who use it to pack purchases destined for fresh fish markets.

The stated purpose of both the TPIs and government loan programs channeled through KUDs is to break the hold of local fish buyers over fishermen. Because only limited sums of money are available through government loan programs (Chapter Four), and because TPIs have been established in only a few of the many coastal fishing communities, these programs have had minimal effect on the majority of small-scale fishermen and the local buyers of their catch. Location of TPIs in the largest of the small-scale fishing communities does provide access to auctions for the maximum possible number of fishermen given the limited number of auction halls which currently exist or are likely to be established in the future. The costs of constructing and staffing a TPI in a small isolated fishing community would be as great if not greater than those incurred in larger communities and would benefit fewer people. Moreover, organizing an effective auction in a small community where only one or a few buyers are present would be difficult as the basis for competitive bidding does not exist under such circumstances.

As is indicated in Fig. 6.1, a wide variety of buyers are involved in auctions held at TPIs, including processors, fresh fish wholesalers and local buyers who are tied at various points along the fresh and processed fish distribution chains. The proportion of the auctioned fish purchased by these different types of buyers appears to vary from place to place. In Muncar, East Java, it appears that a substantial portion of the oil sardine catch is purchased directly by local processors through the TPI. The high oil content of this species causes rapid decomposition and limits its use in fresh fish markets other than those in the immediate vicinity of Muncar itself. Elsewhere, and especially at the various TPIs located along Java's north coast where access to fresh fish markets is assured by good roads and proximity to major urban markets, a higher proportion of the catch sold through the TPI passes through fresh fish distribution channels.

Fishermen selling their catch at a TPI may do so directly or through a broker who takes a small percentage of the purchase price in return for various services, the most important of which is assuring the fishermen that they will be paid for their catch in a timely fashion. Local fresh fish buyers operating at TPIs and elsewhere frequently pay for their purchases several days after taking delivery, by which time they have received payment from others along the distribution chain. Buyers of fish to be processed may delay payments for an even longer period. In some cases, the broker will use his own financial resources to pay fishermen on the day the catch is landed and will collect the purchase price from buyers at some later date. These buyers may incur losses in their subsequent transactions and attempt to pay fishermen a price lower than originally promised. Brokers with knowledge of market conditions are better able than fishermen to resist such pressures. In acting as an intermediary between fishermen and buyers to secure payment, and by providing immediate cash to fishermen who must meet daily operational costs, brokers provide important services to fishermen.

Where TPIs exist, fishermen have access to a relatively large number of buyers serving diverse markets at one central location. However, not all fishermen sell their catch through these facilities even where they have been established. In Muncar, canneries which process oil sardines purchase fish directly from local buyers who act as financiers for various types of fishing units, especially small purse seiners which were introduced during the mid-1970s (Emmerson 1975, 1980). The canneries pay a premium price for oil sardines of high quality, and local buyers who sell directly to these canneries do not have to pay the 8% auction fee charged at the TPI.

To date, no studies have been conducted comparing prices of fish sold through TPIs with those obtained by fishermen dealing directly with local buyers in the same area and for the same species. For fishermen without credit obligations either to the KUD or a local buyer, prices offered at the TPI would have to be at least 8% higher to match of capital among local buyers and retailers. Under these circumstances, fishermen receive delayed payment for their catch, which may in turn necessitate their obtaining credit from suppliers of fuel or other provisions necessary for continued fishing operations. There is also the possibility that retailers or local buyers may incur losses in their transactions and seek to reduce the previously agreed upon price to be paid to the fishermen.

Fig. 6.1 suggests that local buyers have access to many different distribution networks. Rarely is this the case. In communities isolated by distance or the absence of transportation from major centers of demand for fresh fish, local buyers may have no alternative to selling their fish to processors. Under such circumstances, these buyers may themselves be directly involved in processing the catch. Where geographic location and the availability of transportation provide access to fresh fish markets, the options available to local buyers may still be limited if they are tied by loans to fresh fish wholesalers. It appears that local buyers able to provide loans to fishermen often are linked to wholesalers who provide the capital for such loans. This arrangement benefits the wholesaler, to whom the local buyer is obliged to sell the fish he purchases from fishermen who are in turn tied to him.

Fresh fish wholesalers

Fresh fish wholesalers may be distinguished from other types of fresh fish buyers by the amount of operating capital they possess and by the manner in which they distribute fish which they purchase. Universitas Diponegoro (1978) reported that the largest buyers operating in the port city of Pekalongan (Central Java) during 1976 had as much as Rp 5 million capital and distributed the bulk of their purchases to markets in West Java. These wholesalers were followed in scale of operations by medium- and small-scale buyers whose capital resources were in the ranges of Rp 300,000 - Rp 1 million and Rp 10,000-Rp 100,000, respectively (Universitas Diponegoro 1978). The bulk of the fish handled by medium- and small-scale buyers was sold directly to consumers in Central Java, including those in Pekalongan itself (Universitas Diponegoro 1978). Small-scale fish buyers sold to consumers the majority of their fish within Pekalongan, while medium-scale buyers as a group sold equal proportions (38%) to retailers in Pekalongan and elsewhere in Central Java. Both medium- and small-scale buyers were involved in distributing fresh fish to markets in West Java (25% and 18%, respectively). In comparison, 82% of the wholesalers distributed fresh fish in West Java. While fresh fish wholesalers are far fewer in number than medium- and small-scale buyers, each wholesaler handles larger quantities of fish.

On Java, fresh fish wholesalers operate out of such major fishing ports as Cirebon, Tegal, Pekalongan and Semarang along the north coast and in Cilacap on the south coast. These major ports serve as the base for medium-scale fishing units (e.g., purse seiners and, prior to 1980, otter trawlers). The large quantities of fish landed at these ports, the ready availability of ice and access by road to major consumer markets elsewhere on Java greatly facilitate rapid accumulation and distribution of fish by these wholesalers. Outside of Java, fresh fish wholesalers also are present in major fishing ports where access by road to urban consumer markets is possible (e.g., Belawan and Tanjung Balai to Medan in North Sumatra).

Fresh fish wholesalers on Java purchase and pack in ice fish transported by truck to distributors located in major urban markets both inland and elsewhere along the coast (e.g., Jakarta). These distributors in turn supply fresh fish retailers who sell the catch directly to consumers. Beyond this simple description, however, little is known of the operation of fresh fish wholesalers and the distribution networks which they supply. The authors are aware of no studies which have examined the nature of the relationships which exist within these networks. Are local distributors and retail sellers tied to each other and to particular fresh fish wholesalers by credit or other bonds?

CHAPTER 7

SOCIOECONOMIC FACTORS AFFECTING SMALL-SCALE FISHERIES DEVELOPMENT

C. Bailey

Abstract

Basic demographic information available on small-scale fishing communities is reviewed, including causes for variability in community and household size, and differences in educational attainment between owners and crewmen. Information on occupational and geographic mobility among fishermen indicates a net movement of agriculturalists into fishing.

Nearly half of all fishermen are engaged in other economic activities besides fishing, with farming being the most important. The level of dependence on fishing is seen to vary between islands and is largely determined by population density and the relative availability of land. A strong inverse relationship was found between level of dependence on fishing and household income.

Ownership patterns and sharing systems are described. Available data suggest little concentration of ownership of fishing assets. Sharing systems are shown to be characterized by a high degree of variability, although some of this variation appears to be structurally determined.

Government programs designed to overcome constraints to small-scale fisheries development are reviewed. Two assumptions seem to govern program design and implementation: that middlemen who act as both financiers and fish buyers exploit small-scale fishermen; and that fishermen are reluctant to adopt innovations in technology or social organization. Arguments are advanced calling into question the validity of these assumptions.

Introduction

In recent years, there has been a growing awareness among Indonesian policymakers and researchers that fisheries management and development programs are affected not only by biological and technical factors but also by socioeconomic conditions. The purpose of this chapter is to review the nature of socioeconomic relationships within fishing communities, particularly those which affect fisheries development programs. Special emphasis is given to conditions within small-scale fishing communities. This emphasis is justified by the relative importance of this subsector (Chapter 3) and made necessary by the virtual absence of such information on medium- and large-scale fisheries.

reported no other source of income, lived in the Jakarta metropolis (DGF 1985). The rapid growth of medium-scale fisheries in Indonesia has greatly increased the number of fishermen living in other major population centers such as Cirebon, Pekalongan, Tegal and Semarang on the north coast of Java and Belawan and Bagar Siapiapi on the Malacca Straits.

The majority of Indonesia's fishermen, however, are not urban dwellers, but reside in coastal communities throughout the archipelago. The largest of these rural communities are to be found, not surprisingly, on Java. The population of Muncar in the early 1970s included over 7,000 locally resident fishermen, not counting several thousand seasonal migrants to the area coming from Madura and elsewhere in East Java (Dwiponggo 1974). More typical appear to be the three communities studied by Collier et al. (1977) along the north coast of Central Java, which had populations between 1,900 and 2,400 in 1974.

Outside of Java, populations of this size are less commonly found in rural fishing communities, with the possible exception of those on Bali. The Balinese community of Tanjung Benoa on the south coast had a reported 1980 population of 2,470 (GTZ 1982). The average population of seven fishing communities on the neighboring island of Lombok, the most heavily populated of the Lesser Sunda Islands after Bali, was less than 1,600 (GTZ 1982). Further east in this chain of small islands, average population size of coastal fishing communities is well below that of Bali and Lombok. Hembree (1980) reported a fishing community with a total population of only a few hundred on the island of Lembata. The smallest coastal fishing community reported in the literature, however, is that studied by Collier (1980) in Central Kalimantan Province, which was comprised of only 40 households.

Average household sizes among Indonesian fishermen are between 5 and 6, with owners' households consistently larger than those of crewmen (Table 7.1). Average household sizes for both owners and crewmen on Java are smaller than elsewhere. Moreover, household sizes on Java appear to have declined substantially between the DGF's 1975 and 1980 Socioeconomic Surveys (from 5.6 to 5.0 for owners and from 4.7 to 4.1 for non-owners; DGF 1976b, 1982e). Average household sizes among some categories of owners of inboard powered boats along the Malacca and Makassar Straits are unusually high. It is not clear whether these reflect the size of immediate (nuclear and extended) families or also include non-related household members who reside with the owner and are employed in fishing-related activities or as domestic help. The definition of household member used by the DGF includes such non-related persons if they shared the same dwelling and kitchen facilities as the owner. Most Indonesian households (including those of fishermen) are made up of nuclear families, but as is true elsewhere in Southeast Asia, extended families (grandparents, parents and children) also represent a common household pattern.

Table 7.1 also contains data on numbers of household members who are active in the fishing industry, either as fishermen or in shore-based supportive roles. The most important insight to be gained from these figures is that, on average for all categories of fishermen for which we have data, the number of household members employed in supportive roles is greater than the number of people who actively engage in fishing at sea.

The data in Table 7.1 also indicate possibly important differences in the degree of direct involvement in fishing by owners of inboard powered boats along the north coast of Java compared to those from the Malacca and Makassar Straits. The data suggest that in the latter two areas, owners are much more directly involved in fishing activities than in the case of their counterparts from Java, who appear more inclined to hire captains and crew.

Age difference between owners and crewmen

Variation in household size may be attributable in part to differences in the age structure between owners and crewmen, with owners tending to be somewhat older.

Neither the 1975 nor the 1977 Socioeconomic Surveys report ages of fishermen, but the 1973 Census conducted in Java, Sumatra and Bali did. On these three islands, 38% of all owners were 40 years of age or older, compared with 32% among all crewmen (Table 7.2). The 1980 Socioeconomic Survey (DGF 1982e) of the north coast of Java provides more recent confirmation of this pattern (41% of all owners were 40 or older compared with 27% of all crewmen).

These data suggest that higher proportions of crewmen's households are still in their childbearing years. Moreover, on average the children of crewmen are likely to be younger than those of owners, a factor of particular importance regarding male offspring who in their middle adolescence often begin their careers as fishermen and contribute their earnings to the household economy (Mubyarto et al. 1984). A fisherman who marries at age 20, for example, will be in his mid- to late thirties or early forties before he will have a son able to join him at sea. It is at this stage in a household's development that increasing income makes investment in boat and gear practical, enabling some fishermen to shift from the status of crewman to that of owner.

The data in Table 7.2 show that the majority of all fishermen (both owners and crewmen) are between the ages of 30 and 50. This probably is an accurate reflection of owners' ages, but may underestimate the proportion of younger fishermen employed as crewmen. The 1973 Census was designed to make a full enumeration of all fishermen, but it is relatively easy to miss non-owners. This appears to have been the case in the 1973 Census, which reported 254,000 owners but only 92,000 non-owning crewmen in the three islands covered (BPS and DGF 1979). (Numbers of crewmen are also underrepresented in the 1975, 1977 and 1980 Socioeconomic Surveys.) It can normally be assumed that crewmen would outnumber owners (Chapter 3). While the data on owners in Table 7.2 may be reasonably accurate, those for crewmen probably are not, and in particular underrepresent younger crewmen who may not yet have established households of their own.

Education

The limited educational background of Indonesian fishermen often is used to justify the dominant role of government officials in guiding the process of fisheries development.

Prior to Independence in 1945, educational facilities in Indonesia were concentrated in urban areas and few rural inhabitants, including most fishermen, were able to obtain formal secular education. Since Independence, and particularly over the past 15 years or so, educational opportunities in rural areas have expanded. Many older fishermen never had an opportunity to attend a government school, though increasingly the ranks of fishermen are being filled by younger men who have some formal education. Still, many of the more isolated coastal fishing communities lack primary schools. Moreover, secondary schools typically are located in small towns and cities rather than in rural areas. As a result, many children of fishermen attend primary schools located at some distance from their home community and must travel even greater distances if they are to attend secondary school. Despite the difficulties and expenses involved, it is clear that parents in fishing communities regard education as an important means of bettering their children's lives and broadening their employment prospects (Mubyarto et al. 1984).

Table 7.3 contains data on educational attainment among owners and crewmen in the three areas covered by the 1975 and 1977 Socioeconomic Surveys. The highest proportion of fishermen with no formal education are those on the north coast of Java, including nearly half of all owners and 57% of all non-owning crewmen. By the time of the 1980 Socioeconomic Survey, these figures had dropped slightly to 44% and 53% (DGF 1982e; only aggregate data for all owners were available from the 1980 Survey). A study by Universitas Diponegoro (1980), which covered both the north and south coasts of Java, indicated that on average there was no significant difference in educational attainment

Tabel 7.3. Tingkat pendidikan nelayan pemilik (menurut jenis perahu/kapal) dan nelayan pendega di pantai utara pulau Jawa, Selat Malacca dan Selat Makassar, dalam persentasi[a, c]

Table 7.3. Educational attainment of owners (by type of boat) and crewmen from the north coast of Java, Malacca Straits and Makassar Straits, in percentages[a, c]

Jenis perahu/kapal Type of boat	Pantai utara Jawa/North coast of Java			Selat Malaka/Malacca Straits			Selat Makassar/Makassar Straits		
	Tidak bersekolah No schooling	Sekolah dasar Primary school	Sekolah menegah dan atas Jr. and Sr. high school and above	Tidak bersekolah No schooling	Sekolah dasar Primary school	Sekolah menegah dan atas Jr. and Sr. high school and above	Tidak bersekolah No schooling	Sekolah dasar Primary school	Sekolah menegah dan atas Jr. and Sr. high school and above
Rata-rata rumah tangga pemilik[b] Average of owners' households[b]	49.5	48.6	1.9	26.5	71.6	2.0	37.7	59.8	2.4
Tanpa perahu/Without boat	50.7	49.3	0.0	90.3	9.7	0.0	44.2	55.4	0.4
Perahu tanpa motor Non-powered boat									
Jukung/Dugout	35.4	61.8	2.8	14.6	85.4	0.0	33.6	63.8	2.5
Kecil/Small	49.0	50.7	0.3	32.6	66.2	1.2	32.8	63.1	4.2
Sedang/Medium	46.2	52.0	1.8	28.2	70.0	1.9	31.2	66.1	2.7
Besar/Large	69.8	28.2	2.0	21.7	78.3	0.0	29.0	69.7	1.3
Perahu motor tempel/Outboard	58.1	39.4	2.5	32.0	67.2	0.8	19.3	73.6	7.1
Kapal motor Inboard powered boat									
< 5 GT				28.7	69.7	1.6	38.4	51.5	10.0
5-10 GT				10.3	82.6	7.0	0.0	46.7	53.3
10-20 GT				8.0	88.7	3.4	0.0	16.7	83.3
20-30 GT	33.4[b]	33.8	32.8	8.1	84.1	7.8	0.0	100.0	0.0
30-50 GT				40.0	60.0	0.0	0.0	0.0	100.0
50-100 GT				0.0	66.6	33.3	–	–	–
> 100 GT				0.0	0.0	100.0	–	–	–
Nelayan pendega Non-owning crewmen	57.3	41.8	0.9	18.7	78.3	3.0	46.6	52.1	1.3

[a]Persentasi dibulatkan dan tidak selalu berjumlah 100%.
Percentages are rounded and do not always total 100%.

[b]Data mengenai nelayan memeliki kapal motor di pantai utara pulau Jawa tidak dibedakan atas besarnya kapal.
Data regarding owners of inboard powered boats along the north coast of Java were not disaggregated by size of boat.

[c]Sumber/Source: DGF (1978b).

the agricultural sector before becoming fishermen. This finding is not surprising or unique to Indonesia. The open access nature of marine fisheries resources acts as a magnet drawing to the sea landless agricultural laborers and others who lack access to other productive resources (Bailey 1982, 1983b; Smith 1979).

There also exist in the literature, scattered references to more limited seasonal migration patterns among Indonesian fishermen, though little is known about the socioeconomic characteristics of such short-term migrants. Probably the largest group of seasonal migrants are fishermen from Madura who take part in the oil sardine fishery of the Bali Straits (Dwiponggo 1974). Seasonal migration of Javanese fishermen operating along the Sunda Straits is dictated by weather patterns (Utzurrum 1982). During the northwest monsoon, the coast of Lampung is less exposed than that of West Java, and some fishermen from Labuan and surrounding communities on Java temporarily shift their operations. During the southwest monsoon, they return to the more sheltered waters off West Java together with some fishermen from Lampung. Both groups operate as far north as Banten Bay in the Java Sea. Similar seasonal shifts in fishing operations occur along the north coast of Java. Mubyarto et al. (1984), for example, reported the seasonal presence of fishermen from East Java in the two communities they studied in Central Java.

No discussion of the migratory habits of Indonesian fishermen would be complete without mentioning two highly mobile ethnic groups, the Buginese and the Bajao. The Buginese from southern Sulawesi are noted traders and dominated inter-island trade prior to the arrival of the Portuguese and Dutch in the 16th and 17th centuries, respectively. To this day, Buginese traders in large sailing vessels continue to play a major role in transport between the islands of Sulawesi, Kalimantan and Java (Horridge 1981). They are also excellent boat builders whose skills are much in demand elsewhere in the archipelago (Nazaruddin et al. 1977). Buginese fishermen have been reported in South Sumatra Province (Collier 1980) and on the island of Lombok (GTZ 1982). In this latter area, they constitute the only group of full-time fishermen.

The Bajao are an ethnic group scattered widely throughout insular Southeast Asia. Within Indonesia, their range appears to extend from the Riau Islands to the coastal areas surrounding Kalimantan and Sulawesi, with some groups reported in the Lesser Sunda Islands. The Bajao are often referred to as "sea nomads" as traditionally they roamed scattered coral atolls and isolated coastal areas of larger islands, living aboard their small boats and occasionally erecting temporary shelters in shallow protected waters. Soegiarto and Polunin (1982) noted that many Bajao communities are no longer nomadic. Nessa (1981) reported the presence of Bajao in the South Sulawesi community he studied. It appears from his study, and from observations by this Review team in that community, that the Bajao have only limited interactions with other ethnic groups, who tend to look down upon the Bajao as socially inferior. Available evidence suggests that the Bajao regard fishing as a purely subsistence occupation, with limited involvement in marketing or other aspects of the cash economy.

Dependence on Fishing

There are a number of economic advantages to having a diversity of income sources rather than depending on fishing as a sole source of income. Indonesian fisheries typically are seasonal in nature, resulting in periods of serious underemployment among many fishermen. Especially for small-scale fishermen, occupational specialization may not provide an optimal level of material existence.

Nearly half of all Indonesian fishermen obtain at least part of their income from sources other than fishing (Table 7.4). This pattern appears to have remained relatively constant during the period of 1976-1982 for which data are available from the DGF's annual Fisheries Statistics. There is, however, considerable variation between major island groups regarding the degree of dependence on fishing. The proportion of fishermen coastal fishing villages. Where population pressure is less intense, alternative economic opportunities are more likely to exist (e.g., in agriculture) and permit a more diversified household economy.

A third factor which may explain increasing dependence on fishing is the introduction of improved boats and gear which are designed to increase effective fishing range and choice of available target species. Insofar as these developments are successful in reducing seasonal limitations in catch, they will reduce the need for secondary employment during off seasons and encourage full-time rather than part-time fishing. Moreover, the relatively large capital investment in such new fishing units compared with pre-existing boats and gear also will favor occupational specialization. Those fishermen who invest in new boats and gear tie up a large proportion of their financial resources, which are no longer available for other economic activities.

The relationship between investment level and dependence upon fisheries varies from place to place. Almost all (82%) boat owners along the Malacca Straits rely exclusively on fishing as their sole source of income (Table 7.5). The only exceptions to this pattern are owners of dugouts (many of whom appear to be peripherally involved in fishing as a minor part-time occupation) and owners of outboard powered boats (all of whom earn a majority of their income from fishing).

Along the west coast of South Sulawesi Province, there is no clear correlation between size or type of boat and degree of dependence upon fishing (Table 7.5). Within this area, only 22% of all owners obtain their entire income from fishing, with the highest proportion reported among owners of outboard powered boats (68%), followed by inboard powered boats of the 5-10 GT class (55%) and boats dug out from large logs (49%). In this area, many dugout boats have been modified through the addition of plank sidings and in this form resemble in size and probable investment costs large non-powered plank built boats (DGF 1978b). Insofar as this is true, the positive correlation between investment cost and dependence on fishing appears to hold, at least for the small-scale subsector. (Medium-scale fisheries in South Sulawesi are relatively insignificant and as such not easily comparable to those of the Malacca Straits .)

The fishing grounds within which small-scale fishermen from these two areas operate differ in important respects. Broadly speaking, conditions along the Malacca Straits are far more uniform than is the case along the Makassar Straits. Fishing grounds of the Malacca Straits are sheltered from the northwest and southeast monsoons while the Makassar Straits are more exposed, particularly during the northwest monsoon. In the Malacca Straits, demersal fisheries are dominant, encouraged by a uniformly shallow soft bottom. The fisheries of the Makassar Straits are more dependent upon migratory pelagic species in deepwater fishing grounds, although there also are extensive areas of coral reef and a narrow continental shelf along this coast.

This greater diversity of fishing grounds and climate conditions in the Makassar Straits places a premium on mobility, especially for exploiting such locally important pelagic species as the flying fish (Cypsilurus poecilopterus), which are caught at a considerable distance from shore. Under such conditions, the use of outboard powered boats allows fishermen to take advantage of seasonal variations and exploit a wider range of fishing grounds than those fishermen who rely on non-powered boats. This attribute has not been missed by local fishermen, and the number of boats powered by outboard engines increased threefold between 1975 and 1979, and then doubled again (to over 7,000) between 1979 and 1983 (DGF 1977, 1981a, 1985) in large part through private investment rather than due to government loan programs (Nessa 1981; see also Chapter 4). Data from the 1977 Socioeconomic Survey show that a wider range of gear types is used in conjunction with outboard powered boats along the Makassar Straits than the Malacca Straits (DGF 1978b).

The degree of dependence upon fishing by boat owners along the north coast of Java is lower than that in the Malacca Straits but much higher than along the Makassar Straits (Table 7.4). Data from DGF's 1980 Socioeconomic Survey (Table 7.6) tend to support the hypothesis that level of investment is positively correlated with dependence on fishing as a source of income. Owners of inboard powered boats had the highest levels of total

Tabel 7.6. Persentasi ketergantungannya nelayan pemilik dan nelayan pendega di pantai utara puleu Jawa atas usaha perikanan laut, menurut jenis perahu/kapal, 1980.[a]
Table 7.6. Percentage of owners and crewmen from the north coast of Java and extent of dependence upon marine fishing, by type of boat, 1980.[a]

Jenis perahu/kapal Type of boat	Penuh Full-time	Sambilan utama Part-time (major)	Sambilan tambahan Part-time (minor)
Tanpa perahu/Without boat	18.2	40.3	41.5
Perahu tanpa motor/Non-powered boat			
Jukung/Dugout	44.9	39.2	15.9
Kecil/Small	43.9	43.4	12.7
Sedang/Medium	54.6	41.7	3.7
Besar/Large	56.8	43.0	0.2
Perahu motor tempel/Outboard	34.2	49.3	16.5
Kapal motor dalam/Inboard	65.1	22.0	12.9
Nelayan pendega/Non-owning crewmen	48.8	41.4	9.8

[a]Sumber/Source: DGF (1982e).

in the Malacca Straits and comparable to the need faced by those from the Makassar Straits. However, fewer alternatives are available to Javanese fishermen than to those in South Sulawesi, for reasons discussed above.

Differences in level of dependence upon fishing among owners between the Malacca and Makassar Straits and the north coast of Java are paralleled by similar differences among non-owning crewmen, though it is not possible to disaggregate crewmen by type of boat on which they are employed (Tables 7.5 and 7.6). Along the Malacca Straits, 80% of all crewmen were reported to depend entirely on fishing for their income compared to 49% from the north coast of Java and only 5% of all crewmen from the Makassar Straits. Fishing as a source of income for crewmen in the latter area is, nonetheless, important, as fully 80% of all crewmen from the Makassar Straits reported the majority of their income being derived from fishing, compared to 14% who claim less than half of their income from this activity.

Economic advantages of diverse income sources

Maintaining a diversity of economic pursuits may be crucial to the long-term economic survival of many small-scale fishing households and communities. Fishing is an inherently risky occupation, both physically and economically, and where stocks are heavily exploited or where marketing problems exist, fishing provides a particularly precarious livelihood. Under such circumstances, economic rationality encourages diversification rather than specialization as a means of flattening out fluctuations in income and reducing seasonal underemployment.

One of the more important findings of the DGF's 1975 and 1977 Socioeconomic Surveys was that full-time fishermen -- both owners and non-owning crewmen -- had lower household incomes than part-time fishermen. The 1977 Survey indicates that, with few exceptions, those full-time owner-operators along the Malacca and Makassar Straits who relied entirely on fishing had lower household incomes than those in the category part the relative difficulty in obtaining access to land or employment in the agricultural sector in coastal Javanese communities.

Fishing conditions along the Makassar Straits are more diverse than those found in the Malacca Straits or off the north coast of Java, resulting in a wider range of boat and gear combinations. Under such circumstances, a fisherman who during one season acts as owner-operator may seek employment as a crewman on a fishing unit owned by another during a particular season. Table 7.8 substantiates this observation. Nearly 10% of all owners report that their primary source of household income comes from employment as crewmen, not as owners of their own boats. Less than 2% from the Malacca Straits and the north coast of Java report work as crewmen to be their primary source of household income.

These data probably underrepresent the extent to which owners of fishing units also work as crewmen on boats owned by other fishermen. The data in Table 7.8 reflect only those owners whose primary source of income is from employment as crewmen. The proportion of owners who earn secondary incomes as crewmen is likely to be even higher.

Similarly, data from Table 7.8 probably underrepresent the importance of non-fishing income as they report only primary source (i.e., the largest single source for a given

Tabel 7.7. Rata-rata pendapatan per rumah tangga nelayan pemilik dan nelayan pendega menurut jenis perahu/kapal dan ketergantungannya pada usaha perikanan laut di Selat Malaka dan Selat Makassar, 1977, rupiah x 1,000.[a]
Table 7.7. Average household income among owners and crewmen by type of fishing boat and degree of dependence upon marine fisheries in the Malacca Straits and Makassar Straits, 1977, in rupiah x 1,000.[a]

Jenis perahu/kapal	Selat Malaka/Malacca Straits				Selat Makassar/Makassar Straits			
	Rata-rata	Penuh	Sambilan utama	Sambilan tambahan	Rata-rata	Penuh	Sambilan utama	Sambilan tambahan
Type of boat	Average	Full-time	Part-time (major)	Part-time (minor)	Average	Full-time	Part-time (major)	Part-time (minor)
Rata-rata semua perahu/kapal Average of all types of boat	299	288	354	312	247	232	258	196
Tanpa perahu/Without boat	128	125	160	–	112	108	106	149
Perahu tanpa motor Non-powered boat								
Jukung/Dugout	290	203	–	426	154	141	167	165
Kecil/Small	185	166	269	226	212	182	222	208
Sedang/Medium	264	246	413	333	342	377	333	284
Besar/Large	182	97	693	–	538	457	565	370
Perahu motor tempel/Outboard	278	276	281	–	705	747	588	920
Kapal motor Inboard powered boat								
<5 GT	561	578	519	281	1,076	905	1,118	902
5-10 GT	1,304	1,345	1,134	512	1,990	2,606	758	–
10-20 GT	2,464	2,478	1,942	–	3,409	8,179	1,056	944
20-30 GT	3,788	3,788	–	–	1,028	–	1,028	–
30-50 GT	1,660	1,660	–	–	9,333	–	9,333	–
50-100 GT	12,808	12,808	–	–	–	–	–	–
> 100 GT	61,725	61,725	–	–	–	–	–	–
Nelayan pendega Non-owning crewmen	187	175	191	437	106	93	105	118

[a]Sumber/Source: DGF (1978b).

Boat ownership

Table 7.9 presents data on numbers of fishing boats, and of ownership units and average numbers of boats owned by fishing establishments for different categories of boats. Medium- and large-scale fishing boats and establishments are necessarily lumped together as it is not possible to differentiate between these subsectors on the basis of boat type (Chapter 3). From Table 7.9, it appears that ownership of boats is widely distributed rather than concentrated -- an average of 1.1 boats per fishing establishment -- with slightly more concentration in ownership in the medium- and large-scale subsectors than in the small-scale subsector.

Tabel 7.9. Jumlah perahu/kapal perikanan laut, jumlah rumah tangga/perusahaan perikanan laut, dan rata-rata nombor perahu/kapal per rumah tangga/perusahaan, menurut sub-sektor dan jenis perahu/kapal, 1982.[a]
Table 7.9. Number of fishing boats, number of fishing establishments and average number of fishing boats per establishment, by subsector and type of fishing boat, 1982.[a]

Subsektor Subsector	Jenis perahu/kapal Type of boat	Jumlah perahu/kapal Number of boats	Jumlah rumah tangga/perusahaan[b] Number of establishments[b]	Rata-rata nombor perahu/kapal per rumah tangga/perusahaan Average number of boats per establishment
Jumlah/Total		300,549	276,908	1.09
Skala kecil Small-scale	Tanpa motor (jumlah) Without engine (total)	215,466	198,711	1.08
	Jukung/Dugout	102,454	90,293	1.13
	Kecil/Small	70,683	67,268	1.05
	Sedang/Medium	36,096	34,969	1.03
	Besar/Large	6,263	6,181	1.01
	Perahu motor tempel Boat with outboard engine	55,265	51,797	1.07
Skala sedang/besar Medium-/large-scale	Subtotal	29,818	26,400	1.13
	< 5 GT	22,265	18,142	1.23
	5-10 GT	4,584	5,961	0.77
	10-20 GT	1,610	1,107	1.45
	20-30 GT	1,023	852	1.20
	30-50 GT	180	182	0.99
	50-100 GT	28	99	0.28
	100-200 GT	82	43	1.91
	> 200 GT	46	14	3.29

[a]Sumber/Source: DGF (1984).
[b]Jumlah semua rumah tangga/perusahaan perikanan 304,752, akan tetapi sebanyak 27,844 tidak mengunakan perahu/kapal. The total of all fishing establishments is 304,752, but 27,844 of these do not operate fishing boats.

Gear ownership

In 1982, the DGF reported over 404,000 active fishing gear owned by nearly 305,000 fishing establishments, including 28,000 establishments which fish without the use of boats (DGF 1984). (Most fishing establishments without boats probably are part-time

This complexity is heightened by the role which fish buyers or other financiers play in mobilizing investment credit. Many fishermen identified by the DGF as owners may control daily fishing activities but not the financial resources either for investment or operating capital. In some communities, these buyers or their representatives exert considerable control over the local fishing community (Lewangka 1977; Nessa 1981; Utzurrum 1982). These relationships are not necessarily exploitative (see below), but the degree of control exerted by financiers often blurs the distinction between owners and fishermen who operate the boats of others. There have been a number of reports of fish buyers or other financiers who effectively control 10 or more fishing units in Sumatra (Collier 1980), South Sulawesi (Nessa 1981) and Java (Utzurrum 1982). It is not likely that such concentrated control over fishing units, widespread throughout Indonesia, is reflected in the DGF's data on ownership patterns.

The issue of ownership is further confused by kinship relationships between active fishermen and those who own boats and gear but do not take an active role in fishing activities. The family histories documented by Mubyarto et al. (1982) along the north coast of Central Java provide valuable insights regarding inter-generational relationships within fishing communities.

Typically, a young man begins his career as a crewman, working either with his father or another owner within his community. His wife, and later his children as they grow older, become involved in various shore-based activities related to fishing, including processing the catch or in small-scale retailing. As the family accumulates capital and as the man gains experience in fishing, they may purchase a used fishing unit and become owner-operators. With skill, luck and frugality, this family may be able to purchase a new fishing unit and over time they may come to own several boats. As the sons grow up, they are likely to find employment on their father's boat or boats. The father, as he grows older, may cease active fishing and concentrate on shore-based activities. His sons gradually take control of daily fishing operations with the father earning a share of the proceeds of the catch as owner. Under such circumstances, the share taken by the father may not follow the standard sharing system prevailing in that community. His sons will have young families with children in school, and will have greater needs than the father and mother alone. The actual distribution of shares is likely to reflect these differential needs.

The study by Mubyarto et al. (1982) provides a detailed account of the rise and fall of family fortunes. There appears to be a high degree of vertical mobility among fishing households which is related to the constant depreciation of boats and gear and the need for constant reinvestment. Several family histories are presented describing how through frugality and hard work, a poor family achieved ownership of half a dozen or more fishing units. The reverse also is true: other families beset by difficulties, particularly ill health, forced to sell off boats and other assets. Descendants of local families, which at one time were among the local economic elite, are now among the community's poor while other households have dramatically improved their economic position.

Sharing Systems

The examination of sharing systems provides valuable insights into social and economic relationships within fishing communities. The manner in which the proceeds from the sale of the catch are distributed among owners and non-owning crewmen reflects the respective value placed on capital and labor as factors of production. However, sharing systems are based on more than economic calculations.

Diversity of sharing systems

Within the small-scale subsector, there is considerable variation in sharing systems. Aminah and Widjayanti (1980) studied a fishing community in Muncar, East Java and cash values shown in Fig. 7.1 are based on the study of Mallawa (1982) in Labuan, West Java. In this case, the owner does not take part in fishing and the captain receives an additional half share.

On larger boats equipped with gear that are more labor intensive, such as payang seines and purse seines, there is a greater degree of functional specialization among crewmen, and this is reflected in the sharing system. Nonetheless, the manner in which the proceeds of the catch are distributed is conceptually simple, as shown in Fig. 7.2. This example illustrates the sharing system of payang seines in Labuan (also based on Mallawa 1982). In this case, there are 13 fishermen each with specified responsibilities but only two receive more than one share due to the special importance of their tasks.

In other areas, the sharing system is more complex, and crewmen obtain a different number of shares depending on their tasks. One example of a sharing system used for a payang seine reported by Aminah and Widjayanti (1980) is shown in Fig. 7.3. (These authors did not provide costs-and-earnings data, making it impossible to impute cash value for the various shares received.) In comparing Fig. 7.2 and 7.3, it is obvious that the system used in Muncar is more complex. Another major difference is in the proportion of net receipts which accrue to the owner (46% in Labuan and 59% in Muncar). The main difference in these two cases is that in Muncar, the owner obtains a separate share for the boat and gear to cover costs of depreciation.

Nessa (1981) reported two different sharing systems used for payang seines in South Sulawesi depending upon whether a fish attraction device, rompon (similar to the Philippine payao), is used. The sharing system used for payang seines which use this attracting device is illustrated in Fig. 7.4. In this case, separate shares are given to the owner of boat, engine, net and rompon; the latter typically is owned by the fish buyer/financier, who also earns a single share as a return on his loan. The only other major difference is that, according to Nessa, the boat captain and the individual crewmen each receive equal shares, with no additional share given to the captain.

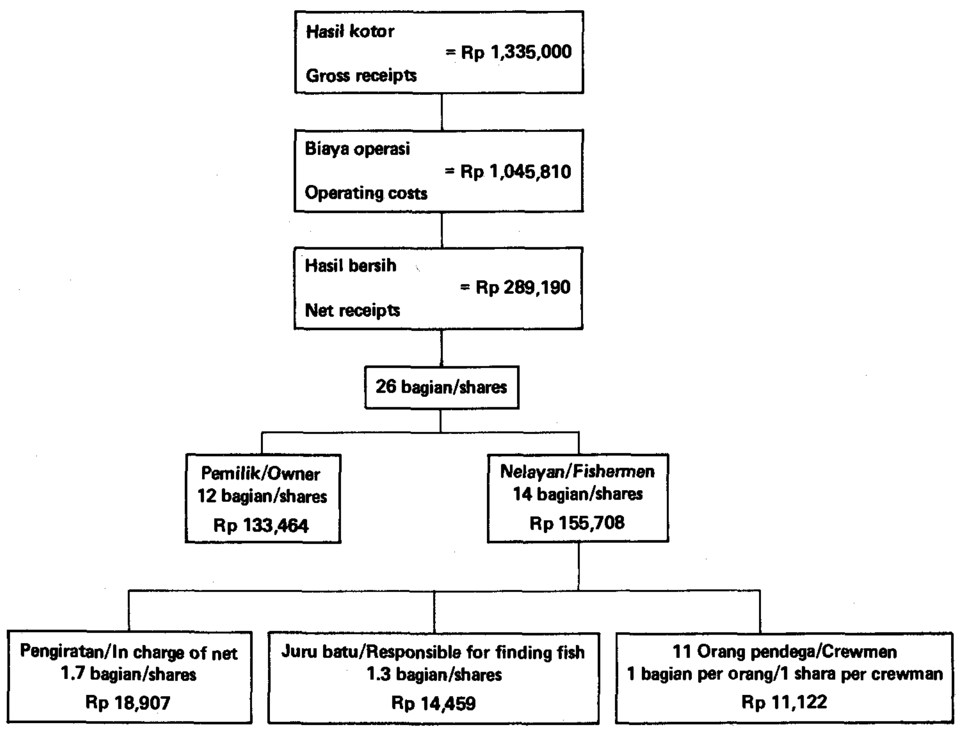

Fig. 7.2. Sharing system and average monthly income of owners and fishermen operating *payang* seines in Labuan, West Java, 1981. (Source: Mallawa 1982).

Structural determinants of diversity

The existence of diversity in sharing systems is well-documented in the available literature, but to date there have been no comparative studies which seek to explain the source or sources of this variation. Differences within individual fishing communities probably are attributable to such personal factors as kinship and are explainable as such, but differences between communities and regions may be traceable to such structural variables as the relative availability of labor and capital in a particular case.

Within the Indonesian economy as a whole, and certainly within the small-scale fisheries subsector, labor is in abundant supply relative to capital. The limited alternative occupational opportunities available to fishermen in coastal communities tend to depress the opportunity cost of labor. Under such circumstances, non-owning crewmen find themselves in a weak bargaining position relative to those who control scarce capital resources, i.e., the owners of fishing boats and gear. However, as with any broad generalization, there are variations in the degree to which this is so, as is illustrated in the following comparison of payang seine sharing systems in Muncar, Labuan and Tanete Riattang.

Among these three communities, it is obvious that fishing unit owners in Muncar earn a higher proportion of net receipts than do those from Labuan and Tanete Riattang (Fig. 7.2, 7.3 and 7.4). As a working hypothesis based on existing studies and visits to each of these three communities, it can be argued that the opportunity cost of labor in Muncar is well below that in Labuan and Tanete Riattang, and that this is a key factor in determining differences in sharing systems among these three areas. There are no data available which directly measure opportunity costs in these three communities, but significant differences in labor supply and economic alternatives to fishing provide evidence to support this working hypothesis.

Payang seine fishing in Muncar is highly seasonal with the primary target species being the oil sardine which enters the Bali Straits between the months of September and March. During this season, several thousand fishermen from the relatively poor island of Madura and elsewhere in East Java swell the ranks of local fishermen. Prior to 1974, payang seines dominated oil sardine production (Dwiponggo 1974; Emmerson 1975) but have since been surpassed by the more efficient purse seines which employ fewer crewmen per fishing unit (Emmerson 1975). Emmerson (1980) noted that between 1974 and 1977, average incomes quadrupled for some 600 households whose fishermen were fortunate enough to find employment on purse seines, but for thousands of other households, real income after inflation actually declined. Under such circumstances, there is considerable competition among fishermen to obtain a place on a fishing boat, and owners have no difficulty in obtaining an adequate crew. Limited opportunities in agriculture or in other sectors of the East Javan economy further weaken the bargaining position of crewmen.

Conditions in Labuan and Tanete Riattang differ markedly from those in Muncar. In both areas, fisheries resources appear capable of absorbing increasing fishing effort (Nessa 1981; Utzurrum 1982; see also Chapter 2). The existence of competition among owners for adequate labor in Tanete Riattang was noted by Nessa (1981), who observed that owners of stationary liftnets found it necessary to adjust the sharing system to attract crewmen. In Labuan, local boat owners and financiers have actively encouraged fishermen and even non-fishermen to migrate to that area on a permanent basis due at least in part to the recent and rapid increase in numbers of fishing units financed through government credit programs. Between 1979 and 1981, the number of fishing units in Labuan increased (from 220 to 430) and the number of fishermen grew by nearly 1,000 (from 1,465 to 2,406) (Utzurrum 1982).

In contrast with Muncar where labor is abundant, in Tanete Riattang and Labuan, there is some degree of competition among owners to attract crewmen. This may explain the higher proportion of net receipts allotted to crew in those two years. Moreover, there appears to be a wider range of alternative economic opportunities available to fishermen the majority of Indonesian small-scale fishermen readily adopted nylon netting due to the clear advantages of synthetic materials over natural fibers. The rapid increase in the use of outboard motors also suggest innovative behavior. Only a small proportion of those fishermen now using motorized boats have been the beneficiaries of government loan programs (Chapter 4). The majority of those adopting this innovation have mobilized their own resources (either personal savings or loans from local financiers) for investment in a technology which offered clear benefits. New gear types such as trammel nets and small purse seines also have been readily adopted by small-scale fishermen in Indonesia. Studies elsewhere in Southeast Asia indicate similar adaptive behavior among small-scale fishermen in Malaysia (Bailey 1983b; Firth 1966) and the Philippines (Spoehr 1980).

This is not to gainsay the need for appropriately devised training programs and extension services. However, these programs need to be designed based on an accurate understanding of the problems which need to be addressed. The common perception that small-scale fishermen are bound by tradition and are irrational and unwilling to accept positive change does not reflect reality and hinders effective communication between government officers who would act as change agents and the group of people they are trying to help (Bailey 1983a).

Resource management

Sustainable small-scale fisheries development cannot be divorced from policies of resource management and allocation. Indonesian policymakers have made clear their understanding of the need for balance between development and management, and have made courageous decisions affecting the allocation of access to resources among competing users. The government's imposition of a ban on virtually all trawling outside of the Arafura Sea is an action without parallel among tropical developing countries. While legitimate concern exists regarding the potential for over-exploitation of coastal resources by large numbers of small-scale fishermen, especially off the north coast of Java, the trawler ban had a positive effect on employment and income distribution within the fisheries sector.

Efforts to encourage increased exploitation of fishing grounds in the eastern half of the archipelago depend on establishing a market for the catch (see Chapter 6). Available evidence suggests that abundant stocks of small pelagic species are present in these waters and that these species would find ready consumer acceptance on Java as a salted sundried product (Bailey et al. 1985). The key problem is forging this link between centers of supply and demand. A central issue is the control of the Java market by a small syndicate who may feel their position threatened by sudden increases in supply from areas outside their control.

Marketing and credit programs

Most of the government's development energies have been devoted to marketing and credit programs which include elements of technical training and other extension services (Chapter 4). These development activities involve establishment of village unit cooperatives (Koperasi Unit Desa or KUD) and fish auction halls (Tempat Pelelangan Ikan or TPI).

The staff of both the KUD and the TPI are government personnel, and their responsibilities include organizing fishermen within these related institutions and providing extension and training services. Extension and training activities by officers of provincial Fisheries Services also use KUDs and TPIs as focal points. The funds for credit programs come from government banks, notably the Bank Rakyat Indonesia (BRI). These funds generally are disbursed to KUD members upon recommendation of the KUD's staff. Loans are repaid from the proceeds of the catch auctioned at the TPI.

catch or if requests for additional loans (e.g., for consumption purposes) are not granted. In the competitive atmosphere among buyers in Muncar, fishermen can easily shift from one buyer to another, and buyers seek to maintain the loyalty of their suppliers by providing loans which formalize their relationship with successful fishermen. The bonds of debt in this situation are not restrictive and serve the interests of both parties. Buyers are assured of a constant supply of fish for marketing, and fishermen are assured of a marketing outlet for their catch. Fishermen also enjoy a reliable source of credit for investment and operational expenses as well as loans for household consumption.

Muncar is one of the largest fishing communities in Indonesia, and competition between buyers to establish permanent working relationships with fishermen in this community may not hold elsewhere. In small coastal fishing communities where only one or a few buyers exist, these may exert monopolistic or monopsonistic control over marketing. Even under these circumstances, however, social pressures within the community may serve to limit the power of middlemen.

Unfortunately, insufficient information exists to determine whether, or under what circumstance, middlemen earn excessively large profits from their twin roles as financiers and buyers. To calculate profit margins, it would be necessary to obtain information on the size of outstanding debts, including credit provided for investment, operational costs and personal needs. An opportunity cost of this capital can then be assigned, perhaps using interest rates in a bank savings account (which would be at least 12%).

As an illustrative example, consider the case of a fisherman using a scad gill net in South Sulawesi. Average investment costs for a fishing unit using this type of gear are Rp 630,000 (Nessa 1981; see Table 5.6). Using 12% as opportunity cost for capital, a middleman who covered the entire investment cost of this fishing unit would need to obtain Rp 75,600/year to equal his earnings from a savings account. Average annual gross receipts for this gear were Rp 1,316,000 (Nessa 1981; see Table 5.7). If this represented the price paid to fishermen after 10% of the market price has been deducted by the buyer, the buyer's margin from this deduction would be approximately Rp 146,000 (Rp 146,000 + Rp 1,316,000 = Rp 1,462,000 x .90 = Rp 1,315,800). This indicates a return to capital invested of 23%, a higher rate than that earned at a bank. However, when the risks inherent in fishing are considered, this does not represent an unreasonable return to investment.

Such simple calculations, however, do not take into account the possibility that the fisherman may have provided part of the investment himself (e.g., the boat) and borrowed only part of the total capital costs for this fishing unit. Neither do they take into account repayments to the principal of the outstanding debt made during the course of the year, or the possibility of additional debts incurred due to poor fishing or personal emergencies. Obviously, the rate of return to a buyer's invested capital would increase as the amount of debt decreased. On the other hand, the amount of outstanding indebtedness may increase over time due to loans to replace a worn-out net, engine repairs or personal consumption needs.

There is virtually no information available on the extent of indebtedness and repayment history. These matters are important in their own right, and critical to understanding the nature of the relationship between middleman and fisherman.

The majority of small-scale fishermen rely on local middlemen for loans and are likely to continue to do so. Between 1974 and 1981 in East Java Province, only 1,348 fishermen received KIK loans (Hotta 1982), compared with a total of nearly 179,000 fishermen reported in that Province in 1981 (DGF 1983a). The availability of official credit through the Pola BIMAS program, introduced as a result of Presidential Decree No. 39 in 1980, increased the amount of loan funds available to small-scale fishermen by Rp 22 billion (Hotta 1982). Average loans per recipient under this program are approximately Rp 2 million, indicating that 11,000 fishermen may have benefitted from this program. This is a substantial number but a small proportion of all possible beneficiaries. Hotta (1982) notes that in Demak (East Java), more than 1,400 applications were received for Pola BIMAS loans. Because of funding limitations, only 250 applications were approved.

The greater flexiblity of local middlemen compared with government agencies in providing loans also is true in loan repayment. As noted above, fishermen with loans from middlemen make payments on the outstanding principal only when the value of their catch is high. In contrast, loan repayments under official credit programs are less flexible. Recipients of government loans are required to sell their catch at a TPI where a fixed percentage of the gross value (typically 15%) is withheld for loan repayment. In addition to this, auction fees of between 5% and 10% are charged at the TPI to cover administrative costs, enforced savings and revenue for local governments. Auction fees and loan repayments combined total 20-25% of the gross earnings. One result of this is the undocumented but widely reported practice of fishermen with government loans selling part or all of their catch at sea or at landing places other than the TPI. This frustrates efforts to obtain loan repayments and undermines the reliability of landings data recorded at the TPI (Wilimovsky 1978). Fishermen with loans from local middlemen are less likely to seek alternative marketing outlets for their catch due to their greater flexibility in repayments; the desire of fishermen to maintain a good relationship with their buyers; and the local knowledge and contacts which middlemen have developed in their own particular areas.

It is important to note that small-scale fisheries development efforts to date have focused primarily on major centers of fishing activity. KUDs and TPIs tend to be established in larger fishing communities where they can benefit greater numbers of fishermen than could be served were such organizations to be established in smaller communities. However, as government credit programs tend to be distributed through KUDs, and repayments obtained through TPIs, the absence of these organizations means that government development programs have little impact on small or isolated fishing communities.

Conclusion

Despite the recent increase in research activity, there remain a number of critical gaps in our knowlege of small-scale fishing communities. These gaps include inadequate descriptive data on basic characteristics of the fishing population and inadequate understanding of relationships between owners and crewmen and between fishermen and middlemen.

Most of the existing socioeconomic research on small-scale fisheries in Indonesia are narrowly focused on particular issues defined by the government agencies that commission such studies. This problem-oriented research strategy has the advantage of addressing specific issues of interest to policymakers, but often leads to such narrowly defined research designs that key variables and relationships are not examined. The problem of narrow focus is exacerbated by the short time frame allotted to such research projects, which limit researchers to the use of quick survey methodologies that provide quantitative data but little qualitative understanding of community dynamics or relationships between people involved in the small-scale subsector.

There is a pressing need for basic ethnographic research on fishing communities in Indonesia. The study by Mubyarto et al. (1984) is virtually the only study of this type. There also is a need for more focused research examining the social relations of production and marketing in Indonesia's fisheries sector. Given the great effort being expended to sever the ties linking fishermen and buyers, it is surprising that no detailed examination of the nature of this relationship has been conducted.

technological factors as they determine the pace and direction of change. Both social and biological scientists have roles to play in assisting policymakers, but they will be most effective if they coordinate their efforts.

Resources

The DGF estimates that total maximum sustainable yield (MSY) for all marine resources within Indonesia's jurisdiction to be approximately 6.5 million tonnes (t) per year, including both territorial waters and the Exclusive Economic Zone. In 1983, total marine fisheries catch was just under 1.7 million t, approximately 26% of this estimate.

It would be simplistic, however, to assume that production can be more than trebled over existing levels. The data upon which total MSY has been calculated are of uneven quality and may overstate sustainable yields. Easily exploitable resources close to major populaton centers (and hence markets) tend to be under heavy fishing pressure and offer little scope for increased landings . Areas where potential for increased production exists generally are located in deep offshore waters and/or at great distance from established fishing ports and marketing outlets.

Three issues requiring further study are raised by the foregoing: the adequacy of existing stock assessment data and the accuracy of estimated MSY; how fishing effort in heavily exploited waters might be managed on a sustainable basis; and if the expansion of fishing effort into offshore waters is economically viable.

Stock assessment

Estimates of MSY presented in this Review are based on a number of different sources with varying degrees of reliability. The most accurate data available are derived from demersal stock assessment surveys of the Java Sea and the Malacca Straits which show that these resources are fully exploited . The pelagic oil sardine fishery of the Bali Straits also has attracted considerable research and in this geographically limited area, it has been possible to establish catch-per-unit-effort (CPUE) data indicating that this fishery is fully exploited if not depleted (Sujastani 1982).

Beyond these particular resources, available information for stock assessment purposes largely depends on comparisons between landings data and indirect estimates of expected yields, which in turn are based on primary production, extrapolations from yields obtained in similar tropical fishing grounds or the results of exploratory fishing surveys. The problem of inadequate data is particularly serious regarding pelagic resources. Many estimates of demersal resources, particularly in deeper waters, also lack a firm database.

Past stock assessment research efforts have focused on areas where levels of fishing effort have raised concerns regarding resources depletion. Research to monitor these fishing grounds clearly must continue. Given limited numbers of research vessels and staff trained in stock assessment methods, it will not be possible to assess the status of fishery resources in more than a few additional areas. The decision on where to concentrate effort should focus on areas which have been identified for special development emphasis in order to monitor the impact on stocks of increased fishing effort.

Stock assessment is but one of many informational needs pertaining to marine fisheries in Indonesia. To make more efficient use of staff and funds, data collection activities should serve a cross-disciplinary spectrum of needs. For example, location-specific information on the impact of fishing effort on stock abundance can be collected together with data on costs and earnings of particular types of fishing units. This coordination of efforts between economists and marine biologists offers clear and mutual advantages. In such a combined effort, researchers can provide development planners with the information necessary to estimate levels of fishing effort which will ensure both profitable operations and resource sustainability.

and food to support extended fishing trips. Profitable exploitation of fishing grounds at great distance from established ports may require purse seiners of the 300-600 GT class. The economic viability of these larger units, however, is not well-established, though there are several such units operating within Indonesia. The regular sighting of illegal foreign fishing vessels, especially in the Banda Sea, suggests that the potential for profitable fishing operations in this area exists, but actual economic performance will need to be monitored by the analysis of costs-and-earnings data.

Supply and Demand

Per capita fish consumption on Java is approximately 6 kg/yr. Elsewhere in Indonesia, per capita consumption of fish is three times or more that on Java. Dietary preferences do not explain differences of this magnitude. Java represents a major market with substantial unmet demand. Providing an adequate supply of fish to the 100 million people living on that island will not be an easy task. Meeting this challenge not only would have a significant impact on the nutritional status of many Javanese, especially the poor, but it also represents a major opportunity to establish a marketing outlet for the catch of fishermen from the eastern half of the archipelago.

Limited local marketing opportunities and the absence of reliable alternative outlets have been prime factors in discouraging increased fishing effort in many areas outside Java. Efforts to increase fish supply on Java will depend on establishing efficient marketing and distribution channels to bring fish from areas of abundant supply to Java.

State fisheries enterprises, particularly P. T. Tirta Raya Mina (the main function of which is fish marketing), have the potential to play a major rôle in the rationalizing of the current imbalance between supply and demand. To date, however, much of the basic infrastructure (ice plants, cold stores, carrier boats, port facilities and distribution channels in the form of a "cold chain" from port to retail outlet) is not yet in place. Moreover, the experience of P. T. Tirta Raya Mina indicates that there are other problems besides lack of infrastructure which act as constraints in the efficient distribution of fish to Java from elsewhere in the archipelago. These include consumer reluctance to accept frozen fish, preference for some species (e.g., small pelagics) rather than others (e.g., skipjack tuna) and problems in wholesale and retail distribution.

The problem of consumer preference will be overcome through experience and product promotion. The more difficult constraint to overcome is the lack of an established distribution channel. The nature of relationships among fishermen, local buyers, wholesale dealers and retail fish sellers has not been adequately examined. It is commonly said that a small group of wholesalers control fish marketing on Java, but no studies have been conducted on this important issue. Neither are there studies available on wholesale or retail price fluctuations, or the credit needs of local retailers.

Incomes and Standards of Living

The third major goal of fisheries development programs in Indonesia is the raising of incomes and standards of living among fishermen, especially those within the small-scale subsector. The government has allocated large sums of money for credit programs to increase productivity per unit and hence incomes of individual fishermen. Through the provision of such loans and the creation of alternative marketing channels associated with KUDs and TPIs, it is hoped that the present dependence of small-scale fishermen upon middlemen who act both as financiers and buyers of fish will be reduced.

These development programs represent a systematic attempt to transform the economic basis of small-scale fishing. As in any major process of change, some individuals and groups are likely to benefit more than the others. By examining the progress of these programs, researchers could contribute to a sharpening of program focus coast of Sumatra) there are local universities which are actively involved in fisheries-related research. These universities might be commissioned to conduct costs-and-earnings studies, with collection of data in the field conducted by students who could use the data to meet their own degree requirements. No student is likely to spend an entire year on such research but it might prove possible to schedule field research of several students in one community during the course of a single year.

These students would work under the supervision of a faculty member who would be responsible for the preparation of a final report. This approach would provide support for students' field research and allow a more systematic approach to the collection of costs-and-earnings data. These data also would provide a basis for further research on other aspects of fisheries development in the sample communities by the universities involved.

Costs-and-earnings data are of fundamental importance to understanding fishing as an economic activity. They provide a basis for measuring incomes of owners and crewmen, and can contribute to more rational implementation of fisheries development programs. Such data also would provide understanding of important socioeconomic relationships which exist between fishermen and the buyers of their catch.

The collection of reliable costs-and-earnings data, despite the difficulties involved, should be given a high priority in future research efforts. As noted above, the study of costs and earnings can be combined with the collection of catch-and-effort data for stock assessment purposes. Such collaboration between economists and marine biologists would reduce the costs of data acquisition and help clarify the relationship between availability and economic exploitation of fisheries resources.

Consequences of development

Little is known about the impact of development on small-scale fishing communities. The Indonesian government has initiated systematic efforts to promote changes (e.g., credit, technological innovation, new marketing channels) which are bound to have a profound impact on small-scale fishing communities. It is important to evaluate the consequences of such changes as they affect various groups both to measure program successes and to predict and thus minimize the likelihood that the benefits of development will negatively affect some groups.

It is, for example, obvious that government loan programs cannot serve all possible recipients. Neither will it be possible for every fisherman to gain access to motorized boats or improved fishing gear either through credit programs or personal savings. Certain dislocations also might be involved if established marketing relationships, which include informal credit ties, are changed by the introduction of a government-sponsored auctioning system operated by local KUDs.

In reviewing fisheries development programs (Chapter 4) and the implementation of these programs in small-scale fishing communities (Chapter 7), it is clear that the benefits of development are unequally shared. In areas where the available resource is heavily exploited, the introduction of improved fishing technologies may negatively affect non-adopters. Competition for a limited resource may occur both among small-scale fishermen and between small-scale fishermen and those in the medium-scale subsector. Within the small-scale subsector itself, competition between fishermen using motorized and non-motorized boats is an issue of growing importance. Available evidence indicates considerable variation in fishermen's incomes even within a single community. Will encouraging the use of motorized boats and more effective fishing gear increase these inequalities?

National development policies call for equitable distribution of economic opportunity for all Indonesians. In view of this, and in an effort to spread the benefits of fisheries development programs as widely as possible, government credit programs for the construction of new fishing units are being modified to promote joint ownership. The pressing need for expanded research effort by social scientists to describe and analyze the social context in which fisheries development programs operate to provide guidance to policymakers.

Research Priorities for the Future

A recommended research agenda for Indonesia's marine fisheries sector may be summarized as follows:

1. In the field of stock assessment, research priorities include:

   * More adequate assessment of pelagic stocks generally, and specifically in areas where expanded fishing effort is likely to occur.
   * More adequate assessment of coastal fisheries resources exploitable by small-scale fishermen, with particular emphasis given to areas where these resources are under heavy fishing pressure and where development programs aimed at improving small-scale boats and gear are being given special emphasis.

2. Research priorities in fisheries economics include:

   * The collection and analysis of costs-and-earnings data.
   * The study of marketing and distribution channels generally and analysis of the feasibility of increasing the supply of fish to Javanese consumers through inter-island trade.

3. In the broad field of socioeconomics, research priorities include:

   * The study of the consequences of development and change within the small-scale subsector.
   * Broad studies on the social relations of production and marketing.

For a developing nation such as Indonesia, research efforts need to be linked directly to development programs. Given manpower and funding limitations, it is necessary to establish priorities to ensure that research is directed to the informational needs of policymakers. The short list of research priorities proposed above by no means covers the range of possible topics that might usefully be addressed. It does, however, include issues which are directly related to fisheries management and development programs.

Many of these research issues should be addressed by teams of researchers representing more than one discipline. At present, there is a tendency for marine biologists and social scientists interested in marine fisheries to work in isolation. Neither fish nor fisherman recognize disciplinary distinctions. More to the point, policymakers concerned with fisheries management and development require information both on human and fisheries resources. Stock assessment research is of fundamental importance to fisheries management and development programs but is most useful when combined with information which provides an understanding of the social and economic context of resource exploitation. Conversely, socioeconomic studies of fishing communities divorced from a realistic appraisal of existing fisheries resources provide limited insight into development potentials.

A multidisciplinary approach to the study of fisheries management and development issues would provide a more integrated body of knowledge appropriate to the needs of policymakers and administrators seeking to reconcile the often differing requirements of fisheries management and development.

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