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AQUATIC RESOURCES DEVELOPMENT FEASIBILITY STUDY

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1.0 EXECUTIVE SUMMARY

As an archipelagic nation, Indonesia's marine environment is both a dominating physical reality and a source of national wealth. An appreciation for the importance of the sea in Indonesian consciousness can be derived from two concepts used by Indonesians in referring to 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). Its islands and the surrounding (or perhaps more accurately connecting) seas are perceived as a single entity which together define the Indonesian nation.

Indonesia has adopted the archipelagic principle in defining her territorial waters, including all areas lying within a line drawn around the country's 13,667 islands as part of the national domain: these territorial waters total 2.7 million km2. Indonesian waters, therefore, cover over five million square kilometers, an area equal to two-thirds of Indonesia's overall territory. With the promulgation of the 200 nautical mile Exclusive Economic Zone (EEZ) in March 1980, a further 2.5 million km2 have been added to Indonesia's maritime jurisdiction.

Indonesia's fishery resources provide the single most important source of animal protein to a protein hungry nation and the only affordable source to the majority of the population. In 1979, fish provided nearly 60% of total animal protein intake. 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 the foreseeable future.

The fishery sector also provides employment to over three million fishermen and fish farmers (about 5% of the labor force) either on a full-time or part-time basis. However, because the fishery sector is comprised of fishermen and fish farmers who generally earn very low incomes and because fish provides an important food source for the low income population, the fishery sector is an excellent target for development.

As an initial step in designing an aquatic resources development project (ARDP), a feasibility study was conducted to "review activities, problems and possible areas of support for fish and shrimp production, marketing, research, and institution building" (Rushing 1984). The ARDP feasibility study team began work in Indonesia on 25 October 1984 with a series of formal and informal meetings with senior GOI officials and scientists in the Jakarta/Bogor area. During the period 4-30 November, the team divided into several smaller groups and visited a total of 11 Provinces. The team's schedule was coordinated so that during the mid-point in their travels (9-17 November) they were together, affording an opportunity for individual and group discussions. The team reassembled in Jakarta on 30 November to write their individual reports and to prepare for a formal briefing on 6 December.

Recommendations regarding specific project areas were made with the following things in mind:

1) GOI's current five-year development plan (Repelita V) for the fisheries sector;

2) Key constraints to further development of aquatic resources in Indonesia;

3) Development assistance activities of bi-lateral and multi-lateral donors; and

4) Need for long-term sustainable development of aquatic resources.

The study and its recommendations are broken into four key areas: Marine Fisheries, Education and Training in Aquatic Sciences, Aquaculture Development, and Coastal Aquatic Resources Management and Development.

The team's major recommendations, as described here and in more detail in the body of the report, are as follows:

Marine Fisheries

1) Stock assessment of currently unexploited species
2) Applied socio-economic research
3) Market policy analysis
4) Quality control of shrimp processing for export
5) Installation of ice plants in appropriate locations

Education and Training in the Aquatic Sciences

1) Small grants program
2) Short courses for fisheries faculty development
3) Equipping new laboratories at IPB
4) Provision of support (including a faculty participant) to UNHAS
5) Institution building through inter-institutional cooperation at Ambon

Aquaculture Development

1) Sumateran freshwater aquaculture development including rice-cum-fish culture, research at Lake Toba and *Pengasius* cage culture
2) Giant freshwater prawn development
3) Small-scale penaeid shrimp hatchery development at Tambak Intensification Program

Coastal Aquatic Resource Management and Development

1) Policy assistance to the Ministry for Population and Environmental Affairs
2) Cross-sectoral resources development at the provincial level (perhaps in South Sulawesi)

1.1 Marine Fisheries

Indonesia's marine fisheries sector is dominated by the small scale sub-sector, which accounts for approximately 90% of the 1,171,000 people directly employed as marine fishermen and who contributed roughly 70% of the total landings of 1.49 million mt in 1982. This in turn represents 75% of the country's total fisheries production. Marine landings more than doubled between 1968 and 1982 while production increases in other fisheries sectors have been modest. Marine fisheries thus not only contribute the bulk of total supply, but over the past 14 years, this sector has grown in overall importance.

The DGF estimates a maximum sustainable yield (MSY) of 4.5 million mt from Indonesia's 3.1 million km2 of archipelagic territorial waters, and a further 2.1 million mt from the 2.5 million km2 within the 200 nautical mile EEZ. These estimates suggest that current levels of resource exploitation are only 23% of MSY. This, however, is misleading as 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, 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 limited potential for expanded production. This is particularly true for the Malacca Straits, the north coast of Java, and South Sulawesi Province, which combined, accounted for just over half of the total landings and 48% of all marine fishermen in 1982. Systematic stock assessment data are available only for fishing grounds (Malacca Straits and the Java Sea) and species (shrimp in the Arafura Sea) which represent approximately one-quarter of estimated demersal resource potentials. With one exception (the oil sardine fishery of the Bali Straits), no stock assessment data are available on pelagic species, which represent nearly 4 million mt out of 6.6 million mt total estimated MSY. Exploratory fishing for underexploited demersal and pelagic stocks has provided limited data for preliminary resource analyses or assessments of the economic feasibility of exploiting deep sea demersal and offshore pelagic species.

However imperfect, available data indicate considerable opportunity for increased harvests from the eastern half of the archipelago. To provide a sound basis for resource development and management, improved resource assessment capabilities are of fundamental importance.

1.1.1 Resource Assessment of Primary Productivity

The huge expanse of Indonesia's oceanic domain makes difficult the task of effectively assessing fisheries stock abundance by traditional means with the small number of existing research vessels. The use of remote sensing techniques, which measure chlorophyl concentrations and temperature differentials, offers the possibility of identifying areas of unusually high productivity. This information can then be used to direct research vessels to conduct sampling trials and make far more efficient use of expensive research vessel sea time.

Satellite remote sensing techniques developed to state-of-the-art levels at the Indonesian National Institute of Aeronautics and Space (LAPAN) can be used to help identify areas of unusual productivity. LAPAN staff are more than willing to assist staff of the National Oceanology Institute (LON) in developing the ability to use satellite data products for oceanographic purposes. Assistance in this area could be coordinated with research efforts at Ambon, described in Section 1.2.3.3.

A valuable contribution to Indonesian scientific development could be made through a specific program of short-term training for a few LON and LAPAN staff members in oceanographic applications of remote sensing techniques. Such short-term training could be arranged at leading U.S. or other centers of remote sensing of the ocean.

Such joint training would establish connections between LON and LAPAN staff that would continue upon their return to Indonesia. In addition, this training would pay dividends in providing a nucleus of trained manpower to take advantage of microcomputer analysis of landsat data tapes, a prospect being explored by UNESCO-Jakarta and the new ASEAN-Australia Cooperative Program in Marine Science.

1.1.2 Policy Analysis

Even granted the imprecision of existing estimates of marine fisheries resource potentials, it is clear that the greatest scope for expanding harvests is in the eastern half of the archipelago. Small pelagic species (mackerels, scads, sardines, etc.) in particular are seasonally abundant in coastal waters in that area.

Existing small scale fishing gear (mini purse seines, gill nets) provide an effective means of exploiting these species. However, levels of investment and fishing effort are constrained by the limited absorptive capacity of local markets. In the Molucca Islands, for example, annual per capita fish consumption was approximately 50 kg in 1982, after discounting exports, compared with the national average of 12.9 kg and an average of

6.3 kg for Java.

The size of Java's population and relatively low level of fish consumption there suggests considerable market potential. Opening the Java market to fishermen from areas where resources are abundant relative to local demand would increase employment and income opportunities in producing areas, expand utilization of available resources, and increase the supply of high quality protein to consumers on Java.

The small pelagic species estimated to be in abundant supply off the coast of Kalimantan and in the eastern half of the archipelago are readily accepted by consumers on Java both as fresh and salted dry fish. Fresh iced fish (including both pelagic and abundant demersal finfish) can be shipped from Kalimantan to Java by carrier boat, as is occuring to a limited extent already. Further east, however, the catch needs to be processed before shipment.

Limited consumer acceptance and the high cost of shipping frozen fish to Java (Rp 200/kg from Ambon) make this option impractical. Establishing canneries may be an option if assured supply on a year round basis is available. However, pelagic species are by nature migratory and no information exists on where small pelagic species go after they leave coastal waters. Canned sardines and mackerels could become an export commodity, but may be too expensive to make a substantial impact on domestic consumption needs on Java. Salted dried fish remains the most practical product form for shipment to Java from the eastern half of the archipelago. To the advantages of long shelf life and low shipping costs (estimated Rp 75 per kg from Ambon) must be added the labor intensive nature of this process.

The extent of inter-island trade in fisheries products remains unknown. It is clear that both fresh and salted dry fish enter Java from Sumatera and Kalimantan. Small quantities of dried fish are shipped to Java from Nasatenggara Barat. It appears that shipments of fish from South Sulawesi to Java have declined over the past decade. No evidence of significant shipments of fish from the Molucca Islands to Java exists despite the considerable potential for such trade.

In examining the feasibility of encouraging development of inter-island fish trade, it was discovered that a small number of wholesalers exert oligopolistic control over the domestic marketing of fresh and dried fish on Java by controlling distribution of fisheries products from point of supply to retail outlet. Potential competitors, including government sponsored cooperatives and private traders, have been forced out of the Java market by price manipulation, limiting of access to auctions, and the threat of violence.

The presence of these oligopolistic wholesalers poses a potentially serious threat to opening new marketing channels. Past actions suggest these wholesalers will attempt to frustrate the creation of new trading patterns outside of areas where long-established relationships with local buyers provide them with a high degree of control.

The potential problems to be faced in developing inter-island fish trade are enormous, but so are the opportunities for bettering the employment opportunities and incomes of fishermen, and for increasing the supply of fish to consumers on Java. Neither goal is likely to be achieved without a concerted effort to overcome existing marketing constraints. Applied socio-economic research tailored to meet the information needs of designing and implementing strategies to overcome these constraints is a necessary step in the development of inter-island fish trade.

1.1.2.1 Applied Socio-Economic Research

The design of effective policy depends on the adequacy and scope of the information available to policy makers. A review of available literature has revealed a number of glaring gaps in current knowledge that need to be addressed by a coordinated set of applied socio-economic research projects.

A major contribution to resolving questions relating to the expansion of inter-island fish trade could be made by establishing an applied socio-economic research program at AARD's Central Research Institute for Fisheries (CRIF). This would ideally include the provision of practical training to the seven social scientists within CRIF and its associated Institutes.

CRIF is in a position not only to conduct research but also to coordinate the efforts of university researchers. CRIF and the MFRI, for many years, have supported socio-economic research by university staff, but in the absence of a clear research agenda, this has been done on an *ad hoc* basis. By establishing such an agenda, research efforts could be focused toward using the same methodologies to address common problems (i.e., marketing) in a wide geographical area. Research results presented at workshops sponsored by CRIF would provide a basis for actions to resolve identified problems. It is suggested that potential constraints to inter-island fish trade be identified as a priority topic.

There are a wide range of other applied socio-economic issues which may be included in the CRIF research agenda at a later point. These include the collection of adequate costs earnings data to establish the economic performance of various boat and gear combinations or aquaculture production systems, and broad examinations of the impact of technological change on employment and household incomes of fishermen, fish farmers, and their communities, among others.

1.1.2.2 Marketing Policy Analysis

The GOI's development of inter-island fish trade can be enhanced by designing a coordinated set of marketing policies to encourage such trade. For example, in developing such policies, the Ministry of Agriculture could identify the most effective means of encouraging expanded domestic trade in fish, recognizing that important differences in opportunities exist in areas close to and far away from Java.

Effective measures to develop inter-island trade are likely to require considerable investment, especially if opposition from wholesalers on Java necessitates direct involvement of the government in trading operations. However, much of this investment is already in place. The various State Fishing Enterprises based at Ambon, Sorong (Irian Jaya), and Aer Tembaga (Manado) own underutilized carrier boats and have shore-based facilities which could support inter-island trade in processed fish. P.T. Tirta Raya Mina, a State Fisheries Enterprise based at Pekalongan (Central Java), could serve as the distribution agency for processed fish on Java. This Enterprise operates an ice plant and cold storage facility, operates carrier boats and refrigerated trucks, and has experimented with direct involvement in retail fish marketing on Java.

This latter Enterprise originally was established with World Bank assistance to market fish on Java, the only State-owned Enterprise with such a mandate. Unfortunately, the product they chose to market was frozen fish, which found limited consumer acceptance on Java. This enterprise has made no attempt to market processed fish on Java. Indeed, it is beginning to shift some of its operations over to the shrimp export trade as a means of reducing or eliminating losses. This may be good company strategy but it represents a movement away from its original mandate which, if pursued to the exclusion of domestic trade activities, will result in loss of a key actor in future development of inter-island trade. For this reason, additional investments in P.T. Tirta Raya Mina would significantly strengthen its ability to play an effective role in domestic fish trade.

In addition to its role of coordinating the development of domestic fish trade, the Ministry of Agriculture would be in a position to perform other valuable functions. These include:

- o Appraising the feasibility of recommendations proposed by joint venture concerns and international assistance agencies to exploit marine resources.
- o Forecasting long-term changes affecting international markets and seasonal variations in prices for various fisheries products in domestic markets.
- o Establishing a fish price monitoring system that makes available, on a timely basis, prices of key species in

a variety of locations. This information system would alert fish farmers when to or when not to harvest, would promote increased efficiency in distributing fisheries products to various markets, and would reduce the likelihood that fish buyers could take advantage of fishermen through unfair pricing practices.

1.1.3 Quality Control for Shrimp

Indonesia is wisely seeking to diversify its export markets for shrimp, which currently are all but limited to Japan. Efforts to establish a U.S. market outlet have been frustrated by problems of quality control that have led to automatic detention of all Indonesian shrimp by the FDA and frequent rejection due to the presence of Salmonella.

It has been suggested that shrimp grown in tambaks may be more prone to contamination by Salmonella and other pathogenic organisms because many tambaks are irrigated with surface water. Investigation of this matter is critical.

The DGF can play a positive role in improving the handling and processing of shrimp through its export quality control laboratories and by working with shrimp processors. When and if processors adopt recommended practices, FDA personnel could be invited to inspect these facilities for certification.

1.1.4 Ice Plants

Although adequate supplies of low cost ice are by no means available in all parts of Java, the greatest needs are on other islands. Sumatera's large and growing population provides good local marketing opportunities, expecially in areas where coastal communities are connected to the interior by roads. On Kalimantan, population densities are lower and coastal communities are more isolated. However, as noted previously, access to reasonably priced ice would encourage shipments of fresh iced fish to Java. Conditions and opportunities in South Sulawesi closely approximate those on Sumatera.

The ice plant constructed at Maringgai appears to have stimulated the local fisheries cooperative and provided the means for marketing fresh iced fish into the interior. The Maringgai experience suggests that an ice plant can be a focal point for social and economic development by strengthening local institutions such as a cooperative (which has a tangible benefit to offer) and opening new markets for fresh fish trade.

It is suggested that ice plant construction be funded in those areas where market potential and the absence of other sources of ice warrant investments. These ice plants, however, should be built only as part of a more complete fisheries development plan for the areas chosen.

1.2 Education and Training in Aquatic Sciences

There are ten government supported universities in Indonesia which offer degree programs in fisheries. Two of these universities (IPB and UNHAS) are about to move into new and larger buildings, one (UNDIP) is about to embark on a major new program of field work for students in its core courses, and one (UNPATTI) has just had 15 young faculty members return to its campus after advanced training at IPB. These activities are occurring at a time of increased government emphasis on living aquatic resources as a source of dietary protein and foreign exchange earnings. These developments provide an opportunity that could dramatically amplify the impact and effectiveness of training programs in fisheries, and ultimately, on the wisdom with which Indonesia develops its living aquatic resources.

Each of these ten university programs in marine fisheries science shares certain common problems:

- a great scarcity (or absence) of scientific equipment and supplies for teaching and research which limits fisheries education to textbook and lectures rather than practical training and inhibits the development of university based fisheries research programs;

- a tradition of older faculty being absent from campus at times other than those of scheduled lectures;

- young faculty who have recently returned from advanced training overseas and whose academic behavior patterns have not yet been established; and

- an almost total ignorance of academic developments at other universities.

Two programs are recommended to address these common problems nationwide: a small grants program and the implementation of short courses.

1.2.1 Small Grants Program

Indonesia has only modest experience with the faculty development benefits that can be derived from extramural funding for equipment, research, and professional activity. No general program of extramural funding for these activities exists in Indonesia at this time, although the Ministry for Population and the Environment funds university-based Environmental Studies Centers for these purposes.

The effects of both the absence and presence of extramural funding are apparent. Indonesian senior faculty have developed non-university activities for extra income, laboratory facilities remain unequipped and largely unused for research, and inter-university professional activity levels are low. On the other hand, staff of the Environmental Studies Centers are generally active in pursuing grants and professional contacts because experience has shown them that their own enlightened self-interest can be served by these means.

A small grants program in fisheries to develop equipment, research, and professional activity could have significant positive impact by improving the quality of education, training, and research in aquatic sciences within Indonesian universities. This program, which could be administered by the Directorate General for Higher Education, could serve as a model for similar developments in other fields.

A program operated by panels of peers would directly stimulate professional interactions. Such panels could formulate specific plans for university equipment development by deciding the relative priority of necessary analyses. Equipment and supplies kits for these analyses could be provided by assembling the needed instruments, glassware, chemicals and instructions (which may have to be imported and to Indonesia), and providing technical assistance for their establishment. Other panels could review research proposals and rank them on the basis of scientific merit. These or other panels could also plan short workshops to stimulate professional interaction.

1.2.2 Fisheries Faculty Development through Short Courses

The General Participant Training Program is an extremely important mechanism for developing trained manpower. Unfortunately, the TOEFL requirements of this program and graduate programs in foreign universities limit the utility of this program as a mechanism for rapidly developing a specific area such as fisheries.

Short courses (one or two weeks) could infuse new ideas and techniques into fisheries faculties throughout the country, and participation in such courses would increase professional activity and the educational development of faculty.

Among the topics of general interest to fisheries faculties that could provide the focus for a series of short courses are:

- coral reef and mangrove ecology;
- fish aggregating devices;
- methods for harvesting demersal resources other than trawling;
- mariculture systems for fish, molluscs, and seaweeds;
- tambak design and operation;
- traditional fishing knowledge and regulation mechanisms;
- population dynamics and stock assessment; and
- use of programmable hand calculators and micro computers in aquatic sciences.

1.2.3 Specific Programs

The above recommendations are designed for generally strengthening education and training within all fisheries faculties. Some of the unique characteristics of these faculties present opportunities for specific support beyond these general programs.

1.2.3.1 Equip New Laboratories at IPB

IPB's fisheries faculty is the best developed in Indonesia. Fifty seven percent of its 79 members have advanced degrees from foreign institutions. IPB is the place in Indonesia to which other fisheries faculties send their young colleagues for advanced training.

IPB's fisheries faculty is about to move to the facilities on the new Darmaga campus. These facilities are not now equipped with laboratory equipment and present laboratory equipment is inadequate even for present needs. The provision of equipment for these new laboratories would provide practical experience for the largest number of best prepared fisheries students in Indonesia.

A list of needed equipment totaling US $241,400 has been recently prepared by IPB faculty, and other equipment and supplies for hydrobiological analyses have been suggested by Professor Cal McNabb (at a total cost of US $201,225). These lists may be used in negotiating a useful and affordable complement for establishing laboratory and research capabilities where none now exist.

1.2.3.2 Technical Assistance to UNHAS

UNHAS has a strong head of the fisheries department, seven young faculty trained abroad, immediate prospects of moving to a new building to be equipped through a loan from the Asian Development Bank, and real prospects of mutually beneficial academic interaction with a new Coastal Aquaculture Research Institute laboratory being built at Maros (22 km from the new UNHAS campus). A faculty member with interests and experience in brackishwater aquaculture could greatly assist effective utilization of the diverse new opportunities available at UNHAS.

1.2.3.3 Support Inter-Institutional Cooperation at Ambon in Marine Sciences

Three institutions that play important roles in marine sciences are active in Ambon: LON, the Marine Fisheries Research Institute (MFRI), and UNPATTI. Their presence in the center of an area with great potential for fisheries development offers a unique opportunity for fostering cooperative and mutually supporting research activities that will make these three institutions more than the sum of their parts.

It is recommended that the following be provided to these institutions:

- o a specialist in primary production and food chain dynamics at the LON station in Ambon;

- a specialist in microbiological assessment of fisheries product quality at the MFRI station in Ambon;

- a specialist in population dynamics and fish stock assessment at UNPATTI;

- equipment, supplies, ship time and research funds suitable for each participant to develop research on topics consciously selected as of interest to permanent staff of all three major institutions;

- specific funds for staff development, especially for degree training abroad, but including support for participation in short courses in Indonesia or in other countries; and

- trawl gear for a research vessel of the MFRI to permit sampling of marine organisms located with existing acoustic fish finders.

1.3 Aquaculture Development

About one million Indonesians were engaged in some form of aquaculture production during 1982. The majority are part-time fish farmers for whom aquaculture provides an important source of income. This sub-sector contributed 12% (241,00 mt) of total fisheries production in that year. The importance of aquaculture, however, is greater than this figure suggests. In inland areas, freshwater aquaculture often provides the only available source of fresh fish to local consumers. In coastal areas, both fish for domestic consumption and shrimp for export are produced in brackishwater tambaks.

Fresh and brackishwater aquaculture has been practiced in Indonesia for centuries, but generally at a level of productivity far below its potential. The recommendations detailed below suggest how easily-remedied constraints affecting tambak shrimp production might be overcome and how to encourage the adoption by small scale producers of several aquaculture systems (rice-fish, cage culture, and freshwater prawns), which current production trials indicate have great development potential.

1.3.1 Sumateran Freshwater Aquaculture Development

Sumatera's diverse freshwater resources and the market potential represented by that island's 30 million inhabitants offer considerable scope for aquacultural developments. It is recommended that the following areas be given consideration.

1.3.1.1 Rice-Cum-Fish Culture

Rice-fish culture of carp in sawah (rice ponds used for rearing fish) is well established in North Sumatera Province, but this system suffers from a number of constraints which impede its development. Brood stock quality is declining due to inbreeding and survival rates of hatchery-produced fry are low due to poor management. Extension services are weak and farmers have limited access to credit which would allow the purchase of sufficient fry to optimize production and incomes.

It is proposed that the provincial Fish Culture Center at Kerasaan, Pematang Siantar be strengthened in order to support DGF activities in rice-fish culture. This can be accomplished by funding renovation of the Center, acquiring brood stock, and providing technical assistance in rice-fish culture to the staff of the Center, to extension staff of the provincial Fisheries Service, and to private hatcheries. This technical assistance would center on designing rice-fish demonstration plots adapted to varying conditions, providing advice on steps to improve the Center's water quality, and designing an improved credit system for rice-fish farmers. In addition, a food nutritionist could develop least-cost diet formulations to increase fry survival.

To encourage self-sustaining development of the Center, long- and short-term training of Center staff within Indonesia or neighboring ASEAN countries where rice-fish culture is well developed might be considered.

1.3.1.2 Limnological and Fisheries Studies of Lake Toba

At the Ambarita Fish Seed Center, a restocking program through increased production of fingerlings is currently underway. However, there have been no limnological studies to date of the lake to determine its capacity to absorb increased stocks.

A limnological study would have several objectives. The lake's primary and secondary productivity could be estimated and hence, its theoretical capacity for restocking carp or other desirable species. The study would develop acquatic research capability in an area of relative weakness. Invaluable baseline data would be generated by which to monitor the lake's water quality. The information and methods applied in the course of this study could be applied to other lakes and reservoirs within Indonesia, which represent important but underutilized productive potential.

1.3.1.3 Catfish Cage Culture in Rivers

Cage culture of Pengasius catfish, a highly valued species, is well developed in Thailand, and production trials currently underway in South Sumatera indicate the strong likelihood of success in Indonesia. Investment levels for cage culture in rivers are low and production technologies are simple, entailing few risks.

The key constraints inhibiting widespread adoption of cage culture for Pengasius catfish (or other species) are limited availability of fry and limited familiarity of extension agents and potential producers with the cage culture system. To overcome these constraints, it is recommended that the DGF assist the provincial fisheries services of Riau, Jambi and South Sumatera in the development and spread of Pengasius cage culture.

The design, construction and operation of model Pengasius hatcheries would serve as demonstration sites in each of the three provinces and as training centers for private hatchery operators and extension agents. Assistance should also be provided to the staff at the Palembang station to monitor water quality of the Musi River and later in other rivers where Pengasius culture is likely to occur. Finally, the identification of the credit needs of hatchery operators and fish farmers and a plan to meet those needs is necessary.

1.3.2 Freshwater Prawn Culture

Pond production of giant freshwater prawns (Macrobrachium rosenbergii) is a relatively new enterprise. Under the current Small Scale Fisheries Development Project, freshwater prawn hatcheries were established in Java and hatchery technicians were trained. Visits to these sites by members of the ARDP team showed that these hatcheries continue to function, but that adoption of this species by farmers has been inhibited by limited marketing outlets.

At present, shrimp exporters are operating well below capacity and several expressed interest in handling or expanding purchases of this commodity. In Sumatera, prices paid by those processors who buy freshwater shrimp are only slightly below those paid for premium quality tiger shrimp (Penaeus monodon), but demand is weakened in Java.

Freshwater prawn culture can be successfully accomplished on a small scale and provide important income generating opportunities due to the high prices paid for this commodity. Freshwater prawns can be raised successfully in existing ponds together with the Java carp (Puntius javinicus), which is widespread on Java and which, due to its low price, is an important food fish for rural consumers.

To capitalize on and extend the benefits from this recently concluded project, it is recommended that assistance be provided in the development of machrobrachium market channels and demonstration ponds in Yogyakarta and Sumatera be established. In addition to assisting local Fisheries Services in organizing marketing outlets and in designing credit programs for private hatchery and pond operators, technical and management assistance could be provided to hatchery operators and extension agents.

1.3.3 Small Scale Penaeid Shrimp Hatchery Development and Tambak Intensification Program

Increased production of shrimp in tambaks is a matter of high priority for the GOI because its of foreign exchange earnings potential. In 1983 Indonesia earned over US $194 million from shrimp exports, at least a third of which came from tambak production.

Modest improvements in current practices could produce major increases in the productivity of existing tambaks. The major constraint to increased shrimp production is a shortage of post-larval (PL) shrimp for stocking tambaks. The only way to remove this constraint is through raising PLs in hatcheries; harvest of PLs from the wild is sufficient to supply only 16% of estimated demand for semi-intensive shrimp culture. Moreover, natural PL supply is dependent on proper environmental conditions and tends to fluctuate from year to year.

In the last several years, nearly 40 privately owned hatcheries have been established to meet the demand for PLs of *P. monodon*, the most valuable species. However, productivity is only about 10% of installed capacity due to high larvae mortality, and a number of these hatcheries are likely to fail. A survey of shrimp hatcheries in Indonesia revealed that most are suffering from a series of technical problems, including improper siting and poorly designed facilities, as well as poor hatchery management.

1.3.3.1 Technical Assistance to Penaeid Shrimp Hatcheries

It is recommended that the provision of support to the development of small-scale hatcheries and to the building up of DGF model hatcheries be given careful consideration. If investment in this area is to be undertaken, it is recommended that two DGF hatcheries be renovated to reflect appropriate technology and to serve as technology transfer mechanisms and training centers. Small-scale private hatcheries would be developed through innovative private sector organizations or used as a vehicle to strengthen producer groups.

By providing technical assistance to private hatchery operators, small business development in a potentially profitable venture would be stimulated while simultaneously reducing the key production constraint impeding increased tambak shrimp production. This would have a highly favorable impact on Indonesia's balance of trade, given projected high levels of international demand throughout the remainder of this decade and beyond. It would also directly benefit not only hatchery operators but also tambak owners and those they hire.

1.3.3.2 Tambak Intensification Program

In order to improve product quality and income to small-scale shrimp farmers through better tambak water management and post-harvest handling, technical assistance could be provided in the following areas:

1) Upgrade DGF tambak demonstration centers in Central Java and South Sulawesi, and finance short courses.

2) Provide direct technical assistance to tambak farmers through the lead farmer system. This assistance would emphasize quality control through the introduction of the best possible post-harvest handling. Processors should be encouraged to provide incentives to tambak farmers if they provide higher quality shrimp.

3) Establish a model in-kind credit program to provide fry, fertilizer, milk fish fry, feeds and pumps to groups of small scale tambak farmers. The mechanism, i.e., type of bank, would depend on the borrower--whether kelompok tani, KUD, or a "pioneer" company.

1.3.3.3 Artemia Culture

Artemia (primitive crustaceans inhabiting highly saline waters) is critical input to the production of shrimp fry in hatcheries. At present, artemia are being imported at a cost of U.S. $70/lb. Although world supplies are more than adequate to meet demand, artemia cysts are so expensive (due in part to high duty rates) that many hatcheries cannot afford adequate supplies; this is one of the causes of low hatchery productivity. It also appears that the nutrient quality of some imported artemia is low.

An artemia production project is viewed as complementary to a penaeid shrimp hatchery development program. Artemia currently are being produced for hatchery consumption in Thailand and the Philippines using low-level technology that is readily transferable to Indonesia. Such a production project could be located on Madura and work directly with small-scale private salt farmers, significantly increasing their income. Technical assistance could be provided both for artemia production and direct marketing to hatcheries.

1.3.3.4 Issues

Several key issues arise for shrimp aquaculture that might be considered:

1) Can appropriate institutional mechanisms be developed by which small-scale hatcheries can be owned and operated to the benefit of small-scale tambak owners and producer groups (in contrast to supporting private hatchery operators who are generally well-to-do)?

2) Can the GOI select projects in this sub-sector which are not covered by the current ADB sponsored Brackishwater Aquaculture Development Project?

3) Should the GOI place emphasis on an export commodity rather than on increasing the production of food fish?

4) Can quality control problems with tambak produced shrimp be overcome by improved handling and processing or, given that problems of contamination are tied directly to water quality management and improvement, can these problems be overcome?

These issues are fully addressed later in this report. The ARDP team believes that they should be analyzed before proceeding with project design.

1.4 Coastal Aquatic Resource Management and Development

It is the consensus of the team that the proper goal of an ARDP is sustainable development. Evidence was seen of serious environmental stress on critically important coastal aquatic resources (mangroves, estuarine ecosystems, coral reefs) in virtually every area visited by the team.

The primary causes of this problem appear to be:

- overfishing and the use of destructive fishing practices, including explosives and poisons;
- sedimentation caused by watershed erosion;
- pollution from domestic, agricultural, and industrial sources; and
- disruption of mangrove and coral reef ecosystems.

Because of the complex land-sea interrelationships which exist in coastal areas, efforts to manage aquatic resources and ensure sustainable productivity cannot be divorced from broader environmental concerns such as watershed management and pollution control. It is also obvious that managing coastal aquatic resources is most effectively accomplished in a cross-sectoral setting. For example, agricultural practices and other human activities in the watershed that contribute to erosion result in heightened rates of sedimentation in coastal areas which negatively affect coral reefs and tambaks. These problems and their solutions cannot be addressed by a program devoted exclusively to commodity production and marketing; indeed, the advanced rate of environmental degredation in many areas threatens the resource base for such development.

As such, the ARDP team recommends policy assistance at the national level and assistance in project implementation at the regional level. Assistance at the national level will promote a policy environment conducive to cross-sectoral planning, a necessary condition for wise resource allocation and management decisions. These national policies could be implemented, tested, and refined by parallel efforts at the provincial level.

1.4.1 Policy Assistance at the National Level

It is recommended that the State Ministry for Population and Environmental Affairs (MKLH) design workable policies for coastal aquatic resource management and development at the national level. MKLH efforts would include encouraging integrated and informed decision making at the national and provincial levels to promote sustainable intensification and use of aquatic and related natural resources while at the same time promoting compatible multiple uses that do not foreclose future opportunities or reduce existing values.

Specifically, the Ministry could:

- identify substantive and geographical priorities for implementing aquaculture and coastal resource management policies;

- improve the decision making process at both the national and provincial levels, with special reference to inter-agency coordination and cross-sectoral planning;

- improve the quality of information available to policy makers through supporting research, publications, and workshops; and

- provide for on-the-job-training and specialized training for GOI officials and researchers affiliated with the MKLH, other Ministries, and the Environmental Study Centers.

1.4.2 Policy Implementation at the Provincial Level

It is recommended that a cross-sectoral effort be made to develop a coastal and aquatic resource management program in an area where significant capture and culture fisheries production exists and where pressure on the resource is sufficiently intense that sustainability of harvests is threatened.

It is proposed that a single province be identified, within which several project components might be sited. A coastal aquatic resource management specialist might be provided to work with either the local BAPPEDA, university, or other institution with a cross-sectoral mandate. This specialist would encourage the various government line agencies to coordinate cross-sectoral development planning, would encourage applied research on coastal aquatic resources linked to the information needs of local policy makers, and would assist those policy makers in considering development and management options. The specialist would also work closely with the ARDP advisor at MKLH in designing and testing policies. Clearly, a more precise design of project activities would be essential before placement of any such advisor.

South Sulawesi affords a good illustrative case and has been identified as a possible geographic focus for initiatives in integrated coastal and aquatic resource management. South Sulawesi's marine fisheries landings rank third in the nation but levels of exploitation are approaching or have reached MSY, and there is evidence suggesting that some fishermen have responded to reduced landings by using explosives and other destructive fishing techniques. The most important coral reef fishery in Indonesia lies off Ujung Pandang, is heavily fished if not overfished, and to an unknown extent has been damaged by explosives.

South Sulawesi is also an important area for tambak production, which is expanding into mangrove areas on the east coast. Widespread construction of new tambaks may have a negative impact on coastal fisheries resources by disrupting the nutrient-rich sheltered habitat of a mangrove forest, where juveniles of commercially valuable finfish and shrimp are most densely concentrated. This question is a matter of some debate due to the absence of clear evidence that converting mangroves to other purposes has a quantifiably negative impact on fisheries or other activities. The presence of UNHAS, the Environmental Study Center at UNHAS, and the AARD's Center for Coastal Aquaculture Research Station at Maros offer a unique opportunity to examine this question in detail.

The choice of South Sulawesi is a good one, not only because of its many interrrelated natural resource management issues, but also because it seems that there exists the political will in the province to address these issues in a comprehensive manner.

1.4.3 Related Projects

Two possible projects offer considerable opportunity for mutually beneficial bilateral cooperation through increasing the breadth and intellectual resources brought to bear on aquatic and coastal resource management issues in Indonesia. First, Indonesia may be chosen as one of three countries in USAID/Washington's Coastal Resources Management Project, under the auspices of the Bureau of Science and Technology. In planning coastal resources project components, discussions with USAID/Washington should be continued in order to avoid a duplication of effort and to resolve potential problems of coordination and responsibility. A second related initiative relevant to this recommended ARDP component is an ASEAN coastal resource program that is likely to be headquartered at ICLARM in Manila.

1.5. Reference

Rushing, Kevin A. 1984. Background paper: Aquatic resources development feasibility study. USAID/Jakarta. October 31, 1984.

2.0 MARINE FISHERIES OF INDONESIA

2.1 The Setting

As an archipelagic nation, Indonesia's marine environment is both a dominating physical reality and a source of national wealth. An appreciation for the importance of the sea in Indonesian consciousness can be derived from two concepts used by Indonesians in referring to 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). Its islands and the surrounding (or perhaps more accurately connecting) seas are perceived as a single entity which together define the Indonesian nation.

Indonesia has adopted the archipelagic principle in defining her territorial waters, including all areas lying within a line drawn around the country's 13,667 islands as part of the national domain; these territorial waters total 2.7 million km2. With the promulgation of the 200 nautical mile Exclusive Economic Zone (EEZ) in March 1980, a further 2.5 million km2 have been added to Indonesia's maritime jurisdiction.

A leading Indonesian marine scientist eloquently states the importance of the sea for his country (A. Soegiarto, 1981:266):

> 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.

2.1.1 Fish as Food

Fish provides the single most important source of animal protein to a protein hungry nation and the only affordable source to the majority of the population. In 1979 fish provided nearly 60% of total animal protein intake (BPS 1981). 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 the foreseeable future.

In 1982 marine fisheries landings totaled 1.49 million mt, accounting for 75% of Indonesia's total fisheries production of nearly 2 million mt (Table 1). Despite the importance of inland fisheries and aquaculture and on-going research and development efforts to increase harvests from these activities, Indonesia will continue to depend heavily on marine capture fisheries to feed her growing population. Marine landings more than doubled between 1968 and 1982 while production increases in other fisheries sectors have been modest. Marine capture fisheries thus not only contribute the bulk of total supply, but over the past 14 years, this sector has grown in overall importance.

Table 2 summarizes data on total fisheries production and human population by island or island grouping and by province for 1982 to establish a rough approximation of per capita fish supply. These figures suggest that average annual per capita fish supply in Indonesia during 1982 was 12.9 kg. The DGF (1984) reports that supply increased to 13.1 kg in 1983. In that year, Indonesian exports of fisheries products totaled 88,300 mt, while imports of fisheries products fit for human consumption were approximately 7,700 mt (a further 51,600 mt of fish meal was imported in 1983 at a value of US $29 million). The net annual per capita supply of fisheries products within Indonesia in 1983 can be estimated at 12.9 kg per capita when the net decline in national fish supply through international trade is considered.

TABLE 1: Fisheries Production by Sub Sector, 1968-1983

Year	Total Production ('000 mt)	Percentage Increase	Marine Fishery Production ('000 mt)	Percentage Increase	Other Fisheries Production ('000 mt)	Percentage 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	20	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	(0.2)
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	2.5	1,408	1.5	506	5.0
1982	1,998	4.3	1,491	5.9	507	0.2
1983	2,120	6.1	1,600	7.3	520	2.6

SOURCE: DGF, 1981, in press; DGF, 1984.

Note: 1983 data are preliminary.

TABLE 2: Population, Total Fisheries Production, and Per Capita Fish Supply, by Island and Province, 1982

ISLAND	PROVINCE	POPULATION a/	FISHERIES PRODUCTION (mt)	PER CAPITA SUPPLY (kg)
INDONESIA		154,661,700	1,997,541	12.9
	Sub Total	29,961,500	533,369	17.8
	D.I. Aceh	2,767,400	54,689	19.8
SUMATERA	Sumatera Utara	8,803,500	147,003	16.7
	Sumatera Barat	3,560,300	32,767	9.2
	Riau	2,306,300	127,843	5.5
	Jambi	1,566,400	21,830	13.9
	Sumatera Selatan	4,944,300	99,766	20.2
	Bengkulu	837,300	6,314	7.5
	Lumpung	5,176,000	43,159	8.3
	Sub Total	95,103,400	600,722	6.3
	Jakarta	7,038,100	16,070	2.3
	Jawa Barat	28,946,600	212,101	7.3
JAVA	Jawa Tengah	26,226,600	153,916	5.9
	D.I. Jogyakarta	2,813,300	1,619	0.6
	Jawa Timur	30,078,800	217,016	7.2
	Sub Total	8,835,100	95,735	10.8
BALI	Bali	2,555,300	31,283	12.2
NUSA	Nasatenggara Barat	2,855,900	1,443	14.5
TENGGARA	Nasatenggara Timur	2,846,400	22,612	7.9
TIMOR	Timor Timur	577,500	397	6.8
	Sub Total	7,142,900	300,661	42.1
	Kalimantan Barat	2,603,000	65,956	25.3
KALIMANTAN	Kalimantan Tengah	1,021,400	69,868	68.4
	Kalimantan Selatan	2,155,700	98,992	45.9
	Kalimantan Timur	1,362,800	65,845	48.3
	Sub Total	10,887,000	370,435	34.0
	Sulawesi Selatan	6,378,200	235,954	37.6
SULAWESI	Sulawesi Tenggara	1,002,100	45,412	45.3
	Sulawesi Utara	2,215,300	68,735	31.0
	Sulawesi Tengah	1,391,400	20,334	14.6
	Sub Total	2,731,800	96,619	35.4
MALUKU	Maluku	1,493,900	83,633	56.0
IRIAN	Irian Jaya	1,237,900	12,986	10.5

SOURCE: Biro Pusat Statistik, 1984; DGF, in press

a/ 1982 population based on projections from 1980 census

2.1.2 Supply by Island and Inter-Island Trade

Table 2 indicates substantial variation in the supply of fisheries products between islands (or island groups) and provinces (1983 data are unavailable in disaggregated form). Per capita fish supply on Java in 1982 was less than half of the national average, at 6.3 kg. Java's large population and low per capita supply, as measured by production, strongly influence the national average. If we remove production and population figures for Java from Table 2, the average annual per capita fish supply for the rest of Indonesia is 23.5 kg.

The proportion of the catch destined for marketing as fresh or processed fish varies depending on the physical location of landing points in relation to consumer markets. This relationship can be summarized in the following two general statements:

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

2. In general throughout Indonesia, the closer consumers live to the coast the greater is their tendency to consume fresh as compared to processed fish; conversely, those living at greater distance from the coast tend to consume a greater proportion of processed as compared to fresh fish.

Conditions affecting supply and demand for fresh and processed fish on Java differ markedly from those elsewhere in Indonesia due to the presence of numerous large urban centers and greater population densities, even in rural areas surrounding small scale fishing communities. Moreover, there exists on Java a relatively well developed road system which facilitates the rapid shipment of fresh iced fish from such major fishing ports as Cirebon, Tegal, Pekalongan and Semarang to Jakarta, Surabaya, or other urban centers of demand located in the interior (e.g., Bandung and Yogyakarta, among many others). Many small scale fishing communities have limited access to urban markets, but the presence of densely populated agricultural communities and market towns in the immediate hinterland of coastal fishing communities provides ample opportunity for local marketing of fresh fish.

Elsewhere in Indonesia, population densities are far lower than on Java and road systems are far less well developed. The few major urban centers which exist outside of Java are located at or near the coast and depend in most cases on fishermen from the immediate area for supplies of fresh fish. This is largely due to the absence of roads which would permit the rapid transport of a highly perishable commodity between more isolated fishing communities and coastal cities or inland population centers.

2.1.3 Employment

In 1982 a total of nearly 1,200,000 people were directly employed as marine fishermen in Indonesia (Table 3). Approximately half of these had no other source of income.

The largest concentrations of fishermen in Indonesia are along the north coast of Java (over 290,000), followed by the Malacca Straits and South Sulawesi Province. Combined, these three areas account for 48% of all fishermen in Indonesia.

Counting the number of fishermen alone does not adequately represent the total employment generated by this sector. Placing a value on the economic contributions of women and children who are members of a fisherman's household is difficult; however, Table 4 shows that nearly half of all household members are involved either at sea or in shore-based activities, which might include selling the catch, fish processing and net mending.

In addition to household members directly employed in fisheries related activities, additional employment is generated by such supporting activities as boat construction, net making, fish marketing, fish processing, transportation, and the operation of fish ports, ice plants, and cold stores. No precise information exists on the total number of people indirectly employed in such support services, but a conservative estimate is that several hundred thousand people derive a substantial portion of their income from fisheries related activities. Combined with active fishermen and other fishing household members, it may be conservatively estimated that the marine fisheries sector generates as many as two million jobs.

TABLE 3: Number of Marine Fishermen by Province and Dependence on Income from Fishing, 1982

COASTAL AREA	PROVINCE	TOTAL	FULL TIME	PART TIME (MAJOR)	PART TIME (MINOR)
	Total	1,170,864	585,746	433,573	151,545
	Sub Total	69,229	51,994	12,960	4,275
	D.I. Aceh	21,776	15,704	3,958	2,114
WEST	Sumatera Utara	22,958	16,946	5,938	74
SUMATERA	Sumatera Barat	18,487	14,285	2,439	1,763
	Bengkulu	4,340	3,730	470	140
	Lampung	1,668	1,329	155	184
	Sub Total	66,091	40,857	18,952	6,282
	Jawa Barat	34,948	26,964	6,335	1,649
SOUTH	Jawa Tengah	9,979	2,702	5,138	2,139
JAVA	D.I. Jogyakarta	2,895	1,194	1,526	175
	Jawa Timur	18,269	9,997	5,953	2,319
	Sub Total	145,628	112,838	27,046	5,744
MALACCA	D.I. Aceh	17,905	15,057	2,407	441
STRAITS	Sumatera Utara	90,388	70,031	18,247	2,110
	Riau	37,335	27,750	6,392	3,193
	Sub Total	49,216	18,159	21,810	9,247
EAST	Jambi	4,955	2,134	2,028	793
SUMATERA	Sumatera Selatan	27,025	12,649	10,135	4,421
	Lumpung	17,236	3,376	9,647	4,213
	Sub Total	290,328	175,933	84,433	29,962
	DKI Jakarta	12,565	10,476	1,408	681
NORTH	Jawa Barat	41,653	31,120	10,533	nil
JAWA	Jawa Tengah	67,138	23,580	31,790	11,768
	Jawa Timur	168,972	110,757	40,702	17,513
	Sub Total	87,579	35,666	36,700	15,213
BALI	Bali	17,860	9,360	5,265	3,235
NUSA	Nusatanggara Barat	32,425	13,578	13,372	5,475
TENGGARA	Nasatenggara Timur	37,294	12,728	18,063	6,503
TIMOR	Timor Timur	N/A	N/A	N/A	N/A
	Sub Total	34,567	13,956	14,690	592
SOUTH/WEST	Kalimantan Barat	22,851	9,416	9,645	3,790
KALIMANTAN	Kalimantan Tengah	11,716	4,540	5,045	2,131
	Sub Total	68,809	27,402	28,959	12,448
EAST	Kalimantan Selatan	21,174	8,316	9,201	3,657
KALIMANTAN	Kalimantan Timur	47,635	19,086	19,758	8,791

TABLE 3: Number of Marine Fishermen by Province and Dependence on Income from Fishing, 1982 (Continued)

COASTAL AREA	PROVINCE	TOTAL	FULL TIME	PART TIME (MAJOR)	PART TIME (MINOR)
	Sub Total	151,070	30,912	102,328	17,830
SOUTHERN	Sulawesi Selatan	120,831	18,901	89,452	12,478
SULAWESI	Sulawesi Tenggara	30,239	12,011	12,876	5,352
	Sub Total	112,994	40,690	45,159	27,145
NORTHERN	Sulawesi Utara	80,428	27,948	31,342	21,138
SULAWESI	Sulawesi Tengah	32,566	12,742	13,817	6,007
	Sub Total	95,353	37,808	40,536	17,478
MALUKU	Maluku	68,905	27,808	29,120	11,977
IRIAN	Irian Jaya	26,448	19,531	11,416	5,501

SOURCE: DGF, in press

TABLE 4: Number or Household Members Engaged in Fisheries Activities, by Type of Boat, North Coast of Java, Malacca Straits, and Makassar Straits, 1975 and 1977

Type of boat		Malacca Straits			Makassar Straits			North Coast Java		
		A	B	C	A	B	C	A	B	C
Ave. owners' households		5.9	1.2	1.5	5.3	1.2	1.4	5.6	1.3	N/A
Without boat		5.3	1.0	0.0	5.2	1.2	1.6	4.9	1.1	N/A
Non-powered boat	Dugout	7.3	1.4	1.0	5.2	1.2	1.3	5.2	1.1	N/A
	Small	5.8	1.2	1.5	5.7	1.3	1.7	5.3	1.3	N/A
	Medium	6.8	1.4	1.5	5.6	1.3	1.4	6.0	1.4	N/A
	Large	8.5	2.2	1.6	6.3	1.6	1.2	5.7	1.2	N/A
Outboard		6.2	1.2	1.5	6.1	1.4	1.6	6.1	1.1	N/A
Inboard powered boat	5 GT	7.8	1.5	1.5	7.0	2.2	1.6	7.32	1.02	N/A
	5-10 GT	8.1	1.2	1.8	7.4	2.0	1.0			
	10-20 GT	8.2	1.0	1.4	10.6	2.0	0.0			
	20-30 GT	7.7	1.0	1.2	15.0	3.0	3.0			
	30-50 GT	10.0	1.0	2.0	8.0	3.0	1.0			
	50-100 GT	14.5	1.5	0.0	0.0	0.0	0.0			
	100 GT	0.0	0.0	0.0	0.0	0.0	0.0			
Non-owning crewmen		4.9	1.1	1.3	4.9	1.2	1.2	4.7	1.2	N/A

NOTE: A = Average number per household
B = Active fishermen
C = Assist on shore

SOURCE: DGF, 1976; DGF, 1979

2.2 Current Status of Marine Fisheries

Indonesia's marine fisheries sector is divided for planning purposes into small, medium, and large sub-sectors defined on the basis of investment levels (Yamamoto, 1978). Small scale fisheries, by far the most important in terms of employment, numbers of fishing units, and quantity of landings, are distinguished from other sub-sectors 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 sub-sector 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. Joint venture fishing enterprises are chartered under the Foreign Capital Investment Law of 1967. Privately owned large scale domestic fisheries are organized under the Domestic Capital Investment Law of 1968. There are, in addition, six government owned fishing enterprises defined as large scale. Each of these three types of large scale fishing enterprises is characterized by substantial investments both in fleets of boats and in shore-based facilities and are restricted to operating in areas where they do not compete with existing (usually small scale) fisheries.

Unlike large scale fishing enterprises, the medium scale sub-sector is owned exclusively by Indonesian citizens and operates throughout the archipelago. Ownership within this sub-sector typically is in the hands of individual entrepreneurs who have little or no investment in shore-based facilities and who own one or at most, several fishing units. Thus, investment levels within this group are intermediate between the small and large scale sub-sectors.

As may be seen in Table 5, the small scale sub-sector accounts for 90% of Indonesia's entire fishing fleet. It is important to observe that while the number of small scale boats has increased gradually since the mid-1970s, the number of non-powered boats has declined, while those powered by outboard engines have increased ten-fold during the period 1973 to 1982.

The number of boats using inboard engines also has increased dramatically in recent years. Only about 1% of the nearly 30,000 boats in this category are in the large scale sub-sector. The remainder represents Indonesia's rapidly growing medium scale sub-sector, which accounts for less than 10% of the national fishing fleet but approximately 30% of total landings due to the use of more productive fishing gear than small scale fishermen.

2.2.1 Estimates of Maximum Sustainable Yields (MSY)

The DGF estimates maximum sustainable yields (MSY) of 4.5 million mt from Indonesia's 3.1 million km2 of archipelagic territorial waters and a further 2.1 million mt from the 2.5 million km2 within the 200 nautical mile EEZ (see Table 6).

TABLE 5: Number of Marine Fishing Boats, By Sub-Sector, 1960-1982

Year	Totals	Total Small Scale	Without Engine	Outboard Engine	Percent	Total Medium and Large Scale	Percent
1960	169,431	167,975	167,975	-0-	99.1	1,456	0.9
1968	283,913	278,206	278,206	-0-	98.0	5,707	2.0
1969	280.633	275,314	275,314	-0-	98.1	5,319	1.9
1970	295,436	292,200	289,402	2,798	98.9	3,236	1.1
1971	284,838	280,314	277,662	2,652	98.4	4,524	1.6
1972	295,281	289,340	286,463	2,877	98.0	5,941	2.0
1973	242,882	235,634	230,615	5,019	97.0	7,248	3.0
1974	270,369	263,015	257,164	5,931	97.3	7,274	2.7
1975	257,152	248,992	242,221	6,771	96.8	8,160	3.2
1976	245,725	235,990	228,244	7,746	96.0	9,735	4.0
1977	248,544	237,829	228,228	9,601	95.7	10,715	4.3
1978	248.113	235,347	222,121	13,226	94.9	12,766	5.1
1979	257,905	243,147	225,804	17,343	94.3	14,758	5.7
1980	271,856	253,389	226,866	26,523	93.2	18,467	6.8
1981	277,005	257,054	225,949	31,105	92.8	19,951	7.2
1982	300,549	270,731	215,466	55,265	90.1	29,818	9.9

SOURCE: DGF, 1981; DGF, in press

TABLE 6: Marine Fisheries Resource Potentials (MT)

COASTAL FISHING AREAS	PELAGIC					DEMERSAL				
	Small Pelagic		Large Pelagic							
	Territorial Waters	EEZ	TUNA	Skipjack	TOTAL	Territorial Waters	EEZ	Coral Reef Fish	TOTAL	Shrimp
West Sumatera	110,900	132,600	12,800	6,100	262,400	50,400	106,100	12,600	169,100	900
South Java	70,600	88,400	4,800	2,300	166,100	40,800	70,700	1,200	112,700	5,500
Malacca Straits	126,500	-0-	4,800	2,300	133,600	78,300	-0-	-0-	78,300	20,000
East Sumatera	218,600	-0-	-0-	-0-	413,600	323,100	-0-	14,200	631,200	4,000
	-0-	195,000	-0-	-0-		-0-	293,900	-0-		
North Java	363,500	-0-	-0-	-0-	363,500	322,100	-0-	800	322,900	12,000
Bali, Nusa Tenggara, East Timor	112,300	132,600	9,600	4,600	259,100	109,600	106,100	-0-	215,700	500
South/West Kalimantan	156,000	-0-	-0-	-0-	156,000	245,200	-0-	-0-	245,200	3,200
East Kalimantan	127,400	-0-	7,900	19,000	154,300	197,400	-0-	2,100	199,500	5,000
Southern Sulawesi	90,400	-0-	15,300	49,400	155,100	65,500	-0-	3,500	69,000	-0-
Northern Sulawesi	143,500	165,300	21,600	37,700	368,100	78,200	-0-	2,300	80,500	-0-
Moluccas - Irian Jaya	714,500	-0-	89,500	154,000	1,530,000	388,800	70,700	11,400	470,900	18,000
-North Irian Jaya	-0-	483,600	-0-	-0-		-0-	-0-	-0-		
-Arafura Sea/South Irian Jaya	-0-	88,400	-0-	-0-						
TOTAL	2,234,200	1,285,900	166,300	275,400	3,961,800	1,893,400	647,500	48,100	2,595,000	69,100

SOURCE: DGF

These estimates suggest that the current level of resource exploitation is only 23% of MSY. This figure, however, is misleading. Systematic stock assessment data are available only for fishing grounds (Malacca Straits and the Java Sea) and species (shrimp in the Arafura Sea) which represent approximately one-quarter of estimated demersal resource potentials. With one exception (the oil sardine fishery of the Bali Straits), no stock assessment data are available on pelagic species, which represent nearly four million mt of total MSY. Exploratory fishing for unexploited demersal and pelagic stocks has provided limited data for preliminary resource analyses or assessments of the economic feasibility of exploiting deep sea demersal and offshore pelagic species.

2.2.2 Concentration of Fishing Effort

At present, 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 (compare Tables 7 and 8). In other areas, available stocks are under-exploited 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. This is particularly true for the Malacca Straits, the north coast of Java, and South Sulawesi Province.

2.2.3 Where Potential Exists for Increasing Harvests

A key problem facing Indonesia's fisheries policy makers is how to match supply with demand for fisheries products. The uneven distribution of Indonesia's population (Table 2) is paralleled by unevenness in the degree to which fisheries resources are exploited. In broad terms, productive and easily accessible fishing grounds located near major population centers, where demand for fish is strong, are already at or near maximum levels of exploitation. In the eastern half of the archipelago, however, the relative sparseness of the population limits local demand and thereby constrains expanded fishing effort.

Available resource assessment data suggest that fishing grounds in the eastern half of the archipelago offer the greatest scope for expanded harvests (Table 8). Increased exploitation of fisheries resources in the eastern islands of Indonesia would be economically feasible only if marketing and distribution channels to domestic and international markets were established. Export oriented State Fisheries Enterprises in North Sulawesi, the Moluccas, and Irian Jaya have been established, complete with shore-based facilities for handling the catch and carrier boats to transport frozen fish and shrimp to foreign markets. No parallel infrastructure exists to support domestic inter-island fish trade from these islands or from the Lesser Sunda Islands at a level which would increase significantly the supply of fish on Java and encourage expanded fishing effort in these areas.

TABLE 7: **Summary Assessments of the Status of Selected Marine Fisheries Resources in Indonesia**

AREA and STOCK	Extimated MSY (mt)	1979 Landings (mt)	Standardized a/ Fishing Effort Optium	1979	Level of Exploitation
Malacca Straits					
Demersal Fish/Shrimp	167,000	154,000	2,092	2,571	Overexploited
Demersal fish	137,000	86,168	1,758	2,571	Overexploited
Penaeid shrimp	18,000	16,091	1,770	1,969	Overexploited
Pelagic fish	70,000	84,000	N/A	963	Fully Exploited
East Coast Sumatra					
Demersal Fish/Shrimp	28,000	29,692	276	220	Fully Exploited
Demersal fish	25,000	24,400	239	171	Near Fully
Penaeid shrimp	N/A	5,300	N/A	152	N/A
Pelagic fish	N/A	57,400	N/A	N/A	N/A
North Coast of Java					
Demersal Fish/Shrimp	124,000	116,894	1,370	1,642	Overexploited b/
Demersal fish	114,000	105,577	1,338	1,642	Overexploited b/
Penaeid shrimp	7,200	7,800	1,213	1,191	Overexploited b/
Pelagic fish	290,000	185,000	5,500	2,172	Developing
South/West Kalimantan					
Demersal Fish/Shrimp	N/A	32,800	N/A	N/A	N/A
Penaeid shrimp	N/A	5,400	N/A	N/A	N/A
Pelagic fish	N/A	29,800	N/A	N/A	N/A
East Coast Kalimantan					
Demersal Fish/Shrimp	N/A	32,800	N/A	N/A	N/A
Penaeid shrimp	N/A	5,500	N/A	N/A	N/A
Pelagic fish	N/A	37,000	N/A	N/A	N/A
West Coast Sumatra					
Demersal fish/shrimp	23,000	24,395	287	269	Fully Exploited
Demersal fish	21,000	23,117	263	241	Fully Exploited
Penaeid shrimp	N/A	1,278	N/A	N/A	N/A
Small pelagics	N/A	39,000	N/A	N/A	N/A
Tuna	N/A	3,200	N/A	N/A	N/A
Skipjack	N/A	5,300	N/A	N/A	N/A
South Coast Java					
Demersal fish	N/A	20,000	N/A	N/A	N/A
Penaeid shrimp	5,700	4,908	1,271	1,886	Overexploited
Small pelagics	N/A	16,400	N/A	N/A	N/A
Tuna	9	N/A	N/A	N/A	N/A
Skipjack	N/A	5,300	N/A	N/A	N/A

Table 7: Summary Assessments of the Status of Selected Marine Fisheries Resources in Indonesia (cont.)

AREA and STOCK	Extimated MSY (mt)	1979 Landings (mt)	Standardizeda/ Fishing Effort Optium	1979	Level of Exploitation
Bali-NTB-NTT-Timor					
Demersal fish/shrimp	N/A	19,400	N/A	N/A	N/A
Penaeid shrimp	N/A	400	N/A	N/A	N/A
Small pelagics	48,000	48,700	494	464	Fully Exploited
Oil sardines	37,000	24,000	N/A	190	Fully Exploited
Tuna	N/A	2,300	N/A	N/A	N/A
Skipjack	N/A	1,300	N/A	N/A	N/A
South Coast Sulawesi					
Demersal fish	34,000	46,300	187	203	Overexploited
Penaeid shrimp	N/A	4,700	N/A	N/A	N/A
Small pelagics	114,800	132,500	1,972	1,910	Fully Exploited
Flying Fish roec/	135	120	2,700	2,262	Moderately
North Coast Sulawesi					
Demersal fish	N/A	10,800	N/A	N/A	N/A
Penaeid shrimp	N/A	720	N/A	N/A	N/A
Small pelagics	N/A	34,200	N/A	N/A	N/A
Tuna	N/A	2,900	N/A	N/A	N/A
Skipjack	N/A	8,500	N/A	N/A	N/A
Moluccas					
Demersal fish/shrimp	18,000	16,598	340	207	Developing
Penaeid shrimp	5,200	5,122	153	165	Fully Exploited
Small pelagics	27,000	25,833	1,650	1,268	Developing
Tuna	N/A	2,100	N/A	N/A	N/A
Skipjack	N/A	10,999	N/A	N/A	N/A
Irian Jaya					
Demersal fish/shrimp	7,000	7,203	50	74	Fully Exploited
Penaeid shrimp	4,700	4,900	39	54	Fully Exploited

SOURCE: Dwiponggo (in press)

a/: For demersal species, levels of fishing effort are estimated using otter trawlers as the standard measure (=1) and assigning values based on effectiveness to all other demersal gear operating in a particular area. For pelagic species, purse seiners are used as the standard measure of fishing effort.

b/: Overexplited in nearshore waters but underexploited in offshore waters.

c/: Levels of fishing effort for this fishery are defined by number of traps (pakkaja).

TABLE 8: Level of Marine Fisheries Resource Exploitation, 1981

COASTAL FISHING AREAS	RESOURCE POTENTIALS INCL. EEZ (MT)			LANDINGS (MT)			LEVEL OF EXPLOITATION (%)		
	*A	*B	*C	*A	*B	*C	*A	*B	*C
West Sumatera	262,400	169,100	900	58,159	18,088	332	22.2	10.7	36.9
South Java	166,100	112,700	5,500	29,955	12,409	1,176	18.0	11.0	21.4
Malacca Straits	133,600	78,300	20,000	91,100	34,049	8,784	68.2	43.5	43.9
East Sumatera	413,600	631,200	4,000	82,556	43,703	5,833	20.0	6.9	100.0
North Java	363,500	322,900	12,000	233,792	58,747	4,391	64.3	18.2	36.6
Bali, Nusa Tenggara, East Timor	259,100	215.700	500	64,536	10,563	344	24.9	4.9	68.8
South/West Kalimantan	156,000	245,200	3,200	39,180	20,873	5,907	25.1	8.5	100.0
East Kalimantan	154,300	199,500	5,000	42,921	22,996	5,255	27.8	11.5	100.0
Southern Sulawesi	155,100	69,000	-0-	161,018	38,542	3,996	100.0	55.9	-0-
Northern Sulawesi	368,100	80,500	-0-	65,334	9,636	10	17.7	12.0	-0-
Moluccas/ Irian Jaya	1,530,000	470,900	18,000	62,387	15,618	7,363	4.1	3.3	40.9
T O T A L	3,961,800	2,595,000	69,100	930,939	285,224	43,391	23.5	11.0	61.8

NOTES: *A = Pelagic
*B = Demersal, excluding shrimp, including coral reef fish
*C = Shrimp, including only large panaeid shrimp (P.monadon, P. semisulcatus, P. indicus).

Total resource exploitation = 19%

SOURCE: DGF

2.3 GOI Development Priorities and Strategies

In recent years, there has been a fundamental shift in thinking and emphasis in fisheries development throughout Southeast Asia. Fisheries development planners have become increasingly aware that production-oriented programs have tended to benefit relatively few fishermen and in some cases, have increased pressure on available resources and increased inequalities within the sector. In response to these problems, development goals have been broadened to include resource management, and greater emphasis has been placed on programs specifically designed to benefit small scale fishermen. GOI policies and programs parallel these region-wide trends.

Indonesia's first five year development plan, REPELITA I (1968/69 - 1972/73) placed primary emphasis on improving overall production in all sectors, including fisheries (Republik Indonesia, 1968). In reviewing the progress of REPELITA I, however, Indonesia's policy makers became concerned that single-minded pursuit of production goals was leading to increased income inequality. As a result, increased emphasis was given to wider distribution of economic opportunity and greater equality of incomes in REPELITA II (1973/74 - 1977/78).

As marine landings increased during the 1970s, growing awareness of the vulnerability of fisheries resources found expression in REPELITA III (1978/79 - 1982/83), which called for rational management of marine resources to ensure sustainable yields for the generation to come (Republik Indonesia, 1979:241). REPELITA III also stressed the creation of employment opportunities and wider distribution of incomes as part of the national program for the fisheries sector.

These same broad goals -- resource sustainability, occupational opportunity, and greater equality in incomes -- characterize fisheries development plans of the current five year plan (REPELITA IV, 1983/84 - 1978/88; DGF, 1983). Increases in marine landings remain an important goal, but to achieve this, Indonesia's fisheries planners have identified two priority issues for the future development of the national fisheries sector: effective resource management to assure high and sustainable yields, and programs to improve incomes and standards of living among small scale fishermen.

2.3.1 Fisheries Management Policies

A compendium of marine fisheries regulations during the period 1916 - 1976 has been published by Yasamina (1976). During the Dutch colonial period and after independence, marine fisheries management policies have been most concerned with coastal fisheries and small-scale fishermen. This focus of attention is understandable due to the near absence of motorized fishing boats capable of exploiting offshore waters prior to 1970. Even after that time, fisheries management policies have given special attention to coastal fisheries, which have come under increasing pressure from both small and medium scale fisheries. The ban on all trawler operations is the most recent in a series of management policy measures initiated during the colonial era that are designed to protect coastal fisheries resources.

After independence, regulations established during the Dutch colonial period remained largely unchanged until the early 1970s. 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 a manner which best benefits all Indonesians.

Prior to 1966, marine fisheries in Indonesia were almost exclusively small scale in nature, depending on gear of limited efficiency to exploit near shore waters. 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.

For the most part, these measures proved unenforceable. Inadequate patrol craft were available to ensure that trawlers and other highly effective fishing units (e.g., purse seines) did not operate in direct competition with small scale fishermen. Regulations affecting allowable mesh size also went unenforced.

2.3.2 Fisheries Development Programs

The DGF is the government agency primarily responsible for fisheries management and development activities. Viewed from the perspective of the staff and financial resources committed, however, it is clear that the primary business of the DGF is development. In the last two years, development efforts have been focused on increasing export earnings, particularly from shrimp.

2.3.3.1 Motorization

The majority of Indonesia's fishermen are limited by their use of sail powered boats to exploiting near shore fishing grounds (Table 5). This concentration of fishing effort is a major contributing factor to low productivity among small scale fishermen where inshore resources are under heavy pressure and offer little hope of increased landings.

Indonesia's fisheries development programs have emphasized greater exploitation of offshore fisheries through expanded use of inboard and outboard engines. The limited effectiveness of the most commonly used small scale fishing gear (Table 9) is recognized as a constraint to increased landings by small scale fishermen, but the more basic problem is seen to be the concentration of fishing effort in coastal waters necessitated by the widespread use of sail powered boats. Only with the use of engines can small scale fishermen venture more than a few miles from shore.

Several government loan programs have been established to assist small scale fishermen willing to adopt motorized fishing. In some cases, small scale fishermen are being encouraged to use boats powered by small inboard engines, with emphasis currently being given to those in the 5-7 GT class (DGF, 1982b). Boats of this size are sufficiently large to operate in relatively rough conditions. Inboard engines are both more reliable and more fuel efficient than outboard engines, but their initial cost is substantially higher. In addition to higher engine costs, it is nearly impossible to fit inboard engines to existing non-powered boats and the necessity of constructing a new hull further increases investment costs (Yamamoto, 1978). Recognizing these problems, the DGF has decided to encourage through government loan programs, the adoption of outboard engines on existing boats. This lowers the total credit obligations of individual fishermen and allows the government to use finite financial resources to reach a larger proportion of the target group.

TABLE 9: Total Number of Fishing Units by Gear, Total Landings by Gear Units (mt), and Estimated Average Annual Landings Per Unit (mt), Indonesia, 1982

Type of Gear	No. of Gear	Total Landings	Landing/ Unit
Throughout Indonesia	404,259	1,490,719	3.7
Double rig shrimp trawl	188	8,547	45.5
Otter trawl	453	11,290	24.9
Other Trawls	177	5,575	31.5
Payang seine	13,133	131,209	10.0
Danish seine	2,837	18,622	6.6
Beach seine	7,202	51,754	7.2
Purse seine	4,933	191,704	38.9
Drift gill net	65,749	244,410	3.0
Encircling gill net	5,836	33,186	5.7
Trammel net	31,567	89,513	2.8
Set gill net	29,880	83,091	2.8
Mobile lift net	6,493	70,440	10.8
Stationary lift net (inc. kelong)	12,536	85,973	6.9
Scoop net	6,274	13,659	2.2

TABLE 9: Total Number of Fishing Units by Gear, Total Landings by Gear Units (mt), and Estimated Average Annual Landings Per Unit (mt), Indonesia, 1982 (continued)

Type of Gear	No. of Gear	Total Landings	Landing/ Unit
Other lift net	8,442	39,982	4.7
Tuna long line	73	4,970	68.1
Other drifting long line	3,485	6,687	1.9
Set long line	7,701	16,472	2.1
Skipjack pole and line	541	27,126	50.1
Hand lines	98,641	126,586	1.3
Troll lines	39,214	48,527	1.2
Guiding barrier	8,494	46,528	5.5
Stow net	3,732	35,265	9.4
Portable trap	6,610	12,874	1.9
Other traps	11,046	24,390	2.2
Muroami	324	3,479	10.7
Cast nets, harpoons, etc.	21,271	17,292	0.8
Sea Weed gathering	4,840	13,737	2.8
Shell fish gathering	4,840	27,436	5.7

SOURCE: DGF (in press)

The use of outboard engines gives small scale fishermen a wider operational range and reduces dependency upon the vagaries of wind and other weather conditions. By encouraging the use of powered boats, it is hoped that fuller exploitation of offshore resources will be achieved, and at the same time, fishing pressure on heavily exploited inshore waters reduced.

Fishermen using inboard and outboard powered boats are able to operate further from shore, but do not always do so. This is especially the case when, as part of a government loan, fishermen are provided with gear only suitable for operating in near shore 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. With official encouragement, the use of this gear is expanding as a means of exploiting shrimp resources after the banning of trawlers along these coasts. Small scale fishermen using motorized boats in association with this and other gear operate more days each year, but continue to focus their fishing effort on near shore waters (DGF, 1982b).

2.3.3.2 Credit Programs

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 to fishermen. As local residents, these lenders are in a position to assess the relative risks in providing loans to individual fishermen based on personal judgments 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. 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 Emmerson, 1980). 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 inequitable one, and that the credit ties between fishermen and the fish buyers are an important cause of poverty among small scale fishermen. This impression has been supported by several outside observers, including Steina (1972) and Hotta (1982), FAO experts who have advised the Indonesian government on the establishment and implementation of formal institutional credit schemes.

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.

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 with an interest rate of 10.5% per year, well below the commercial bank rate reported by Hotta (1982) of 24-36% per year for loans of this size and relative risk. The repayment period is 10 years with a four-year grace period. In 1972, Rp 6.63 billion (US $10.6 million) was disbursed through the KIK; this amount includes credit to both marine capture fishermen and fish farmers (Hotta 1982).

The KMKP (Kredit Modal Kerja Permanen, or working capital credit program) was designed to supplement the KIK by providing operational rather than investment funds. The interest rate is higher (12%) and the repayment period is shorter (3 years). In 1979, a total of Rp 635 million (US $1.02 million) was disbursed through the KMKP program (Hotta 1982).

The repayment performance of KIK and KMKP loans has been disappointing. Hotta (1982) notes that in East Java, over 20% of all KIK loans were overdue and that in 1981 the BRI regional office for Central Java discontinued the KIK program due to repayment problems. The reasons for these failures have not been assessed adequately but may be related to some or all of the following problems.

KIK and KMKP credit programs are administered by the BRI. Loan applications are prepared with the assistance of fisheries extension officers and are screened by a committee which includes bank officers, staff of the local Fisheries Service, and others. KMKP loans are disbursed as cash, but KIK loans are provided in kind, typically as a package which includes engine, gear, and hulls. Hotta (1982) notes that it takes an average of two to three months before a KIK loan is approved. After this, further delays are encountered by KIK loan recipients, especially if a new boat is to be constructed. In some cases, delays of up to 6 months occur from the time the application is approved until the new fishing unit is ready for operation (Hotta, 1982). In some cases, the boats prove unsuited to local conditions; similar problems have been noted regarding the type of gear provided under this loan program (Comitini and Dibbs 1978).

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.

Other factors also discourage fishermen from applying for KIK and KMKP loans. Loan 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. Loan repayments and auction fees/taxes combined thus 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).

Despite the problems affecting fisheries credit programs in Indonesia, these programs have been successful in increasing the amount of funds available to small scale fishermen. Nonetheless, it is clear that government loan programs have not eliminated the informal credit ties between buyers and fishermen. Part of the reason for this is the more flexible approach taken by local creditors in dealing with the needs of fishermen. Another factor is the limited availability of government funds. Hotta (1982) notes that in one area of Central Java, over 1,400 applications for credit were received during 1980-81; only 250 applications were accepted due to a shortage of funds allocated to that area. Hotta also notes that in East Java, during the period 1974-81, KIK loans were given to a total of 1,348 fishermen. In 1976, the first year for which data are available, there were 141,400 fishermen in that province, a figure which grew to 179,000 by 1982 (DGF, 1979; DGF, in press).

2.4 Socio-Economic Conditions

There is considerable evidence that nearly half of all Indonesian fishermen obtain at least part of their income from sources other than fishing but that this occupational multiplicity declined during the 1970s. By 1983, 61% of fishermen from Java's north coast were totally dependent upon fishing (Table 9), compared with about 45% in 1973 (Biro Pusat Statistik and DGF, 1979). Dependence upon fishing increased at an even higher rate along the Malacca Straits, where in 1973, 47% of all owners and 42% of all crewmen relied exclusively on income from fishing (ibid.). By 1982, 77% of all fishermen operating in the Malacca Straits had no other source of income (Table 3).

Increasing reliance on seasonal and often unpredictable income from fishing reflects a number of important changes in the economy of coastal fishing villages in Indonesia. In some areas, notably on Java, a growing population of landless agricultural laborers limits the ability of the agricultural sector to absorb surplus labor from the fisheries sector during seasons of poor catch. However, case histories have been presented of a number of landless agricultural households who shifted from agriculture to fishing along the north coast of Central Java. Recent studies indicate increasing out-migration from agricultural communities on Java due to population pressure and the introduction of new rice production technologies and practicies which have tended to limit employment opportunities among landless laborers.

The implications of these developments for the fisheries sector are two-fold: a likely increase in numbers of fishermen, particularly in the small scale sub-sector where minimal requirements for capital or skill place few impediments to the entry of additional fishermen; and the reduction of opportunities in the agricultural sector for residents in coastal fishing villages.

Where pressures on agricultural resources are less severe, alternative economic opportunities contribute to reduced dependence upon fishing as the sole source of income. Such dependence is highest on Java and Sumatera and tends to be considerably lower on Sulawesi, Kalimantan, the Lesser Sunda Islands, the Moluccas, and Irian Jaya, where population densities are much lower.

One factor that 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. Particularly significant is the expanded use of outboard powered boats among small scale fishermen (Table 5). The construction of larger boats capable of withstanding rough seas is also being encouraged through government loan programs in some areas and efforts are being made to identify and encourage the use of gear or combinations of gear which will allow for fishing throughout the year (DGF, 1982b).

Insofar as these developments are successful in reducing seasonal variations in catch, technical improvements will reduce the need for secondary employment during off seasons and encourage full time rather than part time fishing. The relatively large capital investment in such new fishing units 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 degree of fishermen's dependence on fishing may also vary due to differences in fishing grounds and types of species exploited. Fishing grounds in the Malacca and Makassar Straits, for example, differ in important respects. Broadly speaking, conditions along the Malacca Straits are far more uniform than is the case along the Makassar Straits. In the former area, the fishing grounds are sheltered from the northwest and southeast monsoons by the island of Sumatera and by Peninsular Malaysia, 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 deep water fishing grounds, though 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. Data from the 1977 Socio-economic Survey shows that a wider range of gear types are used in conjunction with outboard powered boats along the Makassar Straits than the Malacca Straits (DGF, 1978).

2.4.1 Economic Advantages of Diverse Income Sources

Indonesian capture fisheries are typically seasonal, resulting in periods of serious underemployment among fishermen. Thus, there are a number of economic advantages to having a diversity of income sources rather than engaging in full time fishing.

In production terms, the introduction of improved boats and gear represents a positive development, particularly if fish landings are improved during periods of seasonal decline. Improved boats and gear would provide a more constant supply of fish to local consumers and reduce fluctuations in employment and income that are common within coastal fishing communities.

Increasing dependence on fishing as a sole source of income, however, may have unanticipated negative consequences, particularly where seasonally migratory pelagic species constitute a high proportion of the total catch, where the available fisheries resource is not well defined, or where this resource already is under heavy fishing pressure. Under such circumstances, the risks inherent in marine fisheries are increased. Specialization further increases these risks. Maintaining a diversity of economic pursuits may be crucial to the long term economic survival of particular fishing households and communities. Even during peak fishing seasons, the uncertainty of economic returns, heightened in areas where the stocks are under heavy fishing pressure or where marketing problems exist, increases the risks inherent in fishing. Under such circumstances, economic rationality encourages diversification rather than specialization as a means of flattening out fluctuations in income and reducing seasonal underemployment.

In one of the more important findings of the DGF's 1975 and 1977 Socio-economic Surveys, it was found that full time fishermen -- both owners and non-owning crewmen -- had lower household incomes than part time fishermen. The 1977 Survey

(DGF, 1978) indicates that, with few exceptions, owners in the Malacca and Makassar Straits who relied entirely on fishing had lower household incomes than those in the category "part time-major." In many cases, those fishermen's households which reported less than half of their income as being derived from fishing (i.e., part time-minor) had incomes higher than those in the full time category. The only consistent exception to this pattern is among owners of inboard powered boats along the Malacca Straits, whose incomes are far above those in the small scale sub-sector. In both areas, the highest household incomes among all categories of boat owners combined were those from the "part time-major" group.

Along the north coast of Java, the highest household incomes among owners were reported to be those in the "part time-minor" category (Rp 212,000), followed by "part time-major" (Rp 204,000), and finally by full time fishermen (Rp 156,000) (DGF, 1976). Unlike data from the 1977 Survey, those from the 1975 Survey were not disaggregated by type of boat owned. They do, however, underscore the widespread importance and positive contribution to household income of economic activities outside of fishing among owners.

Among crewmen's households, income from sources other than fishing is, if anything, even more important. Along the north coast of Java, "part time-major" crewmen had the highest household incomes (Rp 124,000), followed closely by those in the "part time-minor" category (Rp 122,000), while crewmen who relied on fishing as their sole source of household income had the lowest incomes (Rp 101,000) (DGF, 1976). Full time crewmen from the Malacca and Makassar Straits also had lower incomes than those with other economic activities, with "part time-minor" crewmen reporting the highest household incomes of any category (DGF, 1978).

2.4.2 Primary Sources of Income among Fishing Households

The 1975 and 1977 Socio-economic Surveys provide data on primary source of total household income among owners and crewmen (see Table 10). Among owners' households in all three areas covered by the two surveys, agriculture (including animal husbandry) is the most important primary source of income after fishing and is particularly significant among owners' households along the Makassar Straits. Agriculture is also the most important primary source of income among crewmen's households in the Malacca and Makassar Straits (and especially in the latter area) but not among those from the north coast of Java. Trading activities also are important among owners' and crewmen's households along the Makassar Straits, but less so in the other two areas. A very small percentage of fishermen's families in any of the three areas depend primarily on income from regular salaries, though cash incomes from wages (e.g., carpentry or other labor excluding fishing and presumably agriculture) are important, particularly among crewmen's households from the Makassar Straits. Table 10 shows that fishermen's households along the Makassar Straits have the most diversified economic base of the three areas covered by the 1975 and 1977 Surveys.

TABLE 10: Percentage of Owners' and Crewmen's Households along the Malacca Straits, the Makassar Straits, and the North Coast of Java by Their Primary Source of Income, 1975 - 1977

Major Source of Income	Malacca Straits		Makassar Straits		N. C. of Java	
	Owner	Crewman	Owner	Crewman	Owner	Crewman
Own fishing effort	85.2	-0-	52.5	-0-	87.5	-0-
Fishing laborer	1.8	82.1	9.7	44.8	1.9	96.7
Agriculture and livestock	8.9	9.7	22.9	20.5	4.0	0.7
Trade	0.3	0.6	6.1	7.8	2.4	1.6
Wage other than fishing	3.1	3.8	5.9	14.1	3.4	1.0
Salary	0.3	-0-	0.3	1.1	0.7	-0-
Others	0.4	3.8	2.5	2.6	0.1	-0-

SOURCE: DGF, 1976, DGF, 1978

Along the north coast of Java, fewer households rely on employment other than fishing as a primary source of income. This is particularly so among crewmen's households, 97% of which report their primary source of income as being derived from fishing labor. Less than 1% of these households report agriculture as the primary source of income, compared with 4% among owners' households. Both these figures are well below those reported along the Malacca and Makassar Straits and reflect the relative difficulty in obtaining access to land or employment in the agricultural sector in coastal Javanese communities.

It was suggested above that fishing conditions along the Makassar Straits were more diverse than those found in the Malacca Straits or off the north coast of Java, and that this resulted in a wider range of different boat and gear combinations being used in the Makassar Straits. 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 10 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% of owners 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. Table 10 only reports those owners whose primary source of income is from employment as crewmen.

Similarly, data from Table 10 probably underrepresent the importance of non-fishing income because they report only the primary source (i.e., the largest single source for a given household) of income. Many households who report fishing as their primary source of income also may earn secondary incomes from other economic activities to supplement that earned from fishing. The contributions to household incomes of women and children have not been adequately documented. Aminah and Widjayanti (1980), the only authors to address this issue to date, report that women earn 8-11% of household incomes in the fishing community of Muncar, East Java, primarily through employment in trading (fish and sundry goods) and fish processing. Mubyarto et al. (1984) also provide insights into this neglected topic, but do not provide quantitative data on incomes earned by fishermen's wives and children.

2.5 Marine Fisheries Commodities Having Development Potential

Indonesia's marine fisheries may be characterized as being multi-species and multi-gear. With few exceptions (e.g., pole and line for skipjack tuna), individual Indonesian fishermen of necessity exploit a wide range of species and often do so by switching from one type of gear to another to take advantage of seasonal changes in species availability. That this is so is clear by comparing the approximately 300,000 fishing boats reported operating in 1982 with the 404,000 gear units in that same year (DGF, in press). Many of the most common fishing gear found in Indonesia (Table 9), including the various types of gill nets and seines, are designed to capture a wide range of associated species. Even fishermen who use only one gear type targeted for one species (e.g., trammel nets for penaeid shrimp) typically capture a mix of associated species.

Seasonal variability in species availablity is particularly important for migratory pelagic fish. During certain seasons various mackerels, scads, herrings, and sardines are concentrated in nearshore waters and are more easily exploited than when these same species migrate and probably disperse offshore. The factors which appear to determine the migratory patterns of these small pelagics are related to increases in primary productivity in nearshore waters associated with seasons of heavy rainfall, notably the West Monsoon (November-February). During this season, nearshore waters are enriched by nutrients carried by rivers and by general turbulence in shallow waters which mixes nutrients from the bottom throughout the water column.

Demersal finfish and shrimp species are far less migratory than pelagic species. As a general rule, the spatial distribution of demersal species of current commercial importance in Indonesia is linked to the species' life cycle. Juvenile coral reef fish, for example, are concentrated in relatively shallow reef flats while mature larger individuals of these species are more commonly found in deeper waters at the reef edge. Other demersal finfish follow a similar pattern wherein shallow coastal waters, mangrove forests, and estuaries serve as nursery grounds while mature fish are concentrated in deeper waters; penaeid shrimp follow a similar pattern (Pauly, 1982).

Compared to the more highly migratory pelagic species, the presence of demersal species is less seasonally variable. However, during seasons when these pelagic species are locally abundant, fishermen, who for most of the year operate demersal gear, often switch to the use of pelagic gear. In some cases, an owner-operator will possess more than one type of gear to take advantage of the seasonal shift in resource availability. In other cases, an owner-operator of a boat used for demersal fishing joins, as a crewman, a fishing unit equipped for pelagic fishing. Crewmen who own neither boats nor gear also shift from one type of fishing unit to another.

In this multi-gear, multi-species context, the identification of specific fisheries commodities with development potential in Indonesia generally must focus on species groups rather than individual species. Further, given the concentration of effort in a limited set of fishing grounds, notably the north coast of Java, the Malacca Straits, and the Province of South Sulawesi, discussion of development potentials divorced from geographic referents is not realistic.

2.5.1 Small Pelagic Species

Considerable potential exists using locally available small scale fishing technologies to incease harvests of small pelagic species, especially in the eastern half of the archipelago (NTB, NTT, the Molucca Islands, and Irian Jaya) and in waters off Kalimantan and the northern portion of Sulawesi (Table 8). Abundant and relatively underexploited pelagic resources are also reported to exist off the eastern coast of Sumatera (i.e., the South China Sea) and in waters of the Indian Ocean off Java and Sumatera (Table 8). However, the ability of small scale fishermen to exploit pelagic resources in these areas is limited either by distance (e.g., the South China Sea) or by frequently rough seas, conditions which require investment in larger, more seaworthy boats. Development in this direction is problematic given the discouraging results of the recently concluded exploratory fishing surveys in the Indian Ocean conducted jointly by the DGF, the GTZ, and the Australian government (JETINDOFISH, 1982). These surveys failed to locate any significant concentrations of pelagic fish, calling into question estimates of stock density based on analyses of primary production both in these waters and in the South China Sea (reviewed in Dwiponggo, in press).

Discussions with local fisheries officers and fishermen in Ambon, the Moluccas, the island of Sumbawa, South Kalimantan Province and North Sulawesi Province indicate the existence of abundant stocks of small pelagic species and the ability of local small scale fishermen to exploit these resources in coastal waters using drifting gill nets, small purse seines, payang seines, and lift nets.

The primary constraint limiting fishing effort in these areas is the limited absorptive capacity of local markets due to low population densities and the lack of an effective distribution system which links these areas of abundant supply with Java where levels of fish consumption are far below the national average (Table 2).

As described later, the resolution of these marketing constraints offers considerable opportunities for expanded harvests and employment opportunities, increased incomes of small scale fishermen, and increased availability of fish to consumers on Java. Efforts in this direction will have no impact on fisheries exports and minimal impact on imports of fisheries products (e.g., canned fish).

2.5.2 Demersal Finfish

Estimated levels of exploitation of demersal finfish resources suggest considerable scope for expanded harvests (Table 8). However, these estimates include both coastal and offshore stocks and are therefore misleading. Demersal finfish resources in coastal waters off the north coast of Java, for example, appear to have been fully exploited in 1981 even after trawlers (which on average between 1975 and 1979 accounted for 40% of total demersal landings in this area) were banned by Presidential Decree No. 39 of 1980 from operating in these waters (Dwiponggo, 1983).

Those demersal finfish resources which remain underexploited for the most part occur in offshore waters. The only systematic surveys of such resources were conducted jointly by the MFRI and the GTZ in the Java Sea during the period 1975-79. The findings of these surveys, reviewed by Dwiponggo (in press), indicate that stock densities tend to decline with increasing depth and distance from shore. The only practical means of exploiting these resources is by trawling, but low catch rates combined with the presence of bottom obstructions which snag nets raise doubts about the economic feasibility of such trawling, which is, in any event, currently banned.

The only area where clear evidence exists indicating abundant demersal finfish resources is in coastal waters off Central Kalimantan Province. Less than 12,000 marine fishermen operate along this sparsely populated coast (Table 3), though limited numbers of Javanese fishermen appear to cross the Java Sea on a seasonal basis to exploit the relatively rich fisheries resources in this area. Collier (1980) reports that 300 Javanese fishermen attempted to settle in this area but were denied permission by the Provincial government when local fishermen objected.

The economic feasibility of exploiting demersal (as well as pelagic) resources in this area depends on improvement of marketing channels to Java for fresh, iced and salted dry fish. At present, small privately owned carrier boats carry ice from Jakarta across the Java Sea and purchase fish directly from fishermen at sea (Ir. Hendrik Sihombing, Head, Central Kalimantan Fisheries Service, pers. comm., 1984), suggesting that this approach is economically feasible. Questions remain regarding prices paid to fishermen under this system (ibid.).

Providing that market access at attractive prices is available, considerable scope exists for expanded harvests of demersal finfish from Central Kalimantan Province by small scale fishermen. Proximity to Java and the existence of seasonal migration of Javanese fishermen suggests that the impact on employment and earnings could be more substantial than suggested by the relatively small numbers of marine fishermen reported to operate in Central Kalimantan Province. Increased utilization of fisheries resources in this area promises to increase supplies of fish to domestic consumers, especially on Java. The impact on export and import of fisheries resources is likely to be minimal.

Figures from Table 8, which suggest low levels of demersal finfish exploitation in the Indian Ocean and other generally deep water fishing grounds (e.g., the Moluccas Islands, Irian Jaya, and the northern portion of Sulawesi) are not based on adequate data regarding stock densities. Moreover, the economic feasibility of exploiting deep water demersal species is unclear.

2.5.3 Penaeid Shrimp

Given their high value, it is not surprising that levels of exploitation of penaeid shrimp are, on average, far higher than for either pelagic or demersal finfish (Table 8). Neither is it surprising that the DGF projects that penaeid shrimp resources will be exploited at nearly 100% of MSY by 1994 (Table 11).

The banning of trawlers from waters off Java and Sumatera, which came into full force in 1981, and the extension of this ban throughout Indonesia except for the Arafuru Sea at the beginning of 1983, reduced shrimp harvests but also gave greater opportunities for small scale fishermen to exploit these resources. Expanded government credit facilities were made available to small scale fishermen to motorize boats and purchase gear, especially trammel nets, which are effective in capturing shrimp. Between 1979 and 1982, the number of these nets increased from approximately 24,800 to 31,600 (DGF, 1981; DGF, in press). Other significant concentrations of trammel nets (in order) are found in the Malacca Straits, South Sulawesi Province, and the south coast of Central Java Province, and in West and East Kalimantan Provinces (ibid.).

Table 11: Projected Level of Marine Fisheries Resource Exploitation, 1994

COASTAL FISHING AREAS	RESOURCE POTENTIALS INCL. EEZ (MT)			LANDINGS (MT)			LEVEL OF EXPLOITATION (%)		
	*A	*B	*C	*A	*B	*C	*A	*B	*C
West Sumatera	262,400	169,100	900	87,000	20,000	900	33.2	11.8	100.0
South Java	166,100	112,700	5,500	38,400	20,200	3,400	23.1	17.9	61.8
Malacca Straits	133,600	78,300	20,000	133,600	78,300	20,000	100.0	100.0	100.0
East Sumatera	413,600	631,200	4,000	183,000	210,200	4,000	44.2	33.3	100.0
North Java	363,500	322,900	12,000	363,500	93,700	12,000	100.0	29.0	100.0
Bali, Nusa Tenggara, East Timor	259,100	215,700	500	102,400	38,600	400	39.5	17.9	80.0
South/West Kalimantan	156,000	245,200	3,200	156,000	105,500	3,200	100.0	43.0	100.0
East Kalimantan	154,300	199,500	5,000	154,300	196,000	5,000	100.0	98.2	100.0
Southern Sulawesi	155,100	69,000	-0-	155,100	67,700	900	100.0	98.1	-0-
Northern Sulawesi	368,100	80,500	-0-	165,900	42,800	100	45.1	53.2	-0-
Moluccas/ Irian Jaya	1,530,000	470,900	18,000	422,900	216,200	18,000	27.6	45.9	100.0
T O T A L	3,961,800	2,595,000	69,100	1,962,100	1,089,200	67,900	23.5	11.0	61.8

NOTES: *A = Pelagic
*B = Demersal, excluding shrimp, including coral reef fish
*C = Shrimp, including only large penaeid shrimp (P. Monadon, P. Semisulcatus, P. Indicus)

Total resource exploitation = 19%

SOURCE: DGF

Trammel nets are the most effective but are not the only type of demersal fishing gear capable of exploiting penaeid shrimp. These shrimp also are caught by bottom-set gill nets, and a variety of fixed gear set in shallow water which use coastal currents to carry shrimp and other species into their nets.

The removal of trawlers has significantly reduced pressure on demersal resources (including both finfish and shrimp) in the Malacca Straits, off the north coast of Java, and in several other important fishing grounds (e.g., off Cilacap). The impact on employment and incomes has been favorable (Bailey, 1984; Martosubroto and Badrudin, 1984). Current governmental emphasis on expanding shrimp harvests by small scale fishermen and extending fishing effort away from the heavily exploited coastal fringe is determined not only by these socio-economic factors but also by the desire to increase export earnings from shrimp.

2.5.4 Shellfish

Various forms of shellfish naturally occur throughout Indonesia and provide an important part of the diet of the coastal population, especially when fish landings are low. Total reported harvests of blood cockles, hard clams, oysters, and scallops (in order of importance) were less than 35,000 mt in 1982, 30,000 mt of which came from the Malacca Straits. The blood cockle accounts for about 90% of the harvest from this area.

Shellfish are popular food items throughout Southeast Asia, though relatively less so in Indonesia. Elsewhere in the region, cockles, mussels, and oysters are cultured using small scale production techniques. In Indonesia these techniques are virtually unknown, though in 1981 the Governor of Jakarta launched a highly publicized green mussel production scheme in the heavily polluted Jakarta Bay in an effort to diversify the incomes of local fishermen. The appropriateness of this site for production of filter feeding mussels can be questioned. However, similar production trials in Banten Bay conducted with the assistance of the Japanese International Cooperation Agency (JICA) showed promising results. The advantage of shellfish mariculture compared with mariculture of finfish is that no supplemental feeding is required. What is required is a sheltered body of water with high natural productivity in areas of natural spat fall. However, fisheries development planners have available only limited information on areas of potential for shellfish culture.

In the absence of sewage treatment facilities, shellfish mariculture sites need to be located away from major population centers. Shellfish contaminated with heavy metals are unable to cleanse themselves and, unlike pathenogenic organisms, are not destroyed by adequate cooking. Water quality must be a paramount concern when considering expanded shellfish production from mariculture systems or from the natural environment.

Consumer acceptance of shellfish remains unproven, except in areas along the Malacca Straits, yet these products offer great potential for increasing supplies of high quality protein to domestic consumers. As is true for most marine commodities, the Java market offers the greatest potential for absorbing increased production. Pollution from industrial, agricultural, and domestic sources limits the number of potential production sites on Java, but it is possible that favorable locations exist in nearby Lampung and South Sumatera Province. Because of the high weight-to-value ratio of shellfish, production aimed at the Java market from more distant locations may not be economically feasible.

Production trials for green mussels in Banten Bay indicated that 5-6 mt per hectare were possible (Tokio Asazu, pers. comm., 1982). In 1982 retail prices for this product in Jakarta were approximately Rp 400/kg. No costs of production data were available, but if the producer received half the retail price for 5 mt of green mussels, gross receipts would be Rp. 1 million per hectare.

Were shellfish production to increase dramatically, consideration could be given to canning part of the production for domestic and export markets. This remains a long term possibility. In the short term, production should be geared to domestic markets, especially on Java. The overall impact on available protein supply is likely to be small compared with other fisheries products. However, increased supplies of shellfish would diversify sources of food supply and provide substantial economic opportunity to small scale producers.

2.5.5 Skipjack Tuna

Estimated annual MSY for skipjack tuna in waters under Indonesian jurisdiction is over 275,000 mt (Table 6). Reported skipjack landings in 1982 totaled less than 62,000 mt. However, foreign pole and liners and purse seines also are involved in exploiting these resources, sometimes with licensed permission and sometimes not. Ayodhyoa (1983) reports that in 1974 nearly 11,000 Japanese pole and liners, mostly large boats displacing over 250 gt, operated in Indonesian waters (including the EEZ) and caught over 66,000 mt of skipjack. Thereafter, numbers of Japanese pole and liners declined and purse seines from Japan came to play an increasingly important role in skipjack harvests. Ayodhyoa reports that in 1979 Japanese purse seines caught over 26,000 mt of skipjack and in the first four months of 1980 caught over 14,000 mt. He suggests that South Korean and Taiwanese fishermen may have caught an equivalent amount. Fishermen from the Philippines, Thailand, and the U.S. also are active in Indonesian waters, but no data on their harvests of skipjack were available to Ayodhyoa or reported in the "Proceedings of a Technical Working Group Conference on Tuna and Skipjack" held in Bali during May 1982 (Pusat Penelitian dan Pengembangan

Perikanan, 1983).

Stock assessment and management of such highly migratory species as skipjack tuna are made difficult by the refusal to acknowledge international boundaries. Harvests of skipjack in Philippines' waters, for example, probably affects skipjack populations which pass through Indonesian waters (ibid.). The widespread use of aggregating devices in conjunction with purse seines in the Philippines has been reported to have led to the capture of juvenile skipjack, which may negatively affect recruitment of stocks shared by Indonesia and the Philippines (D. Pauly, ICLARM, pers. comm., 1981).

Nonetheless, there is general consensus within Indonesia that increased landings of skipjack are possible, especially in the eastern half of the archipelago. The Asian Development Bank (ADB) obviously agrees and has recently signed a loan agreement for US $34 million to expand operations of P.T. Usaha Mina, a State Fishing Enterprise based at Sorong, Irian Jaya. In 1973, ADB supported the creation of this Enterprise through a loan of US $7.9 million. Two other State Fishing Enterprises (based in North Sulawesi and Ambon) engaged in skipjack fishing were established with assistance of loans from the World Bank totaling US $7.4 million.

Thus, total international assistance in developing Indonesia's skipjack fisheries currently stands at US $49.3 million. The Indonesian government invested over Rp. 11.6 billion in these three enterprises during the mid-1970s (approximately US $28 million using an exchange rate of Rp 415 = USD $1.00). The government has committed a further Rp 9.75 billion (US $9.2 million at the current exchange rate of Rp 1060 = US $1.00) to expansion of P.T. Usaha Mina.

Between 1976 and 1982, these three State Fishing Enterprises exported just over 32,000 mt of skipjack valued at US $33.3 million (ibid.). These three enterprises accounted for 12% (7,426 mt) of total skipjack landings in Indonesia during 1982 (61,557 mt) and exported 90% of their catch, earning US $4.7 million in foreign exchange.

The ADB and the World Bank currently have major investments in this field. Projected increases in landings require extended voyages by large purse seines and pole and liners. These are capital rather than labor intensive operations and, while contributing to foreign exchange earnings, offer limited employment opportunities and add little to domestic fish supply.

Recommendations proposed elsewhere in this report regarding stock assessment research will directly benefit development of pelagic fisheries, including skipjack, in the eastern half of Indonesia by identifying underexploited fishing grounds for skipjack and baitfish (primarily anchovies) used as chum by pole and liners.

2.5.6 Large Tunas

Estimated annual MSY for large tunas is 166,300 mt, with fishing grounds in the eastern half of the archipelago showing the most promise (Table 6). Total landings of these species in 1982 were only 28,000 mt (DGF, in press). Like skipjack tuna, these large tunas are migratory and precise information on their abundance is lacking. Nonetheless, there is a clear consensus that levels of fishing effort can be expanded (Pusat Penelitian dan Pengembantan Perikanan, 1983).

If properly handled and quickly frozen to at least $-55\,^{o}C$, these large tuna species are a valuable export commodity. Unlike skipjack tuna whose price fell from approximately US $1,100 to less than US $700 per mt between 1981 and 1983, the world price for large tunas of higher quality has remained relatively constant at US $1,600 per mt (ibid.).

The only major exporter of large tunas within Indonesia is P.T. Samudra Besar, a State Enterprise based in Bali. This enterprise began operations in 1973 with assistance of a US $9.9 million loan from the Japanese Overseas Economic Cooperation Fund; the Indonesian government invested a further US $6.3 million in Rupiah equivalent (ibid.). Between 1976 and 1982, the volume of exports increased by over 400% to nearly 3,800 mt, while the volume of these exports increased 770% to US $5.2 million in 1982. Only a fraction of 1% of this volume was marketed domestically.

P.T. Samudra Besar accounted for only 13% of total landings of large tunas in 1982. Most of the remaining catch is landed by fishermen from South Sulawesi, the Moluccas, and West Sumatera Province using a variety of typically small scale fishing gear, including drifting long lines and troll lines. These gear are not targeted exclusively for tuna, but are used to capture a variety of pelagic species. Little, if any, of this catch is exported.

JICA has taken a lead role in developing capital intensive tuna long-line operations. The World Bank currently is considering a project to provide assistance to small scale fishermen exploiting large tunas with hand lines and other simple gear through the establishment of a freezing plant.

2.5.7 Cephalopods

Three species of cephalopods (squid, cuttlefish, and octopus) are present in Indonesian waters. Reported 1982 landings of these three species totaled less than 11,000 mt; squid accounted for approximately 90% of this total, with cuttlefish making up all but 86 mt (the octopus catch) of the remainder.

Approximately half the total squid catch was landed in three provinces (ranked by order): East Java, NTB, and South Sulawesi, but this species was landed in almost every province within Indonesia (DGF, in press). Cuttlefish appear to be less widely distributed, based on landings data, with the bulk of the catch occurring in the Malacca Straits and in West Kalimantan Province. Reported octopus landings are reported in only six provinces, the most important of which are South Sulawesi, NTT, and the Moluccas.

No data on MSY of these three species are available. Squid and cuttlefish are pelagic species commonly captured at night by use of lights to attract them and scoop nets to capture them. It is likely that levels of exploitation are nowhere near MSY, with the possible exception of squid in East Java. MSY for octopus, a coral reef dweller and hence classified as a demersal species, probably has not been reached though potential increases in landings are likely to be far more limited than in the case of this species' pelegic cousins.

There is a substantial international trade in cephalopods focused primarily on the Japanese market. High quality dried cephalopods are imported from various developing nations, and Indonesia could profit from this trade. Expanded harvests of cephalopods for domestic consumers depend largely on improving existing marketing and distribution channels for fresh and dried fisheries products in general. The latter commodity form is likely to be the more important, especially in areas far from major population centers.

Fisheries for migratory pelagic squid and cuttlefish are likely to be seasonal in any given area. As such, it is not likely that small scale fishermen will be able to depend on harvests of these species for more than a few months of the year. If market access is improved, however, these fisheries could provide important additional income to small scale fishermen. If through experimental fishing surveys (of the type proposed by Dr. Frankenberg) significant concentrations of these species were located, exploitation on a more sustained basis could occur. This would, however, require more intensive fishing units equipped with mechanical jigging devices long used by Japanese fishermen. Mid-water trawling is used in many parts of the world to catch related species in offshore waters, but the current ban on trawl gear in Indonesian waters precludes this option.

2.5.8 Seaweeds

Considerable interest exists in Indonesia regarding seaweed culture, especially in the lesser Sunda Islands (Bali, NTB, and NTT) and in the Molucca Islands. Culture techniques are simple and require relatively low levels of investment. Seaweed culture offers considerable scope for providing employment and income-earning opportunities to people living near shallow and sheltered coastal waters (e.g., between a coral reef and the shoreline). Small scale fishermen dependent primarily on seasonal pelagic fish stocks would be able to diversify their sources of income.

Production could be aimed at both export and domestic markets. Indonesia currently imports 350 mt of agar valued at US $530,000 in 1983. Total seaweed production in 1982 was 7,500 mt, 85% of which came from the Moluccas. All but a small portion of the total harvest comes from harvests of naturally occuring Eucheuma and (less important) Gracilaria stocks. Eucheuma culture in Indonesia has been attempted on a trial basis in East Java (Hollenbeck, 1980), NTT (Hollenbeck 1981), the Moluccas (Hollenbeck, pers. comm., 1982) and recently with technical assistance from LON on Bali (pers. observation, 1984).

The major constraint to expanding seaweed culture and production is marketing. Hollenbeck (1980) notes that there is only one international buyer in Indonesia and that the world market for Eucheuma is dominated by seaweed farmers in the Philippines. The world market is, moreover, highly volatile and characterized by extreme price fluctuations (Hollenbeck, 1980; Smith and Pestano-Smith, 1980).

Sustained development of seaweed production depends on the creation of reasonably stable market conditions. A major step in this direction would be for Indonesia to increase domestic capability to process seaweeds for use by local industries engaged in production of various commodities ranging from cosmetics to food. However, the relative ease with which seaweed production can be expanded to meet market demand suggests that supply will quickly outstrip domestic needs and that some degree of dependence on international markets will continue. By expanding processing capabilities, it may be possible for Indonesia to gain the benefits of added value and minimize the dislocations associated with international trade in dried seaweeds.

2.6 Marine Species/Species Groups with Greatest Development Potential

The preceeding section identified eight species/species groups having development potential in Indonesia. These qualitative assessments were based on criteria summarized in Table 12. This section identifies five main commodities or commodity groups having the highest development potential. As indicated on Table 12, the five species/species groups identified are small pelagics, demersal finfish, penaeid shrimp, shellfish, and seaweeds.

Skipjack tuna and large tunas are not included in this group due to the capital intensive nature of these fisheries, the limited employment opportunities they provide, and the high level of investment in these fisheries by international agencies (ADB, World Bank, JICA). However, recommendations in the following section regarding exploratory fishing and stock assessment for pelagic species will benefit these tuna fisheries.

Similarly, extensive investment in cephalopod fisheries is not recommended at this time. But here too, the recommendation for support of exploratory fishing and stock assessment of pelagic resources will benefit squid and cuttlefish fisheries.

Potential increases in harvests of octopus at this time appear to be insufficient to warrant investment as a separate endeavor. However, the recommendations in the following sections related to marketing and resources management could have a favorable impact on fisheries for all three species of cephalopods.

TABLE 12: Major Species/Species Groups With Development Potential in Indonesia

SPECIES/ SPECIES GROUPS	POTENTIAL DEVELOPMENT IMPACT, RANKED 1 (LOW) TO 5 (HIGH)						INT'L DONORS INVOLVED ?
	*A	*B	*C	*D	*E	*F	
Small Pelagics	5	5	5	1	1	5	No
Demersal Finfish	5	5	5	1	1	5	No
Skipjack Tuna	3	1	1	5	1	1	Yes
Large Tunas	2	1	1	5	1	1	Yes
Penaeid Shrimp	2	3	1	5	1	5	Yes
Shellfish	2	3	3	1	1	3	No
Cephalopods	2	2	2	3	1	3	No
Seaweeds	2	2	1	2	2	3	No

NOTE:
*A = Production
*B = Employment
*C = Nutrition
*D = Export
*E = Import Substitution
*F = Standard of Living

2.6.1 Small Pelagics

2.6.1.1 Potential for Increased Production

As noted in the preceeding section and shown in Tables 7 and 8, pelagic resources throughout most of Indonesia are underutilized, and this is particularly true in the eastern half of the archipelago. Even granted the imprecision of existing estimates of resource potential, it is likely that harvests could be doubled nationwide, with the exceptions of the Malacca Straits, the north coast of Java, and South Sulawesi. Even in this latter area, Dwiponggo (1983) suggests that potential exists for increased harvests offshore in the Makassasr Straits. In the Malacca Straits and along the north coast of Java, pelagic resources in near shore waters currently are heavily exploited and expanded harvests will depend on exploitation of offshore fishing grounds. This is currently being accomplished by means of medium scale purse seines of the 30 gt class. Purse seines of this type currently account for 27% of all landings along the north coast of Java (DGF, in press) compared to 16% in 1979 (DGF, 1981). During this period, landings by purse seines nearly doubled from under 49,000 mt to over 91,000 mt.

The banning of trawlers and the conversion of many trawlers to operate as purse seines have contributed to this increased fishing effort for pelagic species.

2.6.1.2 Constraints

Underlying the obvious vigor of the purse seine fishery for pelagic species off the north coast of Java is the huge market of that island. Outside of Java (and the neighboring island of Bali) per capita fish supply generally is at such high levels that local markets have limited capacity to absorb increased landings. In Aceh Province, for example, when trawlers were converted for operations with purse seines, the resulting increase in supply of food fish swamped local markets and drove down prices, negatively affecting incomes of many small scale fishermen operating less productive and economically efficient gear (pers. observation, December 1981).

Fishermen operating in the central "crescent" area (i.e., the southern half of Sumatera, Kalimantan, South Sulawesi, and NTB) are located in such proximity to Java as to have access to the market there through existing albeit imperfect distribution channels. Field visits to South Kalimantan and Sumbawa suggest that inefficiencies in marketing and distributing the local catch to Java contribute to low prices and discourage expansion of fishing effort. Fishermen outside of this crescent area are more geographically isolated from the center of demand which Java represents and lack access to that market. Limited absorptive capacity of local markets is a major constraint to expanded utilization of the richest pelagic resources in Indonesia.

2.6.1.3 Methods to Increase Harvests

Improving existing marketing channels and opening marketing outlets to Java from areas where these market do not exist is necessary to encourage expanded fishing effort by existing fishing units and investment in new and more productive boats and gear.

Existing small and medium scale fishing technologies in Indonesia are capable of increasing harvests of pelagic resources in both near shore and offshore fishing grounds. Medium scale purse seines from Java frequently make 7-10 day fishing trips and operate as far away as the waters off Kalimantan during certain seasons when stock abundance of migratory pelagic species in waters nearer to home is low. Small scale fishermen have a more restricted operational range, which frequently results in seasonal peaks in catch when pelagic species are concentrated in near shore waters, followed by seasons of lower catches and limited fishing activity.

The most common small scale gear used for the capture of small pelagic species are the drifting gill net, mobile and stationary lift nets, and mini-purse seines. Lift nets are used primarily for catching anchovies and small scales. Gill nets and mini-purse seines capture a wider range of species. Of these gear, the mini-purse seine, often used in conjunction with a fish aggregating device (rumpon) is the more productive.

The effectiveness of both gill nets and mini-purse seines depends largely on the amount of net put in the water, and this often is a function of capital available to invest. Expanded marketing opportunities should encourage added investment either with the assistance of government loan programs, by existing sources of credit provided by local buyers, or by the fishermen themselves.

Expanded marketing opportunities may also result in investment by small scale and other fishermen in larger, more seaworthy boats capable of extended voyages. This in turn will require the availability of ice to preserve the catch.

2.6.1.4 Resource Management Issues

Experience on Java suggests that small scale fishermen who adopt the use of engines and improved gear types frequently confine their operations to coastal waters rather than venturing further offshore (DGF, 1982b). This may be a function of relative stock abundance near shore (Dwiponggo, in press), but it may also reflect attitudes of Javanese fishermen, some of whom may be uneasy out of sight of land. This latter speculation is based on the relative weakness of seafaring tradition among Javanese when compared to such ethnic groups as the Bugis, the Moluccans, or the Bajao, to name the most famous. In addition, many Javanese fishermen, though by no means all, come from agricultural backgrounds either themselves or are one generation removed from this or other land based occupations.

Whether or not this characterization of Javanese fishermen is true, there can be no gain saying the ability and willingness of Bugis fishermen, who are scattered throughout the archipelago from Sumatera (Collier, 1980) to Sumbawa and beyond, to operate far from shore when the opportunity arises. The same may well hold true for other ethnic groups with strong seafaring traditions.

The implication of the foregoing speculation is that if expanded marketing opportunities were available, increases in fishing effort for migratory pelagic species might result not only when these species are present near the coast but also might continue when these species move to offshore waters. Present knowledge of pelagic resources in Indonesia (life cycles, population dynamics, stock assessment) provides an inadequate basis for resource management. As pelagic fisheries expand, there is a need to monitor the effect of increased exploitation. This can be accomplished effectively by taking length-frequency measurements from samples of the landed catch. The MFRI has a microcomputer and software package provided by ICLARM to analyze length/frequency distribution.

The time to begin management of a fishery is before the resource is threatened by overexploitation. At the present time, this threat is limited to nearshore pelagic fisheries in only a few areas. Even where pelagic resources are underutilized, however, monitoring the catch will provide valuable data for stock assessment purposes and for later management needs.

2.6.1.5 Potential Environmental Problems

Insufficient information is available on the life cycle of pelagic species to ascertain the possible impact of environmental degradation (e.g., disturbances of coral reefs, estuarine pollution) or resource abundance. Estuarine species probably are more at risk than those pelagic species which spend most of their time in oceanic waters.

2.6.1.6 Government Agencies

The DGF is primarily responsible for fisheries management and plays the lead role in such development activities as gear trials and extension services. The DGF also plays a role in fish marketing by establishing fish auction halls. The MFRI plays an important supporting role in conducting exploratory fishing surveys and providing analyses of stock abundance for management purposes.

2.6.1.7 Constraints to Improved Processing

Within the "crescent" area, pelagic species marketed to Java are presented either as fresh iced fish or as salted dried fish. The quantity of fresh iced fish is limited by supply of ice, which outside a few population centers is non-existent. Some carrier boats from Java carry ice to fishing grounds off Kalimantan and transport the catch to Jakarta. For most pelagic species, prices of iced fish are higher than processed fish, but limited availability and high prices for ice in most areas are serious problems. This problem will be discussed further in the following section.

Salted dried fish is the most likely product form for potential shipment to Java of small pelagics caught outside the "crescent" area. (Even within this area, salted dried fish predominates in inter-island trade.) Due to the distance and time it takes a ship to travel, for example, from Ambon to Surabaya (7-10 days), shipment of iced fish is not practical due to product deterioration and cost (Rp. 150-200/kg), and the absence of ice and cold store facilities in many small coastal fishing communities. This latter problem also precludes shipment of frozen fish which, moreover, has limited consumer acceptance on Java.

The only practical means of collecting fish from scattered locations and shipping the product to Java is as dried salted fish. Small pelagic fish in this form are readily accepted by consumers on Java, especially those in West Java. This product has an acceptably long shelf life (a month or more without deterioration) and can be shipped at half or less the cost of frozen or iced fish.

One problem associated with salting and drying small pelagic fish is that seasons of peak supply tend to coincide with the rainy season. As a result, labor costs associated with processing are increased and the product does not become sufficiently dessicated to provide maximum shelf life.

The Fish Technology Unit of MFRI in Jakarta and in Ambon has experimented with passive solar driers and driers equipped with a kerosene burner and fan, but these have achieved limited adoption. Based on limited information, one factor appears to be the absence of a price incentive to producers who have tried these driers in an effort to produce a superior product. Current trials in East Java, with financial assistance from Australia, are underway.

Dr. Gregory Sullivan reports that in an effort to produce high quality dried fish in Jakarta, insecticide (specifically Baygon) is applied to eliminate flies and hence maggots. This practice has been reported elsewhere on Java, and investigations should be performed to see if there is evidence of its use in other parts of Indonesia.

2.6.1.8 Source of Demand

As discussed above, expanded utilization of small pelagic species in most parts of Indonesia depends on developing marketing channels to Java. There appears to be limited scope for export trade unless harvests are increased sufficiently to justify the establishment of canneries.

2.6.1.9 Estimated Consumption

It is assumed here that demand for fish on Java is sufficiently high to absorb at least 100,000 mt of fresh fish. Demand for dried fish may be nearly that high, but no adequate data exist indicating how much of this product currently is being shipped to Java from other islands. Adding 200,000 mt of existing (1982) supply from marine and other fisheries (DGF, in press) would provide for annual per capita consumption of 8.5 kg (assuming a population of 95 million), far below that of any other island except Bali (Table 2).

One important comment needs mention: no adequate data are available regarding price elasticities and demand curves for fish on Java or elsewhere in Indonesia.

2.6.1.10 Past Initiatives

P.T. Tirta Raya Mina is a State Fishing Enterprise based at Pekalongan (Central Java) with assistance from the World Bank. The original purpose of this Enterprise was to exploit pelagic resources in the Java Sea for marketing on Java. Substantial losses incurred by fishing operations led to a switch in emphasis towards marketing and distribution of fish on Java. Operations include sending of large refrigerated carrier boats to Banjarmasin and Kota Baru in South Kalimantan, and to Ujung Pandang in South Sulawesi. Details of these operations are described in Dr. Gregory Sullivan's report. The essential points are that this Enterprise has been unsuccessful in marketing frozen fish on Java and has suffered major losses both with this product and with iced fish. In line with the GOI's emphasis on fisheries exports, this Enterprise has begun to shift use of its carrier boats to the export trade, especially of shrimp.

Other State Fishery Enterprises (e.g., the one in Ambon) have attempted to market frozen skipjack tuna on Java. This product is readily accepted by consumers on Ambon but not at this time on Java. Each of these State Fishing Enterprises, including P.T. Tirta Raya Mina, owns carrier boats which are underutilized. Whether some of this extra capacity can be used for expanded inter-island trade is subject to question. Most of these boats are of the 300-600 gt class and may be too large and expensive to operate for regularly scheduled voyages given current levels of fishing effort in areas of potential surplus supply. This may be a "no-win" situation, as the lack of regular marketing outlets which these carrier boats could provide is the major cause of limited fishing effort for small pelagic species where this resource is abundant.

At present, the World Bank is not directly involved in efforts to assist the GOI in developing inter-island trade for fisheries products. The ADB, through its US $27 million Fisheries Infrastructure Development Project (ADB, 1984), is supporting construction of new fishing ports and the upgrading of existing facilities, primarily outside of Java. The only major new port project currently identified is at Kendri (Southeast Sulawesi) and is being geared for export trade in skipjack and other tunas. This port facility also could serve as a bulking point for inter-island trade in locally abundant underutilized small pelagic species.

It should be noted that by no means all of the proposed ports are major facilities. We found during a field visit to Sape on the eastern tip of Sumbawa Island (November, 1984) that the proposed port in actuality is to be a facility (jetty, auction hall, flake ice plant) for small scale fishermen. The ADB reports that the facility at Prigi (East Java) will be of a similar nature.

There is an absence of international assistance agency involvement in the development of inter-island trade and the importance of such trade in stimulating expanded utilization of existing resources, increasing employment and income earning opportunities for fishermen and supplying high quality, yet affordable protein to domestic consumers in areas where supply does not meet demand. This suggests that this is an area where new investment can make a major difference; recommendations for such action are discussed in Section 2.7.

2.6.2 Demersal Finfish

Many of the problems affecting the expansion of demersal finfish fisheries are similar to those affecting small pelagic fisheries. In brief, expanded fishing effort in many areas is constrained by limited marketing opportunities.

2.6.2.1 Potential for Increased Harvests

Figures presented in Table 8 indicate that demersal finfish resources are minimally exploited except in the Malacca Straits and in southern Sulawesi. These estimates of MSY include offshore and in many cases deep water demersal resources. The technical and economic feasibility of exploiting demersal resources beyond 200 m at best is uncertain. The major bodies of water with depths of 200 m or less are the Malacca Straits, the Sunda Shelf (South China and Java Seas), and the Sahel Shelf (Arafura Sea).

Demersal resources in this latter area are fully exploited by large scale commercial shrimp trawlers which continue to dump most bycatch (i.e., everything but shrimp) back into the sea. This is the only area in Indonesia where trawling is still permitted.

Demersal finfish resources in near shore waters of the Malacca Straits and off the north coast of Java are heavily exploited by large numbers of small scale fishermen. The elimination of trawlers from these areas by 1981 reduced pressure on the resources, which Dwiponggo characterized as overexploited during 1979 (Table 7). After the trawl ban there ensued a dramatic increase in numbers of fishermen in these two areas. The rapid rise in numbers of trammel nets, the target species for which are penaeid shrimp but which also capture demersal finfish, was noted previously. Given that most small scale fishermen in these two areas operate primarily within 3-5 miles of shore, it is likely that resources in these areas can provide little if any increase in landings.

Expanded utilization of offshore demersal finfish resources in the South China and Java Seas is problemmatic without the use of trawlers. Low stock densities and the presence of bottom obstructions in some areas discouraged trawlers from operating in these waters during the 1970s. The economic feasibility of resumed trawling in these areas needs to be assessed prior to giving serious consideration to possible changes in current policies. Unless trawler operators were assured of obtaining a profit from offshore waters and were effectively restricted from operating within the coastal zone (which proved impossible throughout the 1970s), trawlers would move back into the more productive near shore waters.

The most important area where expanded harvests by small scale fishermen could be achieved is off the coast of Kalimantan. Dwiponggo (in press) reports that coastal waters off Central Kalimantan Province contain the greatest abundance of large valuable demersal finfish species and the highest demersal stock densities (for both finfish and penaeid shrimp) of any area in the Sunda Shelf.

2.6.2.2 Constraints

The chief constraint inhibiting expanded fishing effort for demersal finfish, other than on Java and portions of Sumatera and Sulawesi, is marketing. The problems faced are the same as those affecting small pelagic species: limited local demand and the virtual absence of marketing outlets to major population centers on Java.

2.6.2.3 Methods to Increase Harvests

A wide range of demersal fishing gear are employed by fishermen throughout Indonesia to exploit an even wider range of demersal species. As in the case of pelagic fisheries, improving the technical competency of fishermen using demersal gear is less a matter of introducing new boat and gear types than of expanding use of existing technologies, which in many areas can be encouraged chiefly by market incentives.

As noted previously, there is scope for exploratory fishing to identify new demersal fishing grounds and the most effective means of exploiting demersal resources on the continental slope (e.g., with traps). This is likely to be less an introduction of new gear than the extension of existing gear to new areas. The GTZ project located on Lombok is doing precisely this kind of work with traditional demersal and pelagic gear, as is the UNDP/FAO Extension Services project currently based in Mendo.

An interesting feature of this type of foreign assistance is that the utility of traditional gear types, albeit modified, seems to achieve greater credibility among those whose field experience is limited to visits to provincial Fisheries Service offices and who view small scale fishermen as technologically backwards. A contrasting view is that local fishermen are highly motivated to adapt new technologies of proven worth; witness the widespread adoption of nylon netting during the 1950s and 1960s, which was accomplished without benefit of government assistance, and the rapid expansion in use of engines in the last seven years (Table 5), which cannot be fully explained by official credit programs (Bailey, 1983). The limits to innovation are thus economic, not attitudinal.

2.6.2.4 Resource Management Issues

Demersal species are more sensitive to heavy localized fishing effort (e.g., in coastal waters) than are pelagic species. Migratory pelagics move in and out of coastal waters and therefore find refuge from the mortality of fishing. Demersal species, however, typically are more restricted in their movements. Heavy fishing effort in a particular area can decimate a local demersal resource, though there is evidence that short-lived tropical species rebound quickly when pressure is released (Saeger, 1981).

Achieving reductions in fishing effort in such areas as the north coast of Java is an unreasonable hope. Efforts to regulate mesh size of nets to allow escapement of juveniles have not been enforced. No attempts have been made to limit entry to the fishery of small scale fishermen, nor is such a measure proposed, as this would restrict employment opportunities. The shift of labor and capital into fishing on Java in the last few years has been dramatic and is only likely to slow when opportunity costs in this sector decline to the level of other sectors of the island's economy.

In areas where demersal fisheries are in a developing stage, greater potential exists for establishing effective resource management policies. This cannot be achieved by administrative fiat, however. Fishermen need to be persuaded that regulating mesh sizes, refraining from use of explosives or other forms of destructive fishing, and restricting fishing in known nursery grounds is in their best interest.

2.6.2.5 Potential Environmental Problems

As noted above, demersal species are more prone to overfishing than are pelagic species. They also are more vulnerable than oceanic pelagic species to environmental disruptions including habitat destruction (coral reef bombing, coral mining, or siltation of reefs due to watershed erosion, loss of mangrove due to tambak construction, mineral mining, or wood chip production) and to near shore pollution from agricultural chemicals and industrial waters. Coral reef fishery resources are currently the most severely threatened by such environmental perturbation. Overfishing in shallow coastal waters is the primary threat to demersal finfish and effects not only those fishing grounds, but also stock densities of those larger fish species, which at maturity are found primarily in offshore waters but whose juveniles are found in near shore nursery grounds.

2.6.2.6 Government Agencies

Regulation of fishing effort and destructive fishing practices is the responsibility of the DGF, but this agency is not capable of exerting control over activities in other sectors which affect coastal fisheries. This matter is discussed in the report of Drs. Peter Burbridge and James Maragos.

2.6.2.7 Constraints to Improved Processing

Problems associated with handling and processing of demersal finfish are the same as those for pelagic species, as discussed in Section 2.6.1.7.

2.6.2.8 Source of Demand

As is true for pelagic species, the primary market for demersal finfish is on Java. In addition, there are a number of large demersal finfish species (snappers, groupers, sea bass) which command high prices on Java and are in relatively plentiful supply outside of Java. Within the "crescent" area, marketing of these species as fresh iced fish presents few difficulties if sufficient volume is available to make a carrier boat trip worthwhile. The profit margins for these species are likely to be higher than for small pelagic species and may contribute to the economic feasibility of inter-island fish trade.

2.6.2.9 Estimated Consumption

Areas where potential exists for increased harvests of demersal finfish (e.g., Kalimantan) also tend to have high existing levels of fish consumption. Demand for small demersal fish on Java is high, particularly for dried ponyfish (a.k.a. slipmouth), a popular commodity in Central Java. Demand for large high valued demersal fish in urban centers on Java is strong. The potential absorptive capacity for finfish was described in Section 2.6.2.2.

2.6.2.10 Past Initiatives

The largely unsuccessful efforts of the World Bank supported State Fishing Enterprise P.T. Tirta Raya Mina in the field of inter-island trade was discussed in Section 2.6.1.7. and is relevant to inter-island trade in fisheries products. International efforts to encourage adoption of more effective demersal gear were described above in Section 2.6.2.3. These gear trials are useful but do not get to the heart of the problem of increased harvests of demersal species: the establishment of marketing channels from areas of surplus supply to the center of demand on Java.

2.6.3 Penaeid Shrimp

Penaeid shrimp accounted for over 80% of Indonesia's fisheries export earnings in 1983 (DGF, 1984). No published figures are available which indicate what proportion of these exports came from marine capture fisheries as distinct from tambak production of shrimp which has become increasingly important. However, marine fisheries continue to dominate total production and probably play a comparable role in exports. In 1982, landings of the two most important export species, Peneous monodon and P. marguiensis, totaled approximately 10,100 mt and 30,700 mt, respectively. The tiger shrimp (P.monodon) is larger and more valuable than the white (or bananna) shrimp (P.marquiensis).

2.6.3.1 Potential for Increased Harvests

Given the high value of penaeid shrimp, it is not surprising that the level of exploitation of these species is far higher than that for either pelagic or demersal finfish (Table 8). Landings data for 1981 suggest that shrimp resources in three coastal areas (eastern coast of Sumatera and all areas in Kalimantan) were overexploited. Data for eastern Sumatera may be misleading as not all the shrimp landed there were necessarily caught in those waters; it was reported that shrimp caught in Kalimantan waters were bought by an exporter on Sumatera and "landed" there. It is likely that shrimp harvests from Kalimantan waters declined after 1983 when the ban on trawling was extended to those areas.

As with demersal finfish, penaeid shrimp resources in shallow coastal waters are heavily exploited by small scale fishermen. Larger mature shrimp, which form the breeding population, tend to be found further offshore in deeper waters.

Despite the presence of large numbers of fishermen, especially in the Malacca Straits and along the north coast of Java, the elimination of trawlers has resulted in an overall reduction of pressure on this resource. No longer forced to compete with trawlers, small scale fishermen in these areas and elsewhere appear to be benefitting from higher catches and incomes. Nationwide between 1980 and 1982, average annual per unit landings of trammel nets -- the most important small scale gear for shrimp -- increased from 2.0 mt to 2.8 mt (DGF 1981; DGF in press).

2.6.3.2 Constraints

Marketing of shrimp poses few problems due to high prices and steady international demand. Current processing capacity for export is underutilized and processors or their agents actively seek out supplies.

Existing small scale gear (trammel nets, bottom set gill nets, etc.) have limited productivity compared with trawlers. These gear tend to be used in shallow coastal waters where shrimp are most abundant and operation of these gear is easier. Some stationary gear (e.g., stow nets) are restricted to these coastal waters.

Lower stock densities (albeit of bigger shrimp) offshore and the greater physical effort and expense of operating offshore discourage the use of small scale gear in those areas. Continued concentration of fishing effort in near shore waters may result in "recruit overfishing," that is, sufficiently high levels of fishing mortality of sexually immature individuals to negatively affect the biologic regenerative capacity of the resource.

2.6.3.3 Methods to Increase Harvests

Trawling is the most effective means of increasing shrimp harvests, and possibly the only means of exploiting shrimp in offshore waters. Past experience suggests that if trawlers were permitted to resume operations they would move inshore, resulting in competition and conflict between trawlers and small scale fishermen.

Rapid increases in numbers of trammel nets since 1980 suggests that through private initiative and government assistance, small scale fishermen are expanding their capacity to exploit available shrimp resources.

2.6.3.4 Resource Management Issues

The distinct possibility exists that current patterns of exploitation could lead to recruit overfishing and result in declining harvests. This does not yet appear to be a problem but could become so in the not too distant future as levels of fishing effort continue to increase, spurred on by high prices.

Solving this problem is likely to be difficult. There is no precedent in Indonesia for limiting numbers of small scale fishermen or the types of gear they are permitted to operate. On paper, at least, precedent exists for regulating mesh sizes. Trammel nets are composed of three layers of netting, beginning with large (4") mesh behind which are two layers of progressively smaller mesh. Large and small shrimp easily enter through the larger mesh but are entrapped by one or the other layers; once in the pocket between layers, they cannot escape. Increasing the mesh size of the second and third layers would permit smaller shrimp to escape. This would be beneficial for stocks of the larger P. monodon, as a higher proportion of juveniles would survive. However, this would reduce the catch of smaller P. marquiensis which, though less valuable, make up most of the marine shrimp catch.

2.6.3.5 Potential Environmental Problems

Demersal species are vulnerable to the same environmental influences as discussed in relation to demersal finfish (Section 2.6.2.5).

2.6.3.6 Government Agencies

The discussion under Section 2.6.2.6 is applicable.

2.6.3.7 Constraints to Improved Processing

Japan imports approximately 85% of all penaeid shrimp exported from Indonesia. Indonesian exporters are attempting to diversify their markets to include Western Europe and the U.S. However, the FDA has blacklisted some Indonesian shrimp offered for sale in the U.S. due to persistent problems of Salmonella contamination.

Quinn and Hill (1982), employees of the FDA, were invited to Indonesia to assess problems relating to quality control for fisheries export commodities. Their report identifies a wide range of problem areas related to handling and processing, briefly summarized here. Shrimp landed by small scale fishermen reached the processing facility in an acceptable state of freshness, but the ice used in transit was likely to be contaminated. Containers used in transit were unclean and in stacking one upon the other, the possibility of contamination was increased. There was a general lack of sanitation at all stages of processing so that "bacterial contamination of the finished product is practically 100% assured" (Quinn and Hill, 1982:6).

2.6.3.8 Source of Demand

International demand for shrimp is strong and is likely to remain so throughout the 1980s. However, many developing countries are engaged in expanding shrimp aquaculture production and by 1990 increased supply may lead to declining prices.

The high prices paid for large export quality penaeid shrimp limit domestic consumption of this commodity. This situation is likely to continue for the foreseeable future, even if international market demand softens.

2.6.3.9 Estimated Consumption

Total production of penaeid shrimp (marine landings plus tambak production) in 1982 was 60,178 mt (DGF, in press). Shrimp exports in that year were less than 25,000 mt (Biro Pusat Statistik, 1982). Thus, more than half of all shrimp produced in

Indonesia were consumed in Indonesia. For the most part, these are smaller shrimp that are less valuable in export markets. Most of this local supply is *P. marquiensis*, the bulk of which originates in the marine sector.

Even small penaeid shrimp in Indonesian markets are expensive compared to other fisheries products. Data presented by Dr. Gregory Sullivan suggest that as incomes rise so does the amount of money spent on fish, though at higher levels the proportion of total income spent on fish declines. Middle and upper income households are the most likely consumers of shrimp domestically. Domestic demand for shrimp should increase at least parallel to the rate of population increase (2%), and is likely to increase faster than that unless exporters begin processing smaller shrimp for sale overseas.

2.6.3.10 Past Initiatives

Foreign involvement in marine capture fisheries for penaeid shrimp primarily has been in the form of private joint venture enterprises. As of 1981, there were eight joint ventures engaged in shrimp trawling in the Arafura Sea (total fleet: 106) and processing the catch for export; two other joint venture companies were engaged only in processing and exporting (Rachman, 1982).

The ADB and the World Bank have major investments in shrimp aquaculture which are oriented towards increasing production for export. Problems of quality control and diversification of markets are not addressed by either agency.

2.6.4 Shellfish

2.6.4.1 Potential for Increased Harvests

Indonesia's 88,000 km of coastline and numerous sheltered estuaries and bays suggest considerable potential for mariculture of various shellfish species, especially blood cockles, green mussels, and oysters. However, no systematic survey of potential mariculture sites in Indonesia has been conducted.

Mariculture systems of blood cockles, green mussels, and oysters are well established in Southeast Asia. An abundance of highly productive shallow sheltered waters provide potential mariculture sites. Observations in the field suggest that natural populations of clams and oysters are more widely distributed than production data suggest. During 1982, production of clams was reported in only eight provinces and oysters in only five (DGF, in press). Blood cockles production is more widely distributed, indicating the common presence of natural populations.

2.6.4.2 Constraints

Shellfish are popular among consumers in Singapore, Malaysia, Thailand and the Philippines, but have achieved limited acceptance among Indonesians. The reasons for this are unclear but may be a function of limited available supply in all areas other than along the Malacca Straits, where current shellfish harvests, largely from the wild, are concentrated.

Achieving production increases will be relatively simple, but marketing the product poses a serious, but not insurmountable, problem. Indonesian cuisine, like that of neighboring ASEAN nations, has a number of common popular dishes suitable for preparation with various shellfish (e.g., cap cai, nasi goreng, various types of curried dishes, etc.). In neighboring countries, consumers of Chinese ethnic origin in particular, are willing to pay high prices for shellfish. There is no reason to doubt the existence a of similar albeit latent demand in Indonesia.

The existence of potential demand for shellfish cannot be shown in the absence of products to sell, but expanded production is dependent on development of assured marketing outlets.

2.6.4.3 Methods to Increase Harvests

To expand production, it will be necessary to shift from harvesting wild populations to cultivation systems. Requirements include shallow protected waters with high levels of productivity in areas removed from pollution emanating from domestic, agricultural, and industrial sources. The existence of natural populations is necessary to obtain sprats for grow out. These can be transported from one area to another but this increases costs. (In Thailand, the cultivation of blood cockles depends on sprat production in Malaysia.)

Cultivation of blood cockles is a simple process of collecting sprats from the wild and sowing them in shallow waters with muddy bottoms. The only modification of natural processes this represents is that population densities are greatly increased in areas where harvesting is easy.

To make the effort worthwhile, cockle farmers need to be assured that what they cultivate they and they alone can harvest. This need not entail ownership over the seabed, but it does involve extension of personal rights over areas which often are regarded as common property. In South Sumatera, clan (marga) jurisdiction over such areas is well established and provides the basis for extension of individual rights through a "lease" management.

Cultivation of green mussels and oysters most commonly involves the placing of structures in shallow protected waters. Sprat are collected on ropes or bamboo poles and suspended below these structure for grow out. The question of ownership rights over these structures does not appear to be a major issue because the use of such stationary fishing gear as lift nets, guiding barriers, and stow nets is common in many parts of Indonesia.

As a first step in expanding shellfish production in Indonesia, a quick survey of potential production sites is necessary. Production trials, based on Southeast Asian techniques, need to be conducted as a second step to refine these techniques to local conditions.

These production trials should be conducted in areas where access to potential markets exists, e.g., in Lampung and South Sumatera Provinces (assuming favorable results of the initial survey in these areas). Harvests from these trials can be used to conduct market promotion on Java and among local consumers.

2.6.4.4 Resource Management Issues

Shellfish cultivators need to be assured control over their production areas. The setting aside of cockle beds and open water areas for oyster and green mussel cultivation may impede other users of these areas. Sensitivity in site selection would reduce potential conflicts and the limited areal extent of these culture operations is not likely to pose major problems.

Two threats are foreseeable: the possibility of theft by others and environmental degredation (discussed below).

2.6.4.5 Potential Environmental Problems

As filter feeders, shellfish are highly sensitive to pollution from domestic, agricultural and industrial sources. If cultivated in densely populated areas, shellfish are likely to pose health risks to consumers. Experiments in the Philippines with oysters contaminated with *E. Coli*, *Salmonella*, and other pathogenic bacteria have shown that depuration can be accomplished in as little as 48 hours using filtered and oxygenated seawater, and sterilized by high-intensity ultraviolet radiation, which flows through oyster holding tanks (Rosario, et al. 1982).

Heavy metal contamination from industrial sources cannot be removed in this fashion. Neither is it possible to remove chemical contaminants from agricultural or other sources. Care must be taken in site selection to minimize these risks. Because shellfish cultivation is likely to be most productive in estuaries and embayments, sources of pollution along the entire watershed must be considered.

2.6.4.6 Government Agencies

The DGF and local Fisheries Services should play the lead role in promoting shellfish mariculture, including the selection of proper sites. However, the DGF and the local Fisheries

Services exert no control over other uses of coastal areas or activities in upland areas which may effect coastal and estuarine environments.

This situation supports the consensus view of this ARDP Feasibility Team that production-oriented activities cannot be divorced from broader environmental concerns. This view is expressed in great detail in the report by Drs. Burbridge and Maragos and will be discussed further in this report.

2.6.4.7 Constraints to Improved Processing

Depuration of shellfish contaminated with pathogenic organisms may not be economically feasible unless there are price incentives. Limited domestic consumer demand at present and the need to promote acceptance of shellfish suggest that high prices will be counterproductive.

2.6.4.8 Sources of Demand

Here again, the dominating influence of the Java market is felt. Potential demand for shellfish outside of Java is likely to remain relatively small due to the abundance of other fisheries products. An exception to this might be Sumatera, based on current harvests.

Unless strong demand pushes up prices, transporting shellfish over great distances might not be feasible given the high weight to value ratio. This suggests the most likely center for future production should be on the southern portion of Sumatera, where a steady stream of small and large cargo vessels assures accessibility.

This location also may offer opportunities for export trade to Singapore, where high quality shellfish attract sufficiently high prices to attract imports from as far away as Manila.

2.6.4.9 Estimated Consumption

Potential demand for shellfish is at least several times current harvests but at this stage in this commodity's development, it is not possible to project future consumption trends. Shellfish mariculture is not likely to have a major impact on total available fisheries products, but will diversify sources of food and offers potential for expanding employment opportunities and increasing incomes of those living in production areas.

2.6.4.10 Past Initiatives

JICA has sponsored and provided technical assistance to conduct research on mariculture of green mussels in Banten Bay. Results of these production trials were encouraging. JICA has not gone beyond such trials to examine the economic feasibility of shellfish mariculture.

In 1981, the Governor of D.K.I. Jakarta sponsored production trials of green mussels in heavily polluted Jakarta Bay. A flurry of publicity appears to have contributed little to local demand for green mussels.

2.6.5 Seaweeds

2.6.5.1 Potential for Increased Harvests

Current seaweed production in Indonesia comes primarily from harvests of nautrally occuring Eucheuma. Considerable potential exists for expanding these harvests through mariculture. On one site on Bali where Eucheuma was being cultivated on submerged rafts, the team was told that harvests of 400 kg per hectare (dried weight) per month were obtained. At a current local price of Rp. 250/kg, this translates into a monthly income of Rp. 100,000. Most producers in that community operated holdings of one-half hectare or less, however, and depended on seaweed for only part of their household income.

Total seaweed production during 1982 was 7,500 mt (DGF, in press). If 400 kg per month per hectare translates into 4.8 mt per year, production from 1,500 hectares of cultured seaweed would double current production and provide employment and income earning opportunities for several thousand households.

Indonesia possesses extensive areas suitable for seaweed mariculture, especially in the Lesser Sunda Islands, the Moluccas, and elsewhere in the eastern half of the archipelago.

2.6.5.2 Constraints

The world market for seaweed is highly volatile. Price increases encourage expanded production which in turn depresses prices when demand is met. When supply exceeds demand, market outlets close down.

2.6.5.3 Methods to Increase Harvests

Mariculture techniques for seaweed are well established, require limited investment, and -- questions of marketing aside -- entail few risks (assuming proper site location).

2.6.5.4 Resource Management Issues

As with any mariculture system, the operation needs to control a certain area normally considered common property. This is not likely to present major problems.

Seaweed mariculture may reduce resource management problems. At the site visited on Bali, seaweed cultivators were convinced to adopt this practice instead of coral mining for production of lime. Because successful seaweed culture depends on reef integrity as shelter from wave action, the local community is more likely to protect than to mine the reef.

Seaweed mariculture also may tend to reduce harvests of naturally occurring stocks and thus reduce threats posed by overexploitation.

2.6.5.5 Potential Environmental Problems

Seaweed mariculture depends on clean, clear, and shallow protected water, and typically takes place on coral reef flats or in waters between the reef and the shoreline.

Any activity that disrupts the coral reef ecosystem (especially siltation, and to a lesser extent coral reef mining or use of explosives in fishing) poses a threat to successful seaweed mariculture. Similarly, construction of jetties or other structures which impede or modify sand transport or other coastal processes pose potential problems.

2.6.5.6 Government Agencies

Some but not all of the environmental problems which might threaten successful seaweed mariculture are within the jurisdiction of the DGF and local Fisheries Services. Other problems (e.g., siltation, construction of jetties) can only be resolved in a cross-sectoral forum.

2.6.5.7 Constraints to Improved Processing

Local processing of seaweed by producers entails simple sun drying. Quality is enhanced by subsequent washing to remove debris and by redrying. Further processing is done on an industrial scale, for the most part, outside of Indonesia.

2.6.5.8 Source of Demand

Seaweed-based products are used in a wide variety of products, including food (e.g., agar, fillers used in some ice creams) and cosmetics.

Hollenbeck (1980) notes that there is only one international buyer of Indonesian seaweed, who was not identified. Producers on Bali reported that their seaweed was exported to Denmark.

2.6.5.9 Estimated Consumption

Indonesia imported 350 mt of agar valued at US $530,000 during 1983. Establishing local processing facilities would eliminate the need for such imports and may spur local demand in agar and other products if they were offered at lower prices than the imported commodity. The above import data reflect current consumption.

2.7 Recommendations for Action

The foregoing analysis of marine fisheries commodities with greatest development potential has identified marketing as a common constraint to increased production. In this section, recommendations will be made for action to overcome this and other commodity-specific constraints. Suggested activities include applied research in the biological and social sciences, technical assistance to overcome production bottlenecks, and initiation of a process of policy dialog to assist decision-makers in identifying long term strategies for sustainable marine fisheries development consistent with concerns for distributive equity expressed in REPELITA IV.

2.7.1 Marketing

Each of the five commodities discussed in Section 2.6 faces marketing problems. Opening market channels for demersal and small pelagic finfish from areas with abundant resource potential to centers of demand is a problem of pressing importance, the resolution of which is necessary to increase resource utilization, improve fishermen's incomes, and provide adequate supplies of high quality protein to domestic consumers.

Overcoming marketing constraints for penaeid shrimp, shellfish, and seaweeds will not produce such potentially dramatic results. However, it will expand employment opportunities and increase incomes of those engaged in harvesting these resources.

2.7.1.1 Marketing of Demersal and Small Pelagic Finfish

There is a paucity of information available on fish marketing and distribution patterns in Indonesia. What information is available has been reviewed by Bailey and Marahudin (in press). There is a clear need for both micro and macro level research on this topic, with the latter of most pressing concern in identifying constraints related to inter-island trade in fisheries products.

Personal interviews with university researchers, government officers, and with wholesale fish traders throughout Indonesia indicate that on Java, dried and fresh fish markets are tightly controlled by a limited number of major wholesalers based in major urban centers. Fish landed by small scale fishermen on Java generally are sold by a series of petty traders, but landings at major ports destined for urban markets are controlled by major traders who dominate urban wholesale markets. This dominance is achieved by extending credit and ensuring outlets to the initial buyer. Likewise, retail sellers are given credit and assured supply.

It has been reported that such dominance is enforced by the threat of violence, though the mere suggestion of such action by those known in local parlance by the term "mafia" is sufficient to dissuade potential competitors. In one reported case, a KUD on Java dropped plans to engage in direct retail trade when "the hope was expressed that nothing untoward would happen to the KUD's truck on a lonely stretch of road at night." In another case, suggesting the level of control exerted over major fish landing sites on Java, a buyer from Central Kalimantan attempted to ship fish directly to Java. After two successful trips, he had trouble gaining access to a public government-operated auction when stevedores refused to unload his boat until most buyers had left.

A third illustrative case involved a joint DGF-FAO project. An attempt to provide price incentives to both fishermen and retail traders to use ice as a means of improving product quality failed when local wholesalers bid up prices in a public auction to unrealistically high levels until the project buyers dropped out. However, these prices were never paid to the fishermen. This effort was repeated in three separate locations with the same result.

Dried fish markets also are tightly controlled, with six wholesalers in Jakarta and four wholesalers in Bandung controlling distribution of virtually all dried fish in West Java, the largest market for this commodity. Control over dried fish coming from outside Java is particularly strong and is based on vertically integrated dealings from producer to retailer.

2.7.1.2 Unresolved Questions

Little is known about the inner workings of the separate syndicates controlling fresh and dried fish on Java. It is possible that they are highly efficient in physically distributing fish. It is also entirely possible that the elimination of potential rivals reduces competition in the marketplace and that this either depresses prices paid to fishermen, or inflates prices paid by consumers, or both.

The tendency for these wholsesalers to discourage competition poses potentially serious problems to opening up new sources of supply to Java from areas where abundant demersal and small pelagic finfish resources exist. Increased supply may lower prices on Java, affecting marketing margins. Control over markets may be threatened by outsiders attempting to break into wholesale and retail trade. These wholesalers may decide to use their economic power to discourage attempts to expand inter-island fish trade, or they may welcome the opportunity to expand their operations.

2.7.1.3 The Questions Stated

As an initial step in addressing the potential for and problems associated with inter-island trade in demersal and small pelagic fish, the extent of consumer demand for fresh iced and dried salt fish needs to be established. To determine whether adequate demand exists, a detailed feasibility study of costs and marketing margins needs to be conducted. Preliminary investigations suggest that trade in both fresh iced and dried fish within the "crescent area" is economically feasibile, especially if the fresh fish are high valued species. Outside this area, initial efforts should focus on dried fish, which have a longer shelf life and which may be transported at a lower cost (e.g., from Ambon to Surabaya, Rp. 75 compared with Rp. 200 per kg for frozen fish).

Parallel to these efforts, a detailed investigation of current marketing and distribution patterns for these two commodities needs to be conducted. In particular, these studies would focus on the central role of major wholesale traders, with related investigations of relationships up and down the marketing chain.

2.7.2 Applied Socio-Economic Research

A major contribution to resolving the above questions relating to potentials and problems of expanded inter-island fish trade could be made by establishing an applied socio-economic research program at AARD's Central Fisheries Research Institute (CRIF). This program could provide practical training to the seven social scientists within CRIF and its associated Institutes. Two of these individuals currently are studying for Masters degrees at IPB; the remainder have Sarjana or B.S. degrees.

CRIF is in a position not only to conduct research but also to coordinate researchers from universities. CRIF and the MFRI for many years have supported socio-economic research by university staff, but in the absence of a clear research agenda, this has been done on an *ad hoc* basis. By helping to establish such an agenda, research efforts could focus on using the same methodologies to address common problems (i.e., those discussed above) in a wide geographical area. Research results presented at workshops sponsored by CRIF would provide a basis for action to resolve identified problems. It is suggested that potential constraints to inter-island fish trade be identified as a priority topic.

There are a wide range of other applied socio-economic issues that could be included in the CRIF research agenda. These include (1) the collection of adequate costs and earnings data to establish the economic performance of various boat and gear combinations or aquaculture production systems, and (2) broad examinations of the impact of technological change on employment and household incomes on fishermen, fish farmers, and their communities.

Costs and earnings data are of fundamental importance to understanding fishing as an economic activity, providing a basis for measuring incomes of owners and crewmen, and in contributing to more rational implementation of fisheries development programs. A primary reason for encouraging the use of more productive fishing units is that this offers the best hope for increasing fishermen's incomes. To what extent are such gains achieved and to what extent are these economic gains equitably shared among members of small scale or other fishing communities are questions to be addressed. The purpose of this applied socio-economic research would be to provide information directly relevant to policy makers.

Sustaining the organization's capability to conduct and coordinate socio-economic research would require modest investment in further education for at least two additional CRIF staff to the Masters level and the provision of research funds for the life of the project.

Considerable support for socio-economic research has been expressed by the CRIF Director and his staff. By providing valuable information to policy makers, and in identifying means of overcoming production constraints, the basis for a sustainable socio-economic research program at CRIF would be provided and a network of university social scientists actively engaged in fisheries research could be created.

2.7.3 Development of Marketing Policy

It is anticipated that research conducted by CIRF will identify a set of obstacles that impede the development of inter-island fish trade. It is likely that some of these problems will be related to the powerful oligopolies that control fresh and dried fish marketing on Java. The past failure of small efforts by private traders, KUDs, and even the combination of the DGF and the FAO (discussed above), suggest that efforts to resolve these problems will require high level support within the GOI.

The GOI's development of inter-island fish trade can be furthered by having the Ministry of Agriculture design a coordinated set of policies to encourage such trade. This project component could be initiated once policy-relevant information on marketing constraints starts to become available.

Effective measures to develop inter-island trade are likely to require considerable investment, especially if opposition from wholesalers on Java necessitates direct involvement of the government in training operations. However, much of this investment is already in place. The various State Fishing Enterprises based at Ambon, Irian Jaya, and Air Tembaga (Manado) own large carrier boats which are underutilized. P.T. Tirta Raya Mina, from its base at Pekalongan, could serve as the distribution agency for processed fish to Java.

The most effective means of encouraging expanded domestic trade in fish should be identified, recognizing that important differences in opportunities exist in areas close to and far away from Java. It is anticipated that special attention would be paid to the potential role of the various State Fisheries Enterprises operating in the eastern half of the archipelago to contribute to inter-island fish trade.

2.7.4 Ice Plant Construction

The ice plant constructed at Maringgai appears to have resulted in more than the production of ice. It has stimulated the local fisheries cooperative and provided the means for marketing fresh iced fish into the interior.

The Team recommends that funds be provided for the construction of additional ice plants in areas where market potential exists and other sources of ice are absent, thus warranting such investments.

Proper site selection is essential to achieving maximum benefits from an ice plant. The Maringgai experience suggests that an ice plant can be a focal point for social and economic development by strengthening local institutions and opening new markets for fresh fish trade.

Although adequate supplies of cost low ice are by no means available in all parts of Java, the greatest need is on other islands. Sumatera's large and growing population provides local marketing opportunities, especially in areas where coastal communities are connected to the interior by roads. On Kalimantan, population densities are lower and coastal communities are more isolated. However, as noted previously, access to reasonably priced ice would encourage shipments of fresh iced fish to Java. Conditions and opportunities in South Sulawesi closely approximate those on Sumatera.

It is suggested that funds be provided for ice plant construction in those areas where other ARDP components are located. This would facilitate project implementation and be supportive of other initiatives.

2.7.5 Pelagic Stock Assessment

The need to improve understanding of pelagic stocks is of fundamental importance. The MFRI's competent staff are capable of conducting such work if appropriate equipment and funds for extended ship time were available. In addition, remote sensing may be useful as an initial step in identifying and assessing pelagic resources.

It appears that the World Bank is nearing agreement with the DGF and AARD to support such research. In addition, the AARD has made proposals to the Canadian government to support similar efforts.

2.7.6 Shellfish Survey

It is recommended that a small initial investment be made in the development of shellfish mariculture by conducting a survey of potential production sites and species, keeping in mind environmental and marketing constraints to expanded production.

If on the basis of this initial survey there appears to be significant potential for shellfish mariculture production in Indonesia, the support of production and marketing trials should be considered.

2.7.7 Seaweed Marketing and Processing

One task for the Ministry would be to forecast domestic and international demand for seaweed products. The impact of volatile international markets could be lessened if domestic processing capabilities were established. On the basis of information related to actual and potential domestic demand, the Ministry may wish to consider conducting additional investigations of the technical and economic feasibility of domestic processing.

2.7.8 Integrating Resource Development and Management Efforts

Expanding the production of fisheries commodities with high development potential does not address the equally important issues related to resource management. Sustainable development of each of those species identified above depends not only levels of future exploitation of these resources, but also on what happens in the larger environment. This is especially the case for those productive activities that take place in coastal waters, which are vulnerable to a wide range of human activities on land (sedimentation due to watershed erosion; pollution from domestic, agricultural, and industrial sources, etc.).

Moreover, keeping the goal of achieving sustainable fisheries development in mind, equal attention should be paid to areas which not only have limited potential for increased landings but which are also in danger of losing what natural potential exists due to overfishing, the use of destructive fishing techniques (explosives, poisons), sedimentation, pollution, and other disruptions of the coastal environment. Significant gain in marine fisheries landings can be achieved by increased utilization of underexploited resources, but these quickly could be counterbalanced by reductions in harvests from the few fishing grounds which provide the bulk of the current catch.

Because of the complex land-sea interrelationships which exist in coastal areas, efforts to manage aquatic resources cannot be divorced from broader environmental concerns such as watershed management and pollution control. It is also obvious that managing coastal aquatic resources is most effectively accomplished in a cross-sectoral setting. Agricultural practices and other human activities in the watershed which contribute to erosion result in heightened rates of sedimentation in coastal areas which negatively affects coral reefs and tambak. Within the fisheries sector, conversion of mangrove to tambak may have a negative effect on coastal fisheries resources, though this is a matter of some academic debate.

As such, it could be appropriate to engage in a cross-sectoral effort to develop a coastal and aquatic resource management program. This program could be sited in an area where significant fisheries production exists and where pressure on the resource is sufficiently intense that the sustainability of harvests is threatened.

South Sulawesi affords a good illustrative case and has been identified by the Team as a likely candidate for initiatives in coastal and aquatic resource management. South Sulawesi's marine fisheries landings rank third in the nation, but levels of exploitation are approaching or have reached MSY, and there is evidence suggesting that some fishermen have responded to reduced landings by using explosives and other destructive fishing techniques. The most important coral reef fishery in Indonesia lies off Ujung Pandang, is heavily fished if not overfished, and to an unknown extent has been damaged by explosives. South Sulawesi also is an important area for tambak production. In this project, the local BAPPEDA, UNHAS, or some other institution with a cross-sectoral mandate would encourage the various government line agencies to coordinate their development planning, would encourage applied research on coastal aquatic resources linked to the information needs of local policy makers, and would assist those policy makers in considering development and management options.

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3.0 FISH MARKETING IN INDONESIA

The general purpose of this section is to discuss marketing systems for various fish products, constraints to fish marketing, and program strategies for overcoming those constraints. The emphasis for the marketing strategies is placed on improving market coordination. This would lead to greater operational efficiency (lower costs) and higher pricing efficiency (greater competition) that should enhance the total marketing system for all fishery products for both domestic and export markets.

The country strategy would concentrate on rural employment generation, diversification of food supplies, and of food supplies to the low income strata of the population. Appropriate fish marketing projects will help to meet these goals. At present, the fisheries sector provides employment for nearly 5% of the work force, which constitutes a significant portion of the population considering the total number of households that rely on fish production. A large number of people are also involved in processing and distributing the products. The population involved in fishing is regarded by many as being at the lowest economic level of society, particularly the coastal small scale marine fishermen households. Efforts to remove barriers to fish marketing can directly enhance the income of this depressed group.

Another critical area is manpower development for the institutional analysis of economic policy. Development of Indonesian capability is needed to identify economic constraints and carry out research that critically examines the short and long term impacts of these policies on national goals. Of particular concern is the examination of macro- and micro-economic policies that have direct and indirect effects on the fishing sector. Examples of such policies include the imposed trawler ban in western Indonesian waters and removal of fuel subsidies that have affected the marine fishing fleet. Microeconomic issues, which are interdisciplinary in nature, require a holistic approach, including coastal zone management strategies that focus on production and marketing decisions at the household and village levels.

Several additional observations about the performance of the marketing system have become evident. Coordination of the marketing system is a high priority, especially where the public sector has tried to control segments of this system. In addition, available market information is minimal and questionable. This data deficiency retards the development of an efficient marketing system as it relates specifically to the pricing and distribution of products.

A two prong fishery development strategy is therefore suggested which includes (1) strengthening Indonesia's capability to conduct research on market information and marketing constraints and (2) implementing marketing projects to overcome those constraints.

3.1 Fishery Development Strategies

The current involvement by donor agencies in Indonesia's fishery sector is large. It is important, therefore, that the creation of complex and costly projects which duplicate other efforts be avoided. What follows is a brief outline of areas where actions could be taken that will benefit the fishing sector and which do not duplicate already-funded projects.

3.1.1 Development of Market Research Capabilities for Indonesia

GOI development plans place a high priority on increasing exports of fish products. In particular, because shrimp exports are the largest foreign exchange earner in the country's fishing sector, the GOI is encouraging further expansion of the shrimp industry. The commercial tuna industry is also being encouraged to expand with signings of new joint ventures and Asian Development Bank (ADB) loans to expand the tuna industry with investments in new ships and restoration of shore facilities for state fishing companies.

These efforts are constrained, however, by a lack of market information and analysis. A need is clearly evident for market analysis that can assist both the public and private sectors to compete in the world market for shrimp as well as other marine products, e.g., tuna. Several examples of research topics to assist various industry groups are:

1) Examine the distribution system of fresh, frozen and processed fish from the outer islands to Java. Alternative marketing systems which generate efficient flows of products from surplus production areas to deficit consumption areas should be identified.

2) Develop a set of strategies for market promotion of Indonesian shrimp for export. Currently, approximately 90% of all Indonesian shrimp goes to Japan. Diversification of this trade to other countries will require market promotion and quality control efforts which could have a price enhancing effect. It is generally felt that the demand for shrimp is highly elastic. The implication of this is that all shrimp produced will be easily marketed and directly increase total revenues to the industry. If world supplies of shrimp increase throughout the 1980s and if the cost of prodution in Indonesia is higher than in the other shrimp producing countries, a strategy to more efficiently produce and market shrimp will be necessary. Again, quality control will be important.

3) Develop a reporting system of market price information that can assist both public and private firms in the sector in operating efficiently. For instance, market outlook information could be provided on a timely basis so that firms could make better production, marketing and investment decisions.

4) Develop a capability to investigate, in a timely fashion, policies that enhance or retard the development of an industry in the fishing sector. For example, government run hatcheries may result in preventing the entry of small-scale entrepreneurs into the aquaculture industry or unnecessary market power could end up in the hands of hatchery operators or processors. A market research branch could examine such policies and developments and if necessary, recommend changes.

5) Support the development of a Market Research and Development branch which could provide an organized system for collection and dissemination of market information to regional offices. This would improve the capabilities of those offices to organize and plan activities in their provinces.

3.1.2 Development of a Market Information Network

Testing and implementing a market information system for Indonesia would be a unique project. The benefits would affect all participants in the marketing system.

Most of the logistics are in place for implementing such a network. The key to the network will be the creation of a center where information will be received, analyzed and distributed (see Section 3.7). The impact on small-scale artisanal fishermen will likely be immediate because the current market system works to the advantage of the wholesalers, owing to their ability to conceal actual prices.

3.1.3 Project Identification in the Fish Marketing System

Several project areas have been identified as suitable for consideration. These include:

1) The transportation of fresh fish is costly and requires a high level of management for the efficient collection and distribution of fish. The establishment of ice plants at strategic locations can be beneficial, especially for promotion of the "crescent strategy" for trade with Java. If "ice plant" projects are considered, they should focus on broader development than just the upgrading or installation of equipment. Important human organizations and their activities are also affected by the plant. Fostering development of

these closely related activities will provide for greater economic and social benefit than just producing and selling ice.

2) New product development of fish could allow for shipment of fish from the surplus production areas to the consumption deficit region (Java). Examples would be to investigate how to improve the handling of frozen fish, canning of fish in the production region, and other types of processing of fish primarily for low-income consumers, e.g., salted, dried, etc. Specifically, assistance could be given to the model fishing village (next to the Jakarta fishing port) where the Jakarta provincial government has built a processing center for individual local fishermen to process their fish. The project has improved the quality of life for the fishing households involved. A marketing project that would help these private small-scale fishermen expand their markets in the fresh and dried fish trade could be under taken. Rudimentary attempts are already being made at market promotion of new products by the group. A more formalized project could be developed that provides an alternative market outlet to the one currently controlled by a few firms in the Jakarta area.

3) A project for increasing rural employment in proper fish processing and distribution from the outer islands to supply Java could increase employment opportunities, be an income generator in remote areas, and involve women. The concept of small-scale processing on the outer islands is based on a dairy marketing system developed in India for small-scale producers. Collection locations in the rural areas were established and milk was collected in small quantities from individual households. The milk was then shipped in bulk form to the major consumer market in Bombay.

4) Market promotion for exotic food products such as escargot and frog legs can diversify export products for the fishing industry. Other possibilities include squid and the skin of sting rays. The model fishermen's village at Jakarta harbor has developed a small market in Japan for these skins.

5) Expanding the live bait industry needed to supply the expanding tuna fleet in the eastern Indonesia ocean could be considered.

6) Development of the aquarium fish industry, which is currently small but lucrative, could be undertaken.

7) Assistance could be provided to provincial government officials in the analysis of marketing and pricing

policy. An example would be the government pricing policy for shrimp in South Sulawesi. Initial investigation implies that price distortions are possible if the grading and fixed pricing policy established by the government were actually being enforced.

3.2 Fish Production and Demand in Indonesia

3.2.1 Production

The major sources of fish production in Indonesia are marine and inland water fisheries, and brackish and freshwater aquaculture.

3.2.1.1 Production of Marine Fish

Production of marine fish increased about 10% from 1981 to 1982, from 1.2 million metric tons to about 1.33 million metric tons. Estimates of marine fish production by coastal area are provided in Table 13. The greatest production was from zone 5, the north coast of Java, which was about 24% of the total estimated catch in 1982. The intensity of fishing is also the greatest in this zone, with total number of marine fishing units (MFU) being 84,934, 34,965 units greater than the next largest fishing zone in South Sulawesi.

The highest rate of expansion in total marine production was on the south coast of Java, with an increase of 43% from 1981 to 1982. The greatest increase came in the capture of marine fish with only slight increases in crustaceans, molluscs and other species. The total number of fishermen in this area represents 5.6% of marine fishermen (Table 14).

TABLE 13: Production (tons) of Fish by Coastal Zone Areas, 1981 and 1982 a/

Coastal Zone	Name	Year	Total Production	Sub Total Finfish	Crustaceans	Molluscs	Other
			(MT)				
1	West Sumatra	1981	77,848	76,310	1,381	189	24
		1982	80,400	78,116	2,061	197	28
2	South Coast of Java	1981	46,847	41,477	1,975	904	2,283
		1982	68,395	63,921	2,889	435	752
3	Coast of Malacca Straits	1981	252,774	153,255	62,125	37,394	0
		1982	242,568	169,074	41,272	31,422	853
4	East Coast Sumatra	1981	108,228	96,784	10,693	751	0
		1982	114,725	106,482	7,206	1,037	0
5	North Coast of Java	1981	308,262	290,319	13,515	4,262	166
		1982	341,454	320,850	16,078	4,077	449
6	Bali - Nusa Tenggara	1981	76,484	73,695	421	1,435	137
		1982	88,496	86,089	236	1,499	357
7	South & W. Coast Kalimantan	1981	78,588	59,481	18,370	737	0
		1982	78,562	65,864	11,506	1,096	96
8	East Kalimantan	1981	79,817	65,090	13,656	1,019	52
		1982	80,271	67,010	12,393	808	60
9	South Sulawesi	1981	208,672	197,921	8,669	1,886	58
		1982	220,341	209,007	8,972	1,990	92
10	North Sulawesi	1981	75,238	74,647	113	330	43
		1982	81,825	80,532	647	457	66
11	Maluku/Irian	1981	95,514	77,659	9,124	2,040	286
		1982	95,674	79,502	5,308	2,122	341
	TOTAL PRODUCTION	1981	1,408,272	1,206,638	140,042	50,947	3,049
		1982	1,490,710	1,326,447	108,499	45,200	3,094

a/ Statistics for 1982 are preliminary

SOURCE: Fisheries Statistics of Indonesia, 1981 and 1982

Table 14: Number of Marine Fishing Units by Type of Fishing Gear by Coastal Zones, 1981 and 1982a/

Coastal Zone	Name	Year	Number of Marine Fishermen	Marine Fishing Units
1	West Sumatera	1981	66,536	24,990
		1982	69,229	27,697
2	South Coast of Java	1981	57,473	15,133
		1982	66,091	20,112
3	Coast of	1981	139,197	43,372
	Malacca Straits	1982	145,628	41,735
4	East Coast Sumatera	1981	40,116	17,605
		1982	49,216	18,171
5	North Coast of Java	1981	281,104	73,940
		1982	290,328	84,934
6	Bali-Nusa Tenggara	1981	82,200	40,156
		1982	87,579	42,516
7	South-West Kalimantan	1981	33,723	11,956
		1982	34,567	12,087
8	East Kalimantan	1981	63,172	17,122
		1982	68,809	17,162
9	South Sulawesi	1981	145,945	48,852
		1982	151,070	49,969
10	North Sulawesi	1981	99,941	42,161
		1982	112,994	48,771
11	Maluku-Irian	1981	95,242	44,884
		1982	95,553	41,105
	TOTAL NUMBER	1981	1,104,649	380,171
		1982	1,170,864	404,259

a/ 1982 Statistics are preliminary estimates.
SOURCE: Fishery Statistics of Indonesia, 1981 and 1982.

The greatest increases in numbers of marine fishermen from 1981 to 1982 occurred along the south coast of Java, North Sulawesi and the east coast of Sumatera, due to the trawler ban which encouraged greater entry of fishermen into the fishery. The largest catch per marine fishery unit was recorded around the Java Sea (Table 15).

The value of total production in coastal zone regions was approximately Rp. 570 billion in 1982. This represented a 13% increase over 1981 figures. The North Java coast comprised 23% of the total value of the catch, greater than any other coastal zone area. However, the value of catch per fisherman in 1982 for the north coast of Java was only Rp. 443,000, lower than the average catch value for all fishermen of Rp. 487,000. The greatest value per fisherman was in southwest Kalimantan.

TABLE 15: Catch Per Marine Fishing Unit (MFU), Value of Marine Fishery Production by Coastal Area and Value Per Fisherman, 1981 and 1982 a/

Coastal Zone	Name	Year	Catch/ MFU (kg)	Value of Production (Rp 1000)	Value Per Fishermen (Rp 1000)
1	West Sumatera	1981	3,115	34,201,110	514
		1982	2,903	41,609,016	601
2	South Coast of	1981	3,095	16,666,520	289
	Java	1982	3,400	26,425,943	399
3	Coast of Malacca	1981	5,828	76,649,962	550
	Straits	1982	5,812	93,445,240	641
4	East Coast Sumatera	1981	6,147	29,036,255	723
		1982	6,313	36,827,953	748
5	North Coast of	1981	4,169	109,115,042	388
	Java	1982	4,020	128,875,331	443
6	Bali-Nusa	1981	1,904	28,803,368	350
	Tenggara	1982	2,081	29,044,200	331
7	South West	1981	6,573	36,007,001	1,067
	Kalimantan	1982	6,499	29,943,042	866
8	East Kalimantan	1981	4,661	33,444,891	529
		1982	4,677	32,656,510	474
9	South Sulawesi	1981	4,271	77,574,522	531
		1982	4,409	88,841,302	588
10	North Sulawesi	1981	1,784	25,503,723	255
		1982	1,677	31,017,828	274
11	Maluku-Irian	1981	2,128	42,212,059	443
		1982	2,327	31,900,468	333
	TOTAL NUMBER	1981	3,704	504,214,462	456
		1982	3,687	570,586,876	487

a/ 1982 Statistics are preliminary estimates.
SOURCE: Fishery Statistics of Indonesia, 1981 and 1982.

3.2.1.2 The Production of Crustaceans

The effect of the trawler ban on production of crustaceans is seen in the statistics on crustacean production (Table 13), which show total production declining approximately 23% from 1981 to 1982. Important shrimp production areas are coastal zones 3, 4, 5, 7, 8 and 9. These zones are also the areas where shrimp trawlers were active before the ban. Only on the north coast of Java did production increase, rising by approximately 19%. In all other zones, catch of shrimp fell by amounts ranging from 32 to 38%. The decline in marine catch of shrimp has created problems for processors in locating adequate supplies; however, small-scale artisanal fishermen and tambak producers have benefitted from the trawler ban.

The export potential of shrimp and the decreasing catch of marine shrimp has encouraged tambak farmers to focus on shrimp production rather than production for domestic consumption. The market demand for end-products clearly affects which resources will be exploited and to what level.

3.2.1.3 Production from Inland Open Water Fisheries

The country's second largest source of fish is Indonesia's inland open waters. Total production was 265,000 mt or approximately 18% of marine production (Table 16). Kalimantan constituted the greatest supply source with 140,000 mt or 52% of fish production. Fish dominates the types of products produced, with crustaceans accounting for only 5% of total production. In general, the production of fish from inland waters has decreased in recent years, and it is not expected to contribute to the expansion of overall fish production in Indonesia in the future.

TABLE 16: Inland Open Water Fishery Production by Province, 1982 a/

Province	Total		Fish		Crustaceans		Molluscs		Other	
	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value
	MT	(Rp'000)	MT	(Rp'000)	MT	(Rp'000)	MT	(Rp'000)	MT	(Rp'000)
Sumatra	67,757	47,393	63,258	42,250	4,402	5,093	17	5	80	44
Java	21,607	12,904	18,942	11,319	2,040	1,262	284	15	341	305
Bali-Nusa Tenggara Timor	4,354	934	4,295	882	50	47	3	-	6	3
Kalimantan	140,619	84,931	136,784	81,198	3,293	3,529	218	41	324	162
Sulawesi	28,240	14,376	26,576	13,638	1,398	444	266	92	0	60
Maluku/Irian	2,771	1,216	2,630	1,217	130	53	11	5	-	-
TOTAL	265,348	161,833	252,485	150,824	11,313	10,631	799	160	751	516

a/ Statistics for 1982 are preliminary

SOURCE: Fisheries Statistics of Indonesia, 1982

3.2.1.4 Production from Brackishwater Ponds

Brackishwater pond culture has gained increased attention because of the large amount of coastal areas suitable for tambak production. Tambaks provide a supply of high valued shrimp, so even though production is small compared to marine production, the value in 1982 was 23% of the value of marine production (Table 17). Another important consideration is that 50% of the value of tambak production is an export foreign exchange earner for the country.

Shrimp production from brackishwater ponds is likely to increase because the GOI, with assistance from donor agencies and financial institutions, is providing capital for increased production through extensification (new pond development) and intensification of existing ponds (by increasing inputs of fertilizer, feed and stocking material).

The value of milkfish in 1982 represented 44% of total value from tambak production. The outlook for milkfish production, a valuable food fish, is that its share of total value and output will decline. Market demand for shrimp and limited market outlets for milkfish will cause producers to hold milkfish production constant or reduce it.

3.2.1.5 Production from Freshwater Ponds, Cage Culture and Rice Paddies

Freshwater ponds, cage culture and paddy fields contribute a minor percentage of overall fish production in Indonesia. Of these, fish culture in ponds and paddy fields is predominant (Table 18). Java is the principal island producing freshwater fish, accounting for 78% of freshwater fish and 84% of paddy culture fish. In the future, the GOI is looking to expand freshwater aquaculture production as a means of meeting increased fish production targets.

TABLE 17: Brackishwater Pond Culture by Province, 1982 a/

Province	Total	Value	Fish				Crustaceans			
			Milkfish	Value	Other	Value	Prawn/Shrimp	Value	Other	Value
Sumatra	13,310	12,146	9,987	7,916	1,208	515	2,135	3,668	60	39
Java	79,335	67,239	41,202	33,309	18,472	8,299	19,359	21,548	222	4,802
Bali-Nusa Tenggara Timor	1,842	2,593	1,168	1,122	311	118	362	1,351	1	2
Kalimantan	564	408	177	128	264	95	85	172	38	13
Sulawesi	34,205	48,542	20,774	14,965	4,611	2,119	8,661	31,351	159	187
Maluku/Irian	23	3	22	3	1	.558	0	0	-	-
TOTAL	129,279	130,934	73,330	57,446	24,867	11,145	30,602	62,096	480	238

a/ Statistics for 1982 are preliminary

SOURCE: Fisheries Statistics of Indonesia, 1982

TABLE 10: Production from Freshwater Ponds, Cage Culture and Rice Paddies by Province, 1982 a/

Province	Freshwater		Cage Culture		Paddy Field Culture	
	Total Production	Value	Total Production	Value	Total Production	Value
Sumatra	9,158	10,260,977	139	145,820	5,304	7,102,659
Java	56,500	49,245,457	420	659,008	32,923	61,706,662
Bali-Nusa Tenggara Timor	466	304,679	-	-	577	509,175
Kalimantan	314	494,572	331	278,295	-	-
Sulawesi	2,568	2,847,903	-	-	3,256	4,338,238
Maluku/Irian	151	241,532	-	-	-	-
TOTAL	69,245	63,395,120	818	1,083,123	112,600	73,648,726

a/ Statistics for 1982 are preliminary

SOURCE: Fisheries Statistics for Indonesia, 1982

3.2.2 Domestic Demand for Fish and Fish Products

The key factors affecting domestic demand for fish are a combination of: population growth, income changes, price of fish (domestic and export), price of fish substitutes, and tastes and preferences. Information on most of these variables is not available and previous economic analyses have assumed average figures.

Projections are, however, available on population growth (see Table 19). Indonesia's population is expected to grow to an estimated 183 million people by 1990. Without any consideration for other factors, total fish demand, using an average consumption rate of 11.6 kg per capita, would grow to 2,128,097 mt/year. This would mean that total production of fish from all sources will need to increase 123,000 mt (or approximately 10%) per year.

Several government initiatives outlined in Repelita IV cast doubt on Indonesia's capability to meet this growing domestic demand. First, the GOI has proposed greater exports of fish in order to generate foreign exchange earnings. This will focus fishing effort on shrimp, tuna, and other exportable species and away from "food" fish consumed in Indonesia. At the same time, the government wants to increase per capita consumption of fish, especially on Java. Per capita consumption is lowest on Java and attempts to increase consumption will increase pressures on fishery resources and require new marketing channels.

Income effects on fish demand are not clear. Recent estimates of per capita monthly expenditures indicate that fish is a more important commodity than meat, particularly for low income Indonesians (Table 20). It is uncertain, however, what the economic outlook for total per capita income will be during the rest of the 1980s, as the Indonesian economy is directly affected by uncertain oil exports. It is safe to assume, however, that slight improvements in real personal income will occur throughout the rest of the 1980s. The expenditure percentages in Table 20 imply that expenditure elasticities tend to be in the range of 0-1.0, indicating that fish is a normal good and that such income increases will lead directly to increased consumption of fish. However, as income goes up beyong Rp. 15,000/mo/capita, elasticity is positive but declining. This suggests that there will not be "full-effect" gains in consumption as income increases.

TABLE 19: Population Statistics for Indonesia by Province

Province	1982a/	1990a/	Growth Rate 1981-1982
	('000)	('000)	(%)
Sumatera	29,961.5	38,497.8	3.23
Java	95,103.4	109,779.2	1.88
Nusa Tenggara	8,835.1	10,139.3	1.82
Kalimantan	7,142.9	8,957.5	2.90
Sulawesi	10,887.0	12,752.9	2.07
Maluku + Irian Jaya	2,731.8	3,330.0	2.60
INDONESIA	154,661.7	183,456.7	2.21

a/ Projected populations based on 1980 census.

TABLE 20: Percentage of Average Per Capita Monthly Expenditure by Items of Consumption and Monthly Expenditure Classes

Expenditures	Monthly Per Capita Expenditure (Rp)				Average Per Capita
	6,000	6,000-14,999	15,000-40,000	40,000	
	(%)				
Cereals	37.17	21.59	10.07	3.82	12.66
Fish	4.27	6.28	5.29	2.19	5.17
Meat	.37	1.78	4.62	4.05	3.62
Vegetables	7.26	6.47	4.46	2.15	4.84
Misc. Food Items	11.06	10.92	7.60	3.75	8.03
Total Food	74.01	64.96	50.18	30.19	51.63
Total Non-Food	25.99	35.04	49.82	69.81	48.37
TOTAL	100.00	100.00	100.00	100.00	100.00

SOURCE: Statistical Yearbook of Indonesia, 1983.

3.2.3 Potential of Fisheries to Meet Projected Demands

The increased demand for fish in Indonesia requires an understanding of the potential of available resources. Based on figures presented in Table 21, pelagic and demersal fish are not being exploited to their full capacity. In eastern Indonesian waters, exploitation rates are at the lowest of any area in the archipelago. In the Java Sea area, some coastal zones are more heavily exploited than others. Marketing considerations have a direct impact on exploitation rates, in particular on the North Java coast, where there is the greatest number of fishermen as well as the largest potential consumer market. As such, these waters are heavily exploited, unlike West Sumatera where lower population density and a greater distance from key markets in Java combine to hold down exploitation rates. Current utilization rates reflect this economic reality.

The demersal fisheries in the archipelago are relatively untouched. Government initiatives to exploit pelagic and demersal fisheries will have an important effect on Indonesia's capability to meet its growing food demand. Marketing will be one of the major components of such an initiative, as greater commercial catch will only be economically possible if domestic markets are available for the product or export markets can be exploited. Transportation costs and market structure will be key constraints to such development.

3.2.4 Government Plans to Meet Fish Demand

Government development plans for meeting domestic consumption needs are unclear. One potential strategy, the Eastern Waters strategy, consists of large-scale public and private sector efforts to exploit fish stocks in that region. Commercial licenses are being issued and joint ventures signed, mostly with companies that will exploit pelagic or demersal stocks for domestic consumption. One current policy provides for private fishing companies to sell their by-catch to state fishing companies for disposal of the product. This strategy does not work very well because it forces private companies to handle a valueless commodity in addition to their major target species, shrimp.

The important Java Sea area is not being systematically studied or managed. The major policy affecting this fishing region recently was the trawl ban in 1981. Since that blanket policy, no government directive on how this area is going to be managed has been presented. Pressures on the ecological systems are growing while certain fish stocks are overexploited and others are underexploited. A commitment needs to be made by the government to establish a development strategy for this key area.

TABLE 21: Utilization of Marine Fisheries Resources, 1981

Coastal Zone Area	Production (Incl. EEZ)			Level of Utilization		
	Pelagic	Demersal a/	Shrimp b/	Pelagic	Demersal a/	Shrimp b/
	('000 MT)			(%)		
West Sumatera Coast	38.2	18.1	.332	22.2	10.7	36.9
South Java Coast	30.0	12.4	1.2	18.0	11.0	21.4
Mulacca Straits	91.1	34.0	8.8	68.2	43.5	43.9
East Sumatera	82.6	43.7	5.8	20.0	6.9	100.0
North Java	233.8	58.7	4.3	64.3	18.2	36.6
Bali-Nusa Tenggara	64.5	10.6	.344	24.9	4.9	68.8
South-West Kalimantan	39.2	20.9	5.9	25.1	8.5	100.0
East Kalimantan	42.9	23.0	5.3	27.8	11.5	100.0
South Sulawesi	161.0	38.5	4.0	100.0	55.9	-
North Sulawesi	65.3	9.6	.01	17.7	12.0	-
Maluku/Irian Jaya	62.4	15.6	7.4	4.1	3.3	40.9
TOTAL	930.9	285.2	43.3	23.5	11.0	62.8

a/ Excludes penaeid shrimp but includes coral reef fish

b/ Only penaeid shrimp

SOURCE: DGF - Jakarta November, 1984

3.3 Domestic Distribution System for Fish and Fish Products

The distribution and marketing system for marine fish and fish products is varied and complex. No particular market channel can be said to dominate throughout the archipelago. For some marine products, several marketing agents handle the product before it reaches the final end consumer. This seems particularly true for lower valued fish species that are supplied by coastal fishermen. Other high valued species, such as shrimp, have fewer exchanges between producer and final processor before being exported. This observation must be qualified to reflect the size of the production unit from which the product is being marketed. Smaller-scale operations tend to have more market agents handling the product, and the greater the time in the market system, the lower the final quality of the product.

3.3.1 Distribution System by Major Product Forms

A discussion of distribution systems for fish products is divided along product lines: fresh, frozen and dried fish. A strong preference for marine fish seems prevalent across the archipelago, except on Java where there is a large demand for milkfish. When marine fish are not available because of seasonal weather patterns, other types of fish are readily consumed, for example, freshwater species in the interior of Java. Certain freshwater species, for example carp or catfish, demand a high price because of ethnic taste and preference.

3.3.1.1 Marketing of Fresh Marine Fish

The use of ice by fishermen and marketing agents seems pervasive throughout the islands where ice facilities are available. Over the last four years, the availability of ice and its adoption by fishermen and market agents in Indonesia have increased, due in part to the GOI's concerted efforts to improve market infrastructure. However, at retail markets, ice is still not readily available, or if available, is not readily used.

Fresh marine fish is usually consumed close to landing areas or in large coastal cities. Approximately 50% of marine fish caught in 1982 was consumed in fresh form (Table 22). From field observations, this percentage is high and probably does not reflect unsold fresh fish, which are then processed. Fish is rarely discarded and is likely to be converted to other processed forms and sold.

In several large markets, key middlemen specialize in fresh fish distribution. Surabaya is a good example, where middlemen purchase fresh fish for distribution to retailers. The same is probably true for other markets. Information was not readily available due to close business ties and personal relationships, which are difficult to penetrate. In general, however, the fresh fish marketing system is relatively more open for the entry of middlemen than the dried fish trade.

There is some inter-island trade in fresh marine fish but it is limited to production areas close to Java such as the coastal waters south of Kalimantan which are accessible by small carrier boats based at the Jakarta Fishing Port. Figures on operation costs for a carrier boat from Jakarta are illustrated in Table 23. The cost of transporting fresh fish is expensive relative to other product forms, approximately Rp. 150 per kg.

3.3.1.2 Marketing of Frozen Fish

The only substantial marketing of frozen fish is done by P.T. Tirta Raya Mina (TRM) based in Pekalongan. The company is state-owned and receives its major funding from the Asian Development Bank. The frozen fish trade originates primarily in Kalimantan and South Sulawesi. Fish are transported by carrier boat to Java for off-loading and distribution on Java. Currently, TRM is also purchasing skipjack tuna in the Nusa Tenggara region for sale on Java.

The company has its own fleet of insulated trucks for transportating fish to markets on Java. Its major sale outlets for frozen fish in 1983 are listed in Table 24. The largest percentage of sales is in Bandung in West Java, which is also the center of the dried fish trade. It is unclear why Bandung is such a large importing area for dried as well as frozen fish.

The company's marketing plan is to buy fish during the peak production season of September to November and store the fish in cold storage. The fish can then be sold when market supplies are short. Overall mark-up on fish prices ranges from 50-100%. The mark-up during the full moon is 50%.

In the last two years, the company has moved away from a domestic market orientation to an export market orientation. This change in focus is in line with government directives for increased exports, but this leaves a void in inter-island trade of fresh and frozen fish. If greater exploitation of small pelagic and demersal species (particularly in the eastern islands) is to occur, then inter-island marekt channels, as developed by P.T. TRM, need to be perfected. At present, there are no private enterprises developing inter-island trade in frozen fish because the profitability of such a business is marginal due to high transportation costs (ranging from Rp. 150 to 250/kg) and a limited demand for frozen fish on Java.

3.3.1.3 Dried and Salted Fish Marketing System

Dried and salted fish represent an important source of protein in addition to being a traditionally preferred product by some consumer groups. As such, nearly 70% of all marine fish is sold and consumed in processed forms. A much smaller percentage of inland open water fishery products is processed (Table 25). Because of the magnitude of dried and salt fish trade in Indonesia, an extensive and complex market system for these products has evolved.

TABLE 22: Disposition of Marine Fish by Product Form by Province, 1982 (tons) a/

Province	Total	Fresh Fish	Dried/ Salted	Boiled	Fermented	Smoked	Other	Freezing	Canning	Fish Meal
West Sumatra	80,408	60,033	19,572	93	10	44	666	-	-	-
South Coast Sumatra	68,395	29,738	17,616	14,992	1,055	464	3,894	636	-	-
Coast of Malacca Straight	242,568	126,155	86,781	87	26,075	316	584	1,317	-	1,253
East Coast Sumatra	114,725	63,250	43,989	1,031	3,388	-	185	2,044	394	144
North Coast of Java	341,454	117,445	119,695	67,006	7,368	11,581	3,832	8,446	3,641	1,440
Bali-Nusa Tenggara	88,496	45,144	20,715	10,065	68	1,011	5,839	92	3,938	1,624
South West Coast Kalimantan	78,562	45,468	28,157	132	1,762	-	77	2,959	-	-
East Kalimantan	80,271	35,353	35,300	50	6,089	5	51	5,423	-	-
South Sulawesi	230,341	104,091	47,917	4,580	125	1,884	806	938	-	-
North Sulawesi	80,271	35,353	35,300	50	6,089	5	51	3,423	-	-
Maluku/Irian Jaya	93,674	41,660	19,265	970	807	12,124	65	20,783	-	-
TOTAL	1,490,719	770,520	451,347	99,003	46,747	42,814	16,000	40,683	9,044	5,761

a/ Estimated Figures only

SOURCE: Fishery Statistics, 1982

TABLE 23: Costs for Collection of Fish from Coastal Zone of South Kalimantan to Jakarta, November, 1984

Item		Cost
		Rp.
Fuel: 18 drums @ 200 litres/drum	Rp.220/litre	792,000.
Fixed Crew Wages:		
Crew (Rp.20,000/crew member x 8 sailors).		160,000.
Captain		60,000.
Variable Wage (depends on catch):		
Wage/ton (8 crew x Rp5,000/ton x 8 tons)		600,000.
Ice: 16 tons of ice x Rp.50/kg		700,000.
Approximately, total cost		2,312,000.
Cost per unit of landed product a/	(Rp/kg)	154.

a/ Assumes capacity of each boat to be 15 tons; if capacity is greater, then transportation costs per kg will decline.

TABLE 24: Sales of Frozen Fish by P.T. Tirta Raya Mina, Pekalongan, 1983

Location	Net Sales	Percent of Total Sales
	(MT)	%
Bandung, West Java	346	30
Bogor, West Java	162	14
Jakarta	151	13
Semarang	124	11
Pekalongan	120	11
Regional Distribution (Central Java)	24	2
Yogyakarta	24	2
Other	192	17
TOTAL	1143	100

SOURCE: Records from P.T. Tirta Raya Mina.

TABLE 25: Disposition of Inland Open Water Fishery Production by Province, 1982 (Tons)

Province	Total	Fresh	Dried/ Salted	Boiled	Fermented	Smoked	Other
Sumatera	67,757	45,904	12,423	8	919	6,740	1,763
Java	21,607	18,187	1,654	454	170	429	713
Bali - Nusa Tenggara Timor	4,354	1,962	2,201	26	-	-	85
Kalimantan	140,619	76,809	62,073	-	218	1,170	349
Sulawesi	28,240	23,790	3,926	50	-	474	-
Maluku/Irian Jaya	2,771	2,770	-	-	-	1	-
TOTAL	265,348	169,422	82,357	538	1,307	8,814	2,910
Market Weight	222,064	169,422	46,064	417	525	4,286	1,350

Bandung is a major processing center, supplying dried fish to West Java. Large amounts of the product are marketed through a small group of market agents located in Jakarta and Surabaya. These agents control the market, including smaller wholesalers and their retail agents up and down the market channel. Like the fresh fish trade, the exchange process is based on a code of trust, with payment received some time after the sale of the product. Because of the tight control over the market exerted by a few individuals, a special effort will be required to introduce new supplies of processed products developed from stocks of small pelagic fish in eastern Indonesia. While the GOI seems aware that the dried fish trade is controlled by such a small group, no active policy has been taken. Instead, the GOI has focused on the marketing of fresh and frozen fish. This "no-policy" is due in part to the difficulty of changing a marketing system which has been in place for decades.

Market channels in Bogor have also developed over many years. One trader interviewed suggested that market agreements with two of his major suppliers have been in place for between 10 and 20 years. At present, there are about 20 wholesalers in Bogor and 15 retailers. The wholesalers, in addition to supplying the local market, repackage dried fish and distribute it to the interior of Java.

A major development occurring in the dried fish trade is the use of insecticides during processing. There have been numerous accounts of fish processors dipping or spraying Baygon. The potential health hazards are great; and with ready access to the chemical, it will be difficult to monitor this practice unless firm government action is taken. The use of chemicals seems to be limited to Java, but investigation should be undertaken to see if such chemicals are being used on the outer islands.

The model fishing village at Muara Angke offers an alternative scheme for fishermen to break the hold of market agents in the dried fish trade. Processors are using newly built government facilities to salt and dry their fish. The surroundings are excellent, and all available space is rented. Government officials are active in encouraging new product development, such as processing the skins of sting rays for export. One method for expanding small business enterprises in the dried fish trade is to develop a market niche in new products not being currently controlled. As a pilot project, this program could be examined for duplication in other areas of Indonesia, particularly because fish processing is a labor intensive enterprise with opportunities for increasing rural employment, especially for women.

3.3.2 Interisland Trade in Fish and Fish Products

The major components of Indonesian inter-island trade involve the "export" of fish and fish products from Sumatera Selatan, Kalimantan, South Sulawesi and Bali-Nusa Tenggara to

Java (see Figure 1). These "flows" have developed due to the demand on Java and the costs of transporting fish, which make it commercially impossible for Java to "import" fish from provinces further away. Most interisland trade flows are controlled by middlemen on Java.

Average prices for 1982 to the fishermen for various species and price differences between regions are illustrated in Table 26. Prices for anchovies, scad and sardines vary by coastal area within the crescent. Price differences also vary by location and time of year. Trade between the outer islands and Java fluctuates based on these prices, and on supply, demand and transportation costs.

The major supply areas for dried fish to Java are: Lampung, Bagan Siapi-api, Kalimantan and South Sulawesi. Based on site visits and information on market structure, costs of transportation to Java (Bandung) have been estimated (see Table 27). Most dried fish trade enters Java via boogie trading vessels (which are primarily sailing ships) through the ports of Jakarta, Semarang and Surabaya. In addition, interviews with major processors in Ujung Pandang revealed that dried fish was shipped regularly to Java; one processor said that he shipped 120 mt of dried fish per month to Surabaya. He considered Java a residual market when supplies built up on South Sulawesi. Further study is required to fully understand the volume and value of inter-island trade.

3.4 International Trade of Fish and Fish Products from Indonesia

The export of fish commodities from Indonesia has increased dramatically over the 13 years period from 1970 to 1982 (Table 28). Quantities of exports have quadrupled while value has risen at an even faster rate. This rate of increase is placing enormous pressures on fish resources.

The fish products which have increased most in importance are frozen tuna, frozen shrimp, other frozen crustanceans and jelly fish. The export value of shrimp exceeds all other fishery export commodities, with approximately US $180 million in foreign exchange in 1982.

An obvious trend in the world export market has been the shift from fresh to frozen products. The greatest shift occurred in selling shrimp in fresh form to shrimp sold in frozen form, 98% (Table 29). In response, Indonesia has experienced a tremendous increase in cold storage capacity, now estimated to be over 290,000 mt, of which only 14% is currently being utilized.

FIGURE 1: Trade Flows of Dried and Salted Fish

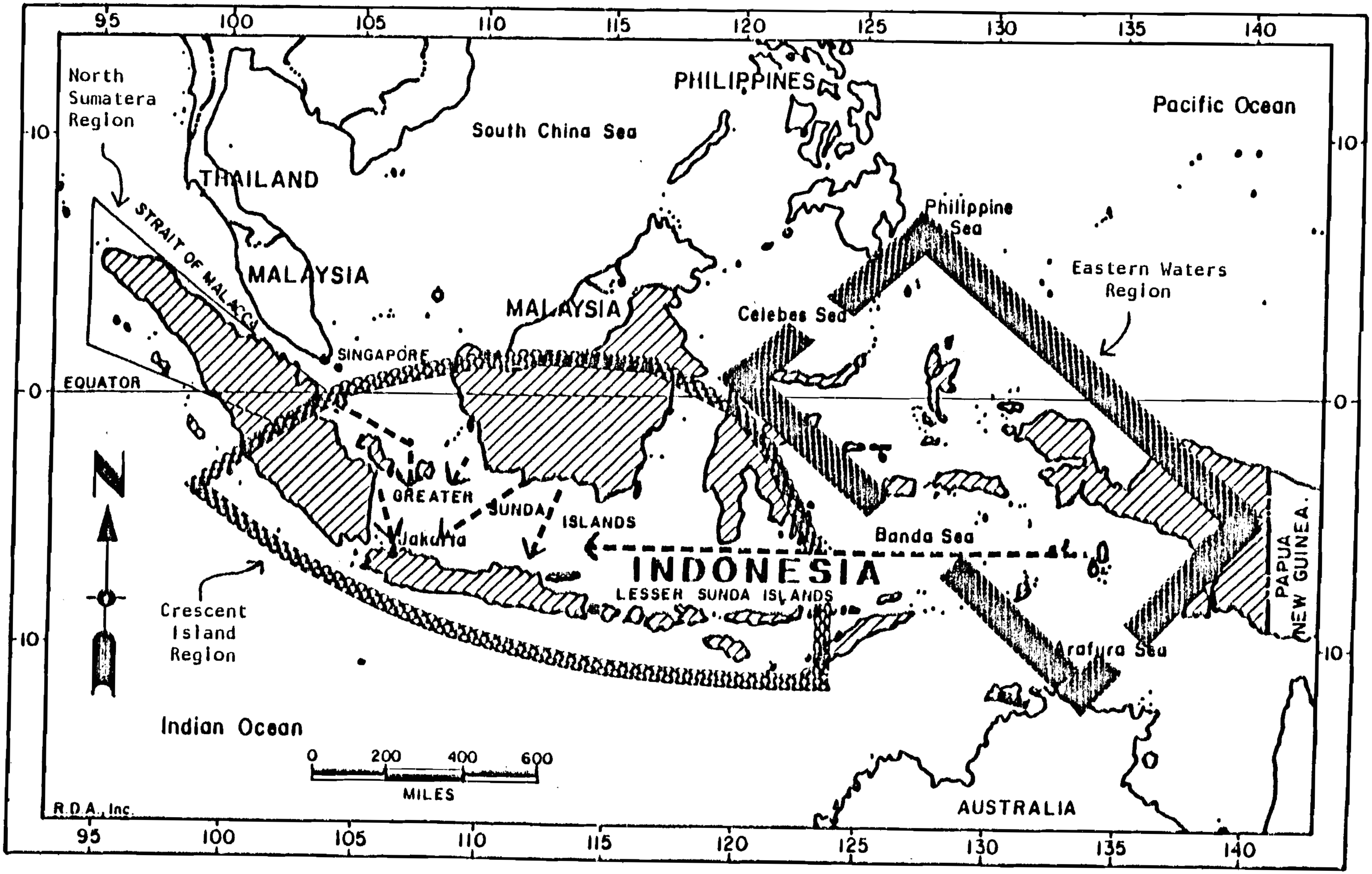

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TABLE 26: Price Differentials for Selected Fish Species for Major Supply and Demand Locations, 1982

Province	Price Anchovies	Difference To Java	Price Scad	Difference To Java	Price Sardines	Difference To Java
	(Rp/kg)					
North Java	212	-	357	-	205	-
Mallaca Straits	620	-408	375	-18	245	-40
East Sumatera	143	69	212	145	151	54
South-West Kalimantan	177	35	-	-	329	-124
East Kalimantan	122	90	225	132	95	110
South Sulawesi	253	-41	382	-25	282	-77
North Sulawesi	173	39	332	25	256	-51
Maluku/Irian Jaya	128	84	177	180	157	48

SOURCE: 1982 Fishing Statistics

TABLE 27: Cost of Dried Fish from Bangermasin to Bandung, Java, November, 1984

	(Rp/kg)
Cost of sprat to processor	400
Government tax to provincial government	50
Transport by sea to Surabaya	75
Transport by truck to Bandung, West Java	25
Cost of Product, C and F Bandung	550
Price to Bandung wholesaler.	600
Return to management	50
Collector's percent of final price (%)	8

SOURCE: Personal interview, November, 1984.

3.4.1 Production and Distribution of Shrimp Exports

Indonesia's major fish export is shrimp. As shown in Table 30, major shrimp processing and export areas are North Sumatera (12%), Jakarta (13%), Central Java (13%), Maluku (12%) and Irian Jaya (11.5%). Some processing companies have plants located in several of the production areas, with most companies having their head office in Jakarta. Except for the Malukus and Irian Jaya, supplies are from small scale marine fishermen and tambak producers. Shrimp exports from the eastern area are from commercial fleets. Processing, packaging, and freezing are done on board.

Processing capacity is generally located close to the shrimp production areas because of the high cost of transportation per unit of product (see Table 30). As such, most of the shrimp processors are located on islands bordering the Java Sea. The trawl ban has caused diseconomies for areas such as Palembang in South Sumatera, because of the lack of sources of shrimp after the trawl ban. The plants in areas where there are extensive brackishwater tambaks have been able to do better than plants solely dependent on marine supplies of shrimp. Shrimp processors as a whole are operating at less than 20% of capacity.

TABLE 28: Time Series Information on Indonesian Fishery Exports, 1970-1982

Year	Shrimp Qty a/	Shrimp Value a/	Tuna Skipjack Qty	Tuna Skipjack Value	Other Marine Fish Qty	Other Marine Fish Value	Froglegs Qty	Froglegs Value	Jelly Fish Qty	Jelly Fish Value	Ornamental Fish Qty	Ornamental Fish Value	Other Products Qty	Other Products Value	Total Qty	Total Value
1970															20.1	7.0
1971															30.8	19.0
1972															41.2	34.9
1973						(Not Available)									52.2	68.2
1974															55.0	92.0
1975															40.7	89.2
1976															54.4	131.4
1977	31.4	139.2													57.5	163.6
1978	32.6	162.0	9.4	6.2	4.2	1.6	2.3	6.2	1.9	4.0	.4	.1	12.7	13.4	63.5	193.4
1979	34.7	200.5	9.8	8.0	6.7	2.2	2.7	7.2	1.4	2.7	.4	.1	12.5	16.2	68.3	236.8
1980	31.9	180.9	11.1	12.9	20.2	6.5	1.6	4.8	1.5	2.0	.5	.1	11.9	19.2	78.7	226.4
1981	25.0	162.8	14.0	15.4	15.4	5.8	2.8	9.4	3.1	5.2	.4	.1	14.5	26.6	75.2	225.4
1982 b/	25.4	181.2	19.4	21.4	22.8	8.3	1.7	4.0	3.4	6.6	.2	.1	15.2	32.0	88.1	253.6

a/ Qty is volume of export in ('000 mt) and Value is in (US $ million).

b/ Estimates for 1982 are preliminary.

SOURCE: Central Bureau of Statistics, Indonesia.

TABLE 29: Comparison of Quantities of Values of Exports for the Periods of 1977 and 1982

Commodity Group	Net Weight	Percent Change From 1977	Value F.O.B.	Percent Change From 1977
	(kg)		(US$)	
Marine Fish-Fresh	7,219,297	- 21	2,580,685	- 32
Marine Fish-Frozen	19,119,915	- a/	7,395,847	- a/
Tuna - Frozen	18,785,453	+ 887	19,861,581	+1400
Fish-Dried, Salted, Smoked	1,182,748	+ 26	6,407,757	+ 39
Prawns - Shrimp (Shell-Headless)				
fresh/chilled	790,009	- 97	3,216,775	- 98
frozen	24,583,449	+5800	177,433,983	24,800
dried or boiled	92,788	- 93	84,108	- 83
Crabs	2,008,723	+ 52	419,662	139
Lobster and Crayfish	110,037	- 59	904,727	- 9
Other Crustaceans				
fresh/chilled	198,432	- 53	148,542	- 72
frozen	746,382	+5904	5,373,384	+46,661
Jelly Fish	2,238,075	+ 73	4,456,597	+ 176
TOTAL	77,075,308		225,953,648	

SOURCE: Export Statistics, 1982

a/ Comparison with 1977 was not possible due to data reporting incompatibility between both years.

TABLE 30: Quantities and Values for Major Fishery Production by Production Areas and Country Designation of Production, 1982

Province	Product	Country	Kg	US$
D.I. Aceh	Prawns - Shrimp (Frozen)	Japan	250,142	2,280,190
North Sumatera	Frog Legs (Frozen)	Singapore	97,228	37,172
		Malaysia	158,375	31,669
		Netherlands	4,500	12,960
		Belgium & Luxembourg	20,000	54,000
		Sub Total	280,103	135,801
	Prawns - Shrimps	Japan	1,693,920	13,822,246
		Hong Kong	139,601	324,965
		Singapore	799,020	3,786,603
		Malaysia	27,912	68,006
		USA	299,645	824,343
		Netherlands	15,744	50,876
		Sub Total	2,975,842	18,877,039
	Crustaceans (Frozen)	Singapore	201,532	534,898
		Sub Total	201,532	534,898
	Other Marine Fish (Fresh)	Singapore	955,277	286,347
		Malaysia	7,333	2,197
		Sub Total	962,610	288,544
	Jelly Fish	Japan	1,067,700	2,146,312
		Hong Kong	10,000	9,805
		Taiwan	77,000	393,875
		Malaysia	239,450	235,861
		Sub Total	1,394,150	2,785,853
Riau	Marine Fish (Fresh Chilled)	Singapore	3,893,430	1,403,840
		Malaysia	701,400	221,677
		Sub Total	4,594,830	1,625,517
	Marine Fish (Frozen)	Singapore	209,725	47,334
		Sub Total	209,725	47,334

TABLE 30: (Continued)

Province	Product	Country	Kg	US$
Riau	Other Crustaceans (Frozen)	Malaysia	5,000	100,000
		Sub Total	5,000	100,000
South Sumatera	Frog legs (Frozen)	Hong Kong	1,330	2,793
		Netherlands	36,844	117,314
		Sub Total	38,174	120,107
	Marine Fish (Fresh)	Hong Kong	7,900	16,590
		Sub Total	7,900	16,590
	Marine Fish (Frozen)	Singapore	300	150
		Sub Total	300	150
	Prawns - Shrimp (Frozen)	Japan	881,922	7,160,252
		Hong Kong	125,888	326,524
		Singapore	7,245	35,431
		Netherlands	117,300	667,068
		France	13,630	64,566
		F.R. Germany	8,100	54,280
		Italy	18,607	72,110
		Sub Total	1,172,692	8,380,231
	Crustaceans (Frozen)	Netherlands	8,040	56,769
		Sub Total	8,040	56,769
Jakarta	Marine Fish (Fresh)	Singapore	240,563	33,335
		Malaysia	1,900	2,180
		USA	500	140
		Sub Total	242,963	35,655
	Marine Fish (Frozen)	Japan	24,540	263,490
		Sub Total	24,540	263,490

TABLE 30: (Continued)

Province	Product	Country	Kg	US$
Jakarta	Prawns - Shrimp (Frozen)	Japan	2,979,829	25,513,696
		Hong Kong	228,697	706,436
		Singapore	45,809	325,314
		USA	8,280	52,560
		U.K.	5,400	38,699
		Netherlands	38,980	243,843
		France	6,050	36,293
		Sub Total	3,313,045	24,916,841
	Jelly Fish	Japan	333,400	629,632
		Hong Kong	25,000	43,800
		South Korea	3,000	4,700
		Taiwan	477,525	980,112
		Sub Total	838,925	1,658,244
Central Java	Frozen Frog Legs	Hong Kong	1,456	2,184
		Netherlands	10,150	18,526
		Sub Total	11,606	20,710
	Prawn - Shrimp (Frozen)	Japan	2,896,550	25,102,519
		Hong Kong	308,547	1,565,250
		Sub Total	3,205,097	26,667,769
East Java	Frog Legs (Frozen)	Hong Kong	25,453	62,403
		Netherlands	332,738	979,267
		France	236,539	737,273
		F.R. Germany	10,950	33,945
		Belgium-Lux	320,510	950,095
		Switzerland	42,337	157,048
		Sub Total	968,527	1,920,031
	Marine Fish (Frozen)	Singapore	69,470	8,097
		Sub Total	69,470	8,097
	Prawns - Shrimp (Frozen)	Japan	1,581,190	14,786,624
		Hong Kong	70,572	324,700
		USA	27,240	159,354
		Netherlands	32,031	325,202
		France	47,987	144,889
		F.R. Germany	16,169	210,017
		Italy	4,500	16,200
		Sub Total	1,779,689	15,966,986

TABLE 30: (Continued)

Province	Product	Country	Kg	US$
	Crustaceans (Frozen)	Japan	68,729	800,128
		USA	10,896	60,472
		Sub Total	79,625	860,600
Bali	Tuna Fish Marine (Frozen)	Japan	630,000	960,100
		Singapore	1,525,000	2,666,000
		Italy	700,000	957,400
		Sub Total	2,855,000	4,583,500
Nusa Tenggara Timur	Marine Fish (Frozen)	Hong Kong	16,889,000	5,836,778
		Sub Total	16,889,000	5,836,778
W. Kalimantan	Prawns - Shrimp (Frozen)	Japan	641,510	3,740,167
		Hong Kong	246,829	1,004,083
		Sub Total	888,339	4,744,250
S. Kalimantan	Frog Legs (Frozen)	Hong Kong	90,005	145,998
		Sub Total	90,005	145,998
	Marine Fish (Fresh)	Hong Kong	408	816
		Sub Total	408	816
	Marine Fish (Frozen)	Hong Kong	3,674	7,812
		Sub Total	3,674	7,812
	Prawn - Shrimp (Frozen)	Japan	1,487,719	9,311,772
		Hong Kong	387,403	1,062,955
		Singapore	56,094	334,244
		Sub Total	1,931,216	10,708,971
	Jelly Fish	Japan	5,000	12,500
		Sub Total	5,000	12,500
E. Kalimantan	Marine Fish (Fresh)	Singapore	15,700	9,500
		Sub Total	15,700	9,500
	Marine Fish (Frozen)	Hong Kong	18,578	27,865
		Sub Total	18,578	27,865

TABLE 30: (Continued)

Province	Product	Country	Kg	US$
E. Kalimantan	Prawns - Shrimp (Frozen)	Japan	1,239,382	7,721,023
		Hong Kong	209,445	757,581
		Iraq	40,018	249,262
		Sub Total	1,488,845	8,727,866
	Crustaceans (Frozen)	Hong Kong	52,205	168,016
		Sub Total	52,205	168,016
N. Sulawesi	Tuna Fish Marine (Frozen)	Japan	5,212,351	5,792,839
		Singapore	2,565,167	2,725,447
		Sub Total	7,777,518	8,518,286
	Marine Fish (Frozen)	Japan	30,000	54,000
		Sub Total	30,000	54,000
S. Sulawesi	Frozen Frog Legs	Netherlands	18,036	53,078
		Sub Total	18,036	53,078
	Prawns - Shrimp (Frozen)	Japan	1,759,846	17,742,979
		Sub Total	1,759,846	17,742,979
	Crustaceans (Frozen)	Japan	316,100	3,129,989
		Sub Total	316,100	3,129,989
	Tuna Fish Marine (Frozen)	Japan	626,954	436,497
		USA	139,233	111,386
		Sub Total	766,187	547,883
S.W. Sulawesi	Tuna Fish Marine	Japan	626,954	436,497
		USA	139,233	111,386
		Sub Total	766,187	547,883
Maluku	Tuna Fish Marine (Frozen)	Japan	4,718,497	3,369,504
		Sub Total	4,718,497	3,369,504
	Marine Fish (Frozen)	Japan	90,518	120,665
		Taiwan	406,188	155,903
		Sub Total	496,704	276,568

TABLE 30: (Continued)

Province	Product	Country	Kg	US$
Maluku	Prawns - Shrimp (Frozen)	Japan	2,991,549	20,519,147
		Sub Total	2,991,549	20,519,147
	Marine Fish (Fresh)	Japan	22,626	13,575
		Sub Total	22,626	13,575
	Tuna Fish Marine (Frozen)	Singapore	1,750,000	1,573,500
		Sub Total	1,750,000	1,573,500
	Marine Fish (Frozen)	Japan	944,238	567,239
		Singapore	500,000	312,500
		Sub Total	1,444,238	879,739
Irian Jaya	Prawn - Shrimp (Frozen)	Japan	2,823,787	17,882,176
		Papua New Guinea	700	2,472
		Australia	500	1,250
		USA	2,160	15,096
		Sub Total	2,827,147	17,900,994
	Crustaceans (Frozen)	Japan	83,580	487,112
		Sub Total	83,580	487,112

SOURCE: Export Statistics, 1982.

The major importer of Indonesian shrimp is Japan (Tables 31 and 32) which purchased 86% of Indonesian shrimp in 1982 valued at approximately US $170 million. This accounted for approximately 72% of the total value of all Indonesian fishery products exported. The heavy dependence on the Japanese market places Indonesia at a disadvantage in negotiating prices (although shrimp prices in Japan are comparable to other international shrimp prices), as Japan holds additional bargaining power because of several large joint venture shrimp operations in the eastern waters. Major Japanese buyers active in the market are: Mitibushi, Casio, Nitiman, Hanwe and Okiya. Negotiations are conducted by telex or phone with bank letters of credit used to transfer funds. Ocean freight rates to Yokohama from Jakarta are approximately US $.18 per kg. The export company quotes their price C.I.F. Yokonama. Export duty is paid by the Indonesian company. Based on a world price of US $14.53 per kg, the export duty is approximately US $0.20 per kg.

The economic outlook for continued growth of shrimp exports is mixed because of several conditions peculiar to Indonesia. The productivity of tambak shrimp production per hectare is low in Indonesia when compared to other countries which are entering the industry. Countries such as Mexico, Ecuador and other Caribbean Basin countries also have a locational advantage in exporting to the US market. Also, small-scale artisanal fishermen are unable to fully replace shrimp which were caught by trawlers. Processors realizing this are investing in tambak production to increase supplies. Finally, questions about quality control in export shrimp still persist and possible increased environmental problems are unresolved.

3.4.1.1 Description of the Export Trade in the Shrimp Industry

The commercial processing and export of shrimp has been reduced since the trawl ban was imposed by the government in 1981. For example, sales for one private company, P.T. Pusar in Jakarta, have declined from 150 tons per month before the ban to 50 tons per month currently. This firm has sought to diversify by exporting snails and frog legs.

Shrimp supplies come from two source: marine and tambaks. The major source of shrimp is from artisanal fishermen in the three coastal zone locations: South Sumatera - Lampung, Kalimantan, and Central Java. Shrimp from each supply area are tansported by boat, airplane (primarily) and truck, respectively. In each location, a collection agent gathers the product for processors. The shrimp is purchased and held until supplies are large enough and then shipped to Jakarta for processing, storage and export. The collection agent will buy from either the fishermen's cooperative or from other private agents.

TABLE 31: Export by Commodity by Country of Destination, 1982

Commodity	Destination	Net Weight	% of Total	Value of F.O.B.	% of Total
		Kg	%	(US$)	%
Frog Legs (Frozen)	Hong Kong	118,244	8	213,378	6
	Singapore	106,018	7	46,102	1
	Malaysia	158,375	11	31,669	1
	Netherlands	459,180	31	1,316,830	37
	France	236,539	16	737,273	21
	F.R. Germany	10,950	1	33,945	1
	Belgium - Lux	340,510	23	1,004,095	28
	Switzerland	42,337	3	157,048	5
	TOTAL	1,472,163	100	3,540,340	100
Marine Fish (fresh)	Japan	22,626	1	13,575	1
	Hong Kong	703,308	11	257,598	11
	Singapore	5,174,440	78	1,741,119	78
	Malaysia	710,633	10	226,054	10
	USA	500	-	140	-
	TOTAL	6,611,507	100	2,238,486	100
Tuna Fish Marine (frozen)	Japan	11,187,802	60	10,558,940	53
	Singapore	6,758,418	36	8,233,855	41
	USA	139,233	-	111,386	1
	Italy	700,000	4	957,400	5
	TOTAL	18,785,453	100	19,861,581	100
Marine Fish (frozen)	Japan	1,089,294	6	1,005,394	14
	Hong Kong	16,911,252	88	5,872,455	79
	Taiwan	406,188	2	155,903	2
	Singapore	710,025	4	359,984	5
	TOTAL	19,116,759	100	7,393,736	100

TABLE 31: Export by Commodity by Country of Destination, 1982 (Continued)

Commodity	Destination	Net Weight	% of Total	Value of F.O.B.	% of Total
		Kg	%	(US$)	%
Prawns-Shrimps (frozen)	Japan	21,227,346	86	163,583,511	92
	Hong Kong	1,716,982	7	6,072,494	3
	Papua New Guinea	700	-	2,492	-
	Singapore	908,168	4	4,481,592	2
	Malaysia	27,912	-	68,006	-
	Iraq	40,018	-	249,262	-
	Australia	500	-	1,250	-
	USA	337.325	1	1,051,353	1
	U.K.	5,400	-	38,699	-
	Netherlands	204,055	1	1,286,989	1
	France	67,667	-	245,748	-
	F.R. Germany	24,269	-	264,297	-
	Italy	23,107	-	88,310	-
	TOTAL	24,583,449	100	177,433,983	100
Other Crustaceans (frozen)	Japan	468,409	63	4,417,229	83
	Hong Kong	52,505	7	168,016	3
	Singapore	201,532	27	534,898	10
	Malaysia	5,000	1	100,000	2
	USA	10,896	1	60,472	1
	Netherlands	8,040	1	56,769	1
	TOTAL	746,382	100	5,337,384	100
Jelly Fish	Japan	1,406,100	63	2,788,444	63
	Hong Kong	35,000	1	53,605	1
	South Korea	3,000	-	4,700	-
	Taiwan	554,525	25	1,373,987	31
	Malaysia	239,450	11	235,861	5
	TOTAL	2,238,076	100	4,456,598	100

TABLE 32: Major Importing Countries of Indonesian Fish and Fishery Products, 1982

Country	Products	Net Weight (Kg)	Value F.O.B. (US $)
Japan	Fish, Fresh, Chilled or Frozen	12,300,267	11,578,159
	Fish, Dried, Salted, Brined, Smoked	236,586	5,100,717
	Crustaceans & Molluscs	23,540,399	174,233,903
Hong Kong	Fish, Fresh, Chilled or Frozen	17,659,250	6,139,400
	Fish, Dried, Salted, Brined, Smoked	63,896	71,155
	Crustaceans & Molluscs	1,827,086	6,323,792
Taiwan	Fish, Fresh, Chilled or Frozen	406,288	155,953
	Crustaceans & Molluscs	554,525	1,373,987
	Fish, Fresh, Chilled or Frozen	13,312,853	10,706,029
	Fish, Dried, Salted, Brined, Smoked	699,252	983,896
	Crustaceans & Molluscs	4,399,319	6,474,394
USA	Fish, Fresh, Chilled or Frozen	197,508	142,666
	Crustaceans & Molluscs	348,221	1,111,825
France	Fish, Fresh, Chilled or Frozen	21,876	9,666
	Crustaceans & Molluscs	238,363	818,767

SOURCE: Export Statistics, 1982

The average price paid to fishermen is currently between Rp. 9,000 - Rp. 10,000 per kg for marine shrimp (30 pieces per kg) and Rp. 7,000 - Rp. 7,500 for tambak shrimp. Before the trawler ban, the price was between Rp. 5,000 - Rp. 6,000/kg (after adjusting the value of rupiah for inflation and the recent devaluation). Premium prices are clearly being paid to obtain supplies of shrimp.

3.4.1.2 Marketing Costs for Shrimp Exporters

Costs of operation for one export business were calculated (Table 33). The average sales price was assumed to be US $14.53 per kg based on company records. Costs and returns were estimated on a processed weight basis and showed an estimated return to management, equipment and machinery of approximately US $1.52 per kg. The margin of net returns varies depending on the transportation costs from different collection centers. The estimates given in the table assumed purchase of shrimp from South Sumatera.

The biggest problem facing shrimp exporting companies is the shortage of raw shrimp supplies. With greater raw material, the cost of processing goes down, especially the costs to fixed equipment, due to the greater utilization of plant facilities. Most shrimp exporters are operating at between 10 to 30% capacity.

In an effort to make up this shortage, an emphasis has been placed on tambak produced shrimp. Tambak shrimp tend to have a slight off-color due to water quality, resulting in a slight price discount for the product. Recent records also indicate that contamination is higher for shrimp from tambaks, resulting in rejection of the product at the market.

Current government policies and trade regulations do not seem to present problems to shrimp exporters. Establishing letters of credit and receiving foreign exchange is relatively easy. Government institutions are able to perform necessary quality tests in order to issue health certificates, and marketing procedures seem to operate smoothly.

3.4.1.3 Identification of Marketing Constraints for Shrimp Exporters

Shrimp exporters currently face several market constraints. First is the difficulty in obtaining regular supplies and second, more serious to processors, is the poor quality of shrimp received, thereby resulting in U.S. blacklisting of some shrimp products from Indonesia.

If Indonesia is to diversity its export market for shrimp, then greater attention needs to be given to improving the market quality of this commodity. A recent USAID sponsored project examined the state-of-the-art of shrimp processing facilities in Indonesia (Quinn et al., 1982).

TABLE 33: Costs and Returns of Export Shrimp from Jakarta on Processed Weight Basis Per Kilo

		Value $/kg
Gross Price		$14.53
Cost		
Purchase Price		12.05
Transportation from Sumatera		.30
Processing Costs:		
facilities rental		.01
cold storage		.16
processing labor		.12
water		.01
Packing Materials		.10
Licenses on Quality		.06
Export Duty		.20
	Cost	$13.01
Return to Management, Machinery, Equipment		1.52

Notes:

Conversion US $1.00 = Rp. 1,060

x conversion to processed weight is 1.42 kg. Liveweight shrimp is equivalent to 1 kg processed shrimp heads off. This assumes a 30% loss to shrink and processing.

The purchase price equals 1.42 x Rp. 9,000/kg on a processed weight basis.

The processing labor equals (150 people x Rp. 2,500/day : (20000 : 7).

The water costs = (1500 m^3 : 24 days operating; x Rp.55/day : (2000 Kg :.7).

The cold storage costs = (Rp. 12.5/kg x 14 days in cold storage).

The packing material = (Rp. 1,200/carton : 10.88 kg/carton).

The export duty = (.02 x volume x world price x 1.6).

The licenses on quality certification = (.001 x quantity x 9.5 x US $6.50).

The project consultants found facilities inadequate for having Indonesia removed from the FDA blacklist. These findings are reinforced by the current level of confiscation of 62,656 kg of Indonesian shrimp in June 1984 by the FDA (Table 34). This confiscated amount was valued at over US $800,000, assuming an average F.O.B. price of US $13.22/kg. This loss could be reduced with proper management, which includes receiving shrimp in better quality from producers or market agents. Efforts to improve quality will require the participation of fishermen, tambak producers, and collection agents as well as shrimp processors.

3.4.2 Production and Distribution of Tuna

The second most valuable Indonesian fish export commodity is tuna, which has experienced an 800% increase in production since 1977. The value of export earnings from tuna has increased by over fourteen times since 1977 (Table 29). Primarily supply areas of tuna in 1982 were Bali (16%), North Sulawesi (44%), Maluku (26%), and Irian Jaya (10%), which shows that tuna production is in fact concentrated in the eastern half of the archipelago. Increased production is in part due to policy, emphasizing joing ventures with other nations as well as the formulation of state corporations to exploit the eastern oceans for tuna as well as shrimp.

The major export market is Japan, accounting for approximately 60% of total tuna export, followed by Singapore with 36%. Actually, the tuna exported to Singapore is transhipped to a major canning facility in Bangkok. Discussions with state fishing companies indicated that the tuna fishing effort and production for 1984 will have decreased because of declining world prices for tuna (Table 35).

3.4.2.1 State-owned Tuna Fishing Companies

One state-owned fishing company, P.T. Usaha Mina (PERSERO), is heavily involved in commercial tuna fishing operations in the waters of eastern Indonesia.

The company fishes for tuna in the Irian Jaya seas with their base at Sorong. Carrier boats are used to transport fish from the pole and line boats to Sorong for subsequent transhipment to Singapore. The carrier boats also bring the tuna to Jakarta for sale. Transport costs from Sorong to Jakarta average Rp. 150-200 per kg.

The company is currently experiencing production problems in this region, as operating fuel costs have increased to 40% of total operational cost. The current fuel price is Rp. 220 per litre; a pole and line boat uses 1/2 ton of fuel per day which costs Rp. 110,000/day. Catch per day averages approximately 12 tons.

TABLE 34: Condemnations of Indonesian Shrimp at Port of Entry into the United States - June 1-June 31, 1984.

Commodity	Quantity (kg)	Port of Entry	Company Location	Reason
Frozen Shrimp	11,796	L.A.	Surabaya	Salmonella
Frozen Shrimp	2,391	L.A.	Surabaya	Salmonella
Frozen Shrimp	35,934	L.A.	Surabaya	Salmonella
Frozen Shrimp	880	L.A.	Palembang	Salmonella
Frozen Shrimp	11,472	N.Y.	Palembang	Salmonella
TOTAL	62,656			

SOURCE: "Monthly Import Detention List."
Food and Drug Administration. Washington D.C.
Report 84-06. June 1 - June 31, 1984.

TABLE 35: Average World Prices for Tuna Received by P.T. Usaha Mina, 1981 - 1984

Year	F.O.B. Price Sorong
	(U.S. $/ton)
1981	1,100
1982	750
1983	600
1984	550

SOURCE: Personal interview at P.T. Usaha Mina, Jakarta, November 1, 1984.

The company is having difficulty in marketing tuna. The local market at Sorong accounts for about one ton per day and the market price is Rp. 450 per kg. The population density is low on this island, so market demand is small. The company has tried to ship surplus tuna to Java for sale but the Jakarta retail price is only Rp. 500 per kg, slightly higher than Sorong. Transportation costs, however, of Rp. 200 per kg make the shipment of tuna to Java uneconomical. Jakarta's daily demand is also small (on the order of 5 tons per day), due to the lack of consumer familiarity with the product and because of price competition from other marine fish. In particular, Javanese have a preference for fresh milkfish, which is available and sells for the same price or less. Consequently, the company exports 90% of its production, primarily to Singapore. However, rapidly declining world prices for tuna and increasing fuel prices led to a Rp. 700 million loss for the company in 1983. The government subsidizes the losses because of its social objective to maintain employment. All boats continue to operate and inventories in the warehouses in Sorong are high.

In addition to its activities in tuna, the state-owned enterprise is required to receive by-catch from trawlers in the Irian Jaya area (Table 36). The by-catch received has not been large, and the fish that the company receives is placed in cold storage for distribution on the local market at a price between Rp. 50-100 per kg. Local fishermen complain that the sales of these fish have saturated the market and drastically lowered local retail prices.

The company currently catches 400 mt of tuna per month but has the potential to increase the catch to 1,250 mt per month. Supplies of tuna in the region might be enough to justify the existence of a canning plant in Sorong. Information on costs and returns of a fish canning plant are presented in Section 3.4.4. A canning plant would create employment and allow for accruing greater value-added from the processed tuna.

The P.T. Usaha Mina company recently received an Asian Development Bank loan of US $39 million with a 20 year payback scheduled at 13% interest. The loan will be used to expand the fishing fleet with the purchase of two purse seines, ten pole and liners, and five shrimping vessels. Shore facilities will also be rehabilitated. The expansion of the fleet puts additional pressure on the need for a viable distribution and marketing system for tuna as well as a method for utilizing the by-catch from shrimp vessels in this production zone.

A key constraint facing the tuna industry in this area is the availability of live bait. The company receives 40% of its bait from local fishermen and 60% from its own fishing enterprise. The company pays approximately Rp. 750 per basket to fishermen and each basket contains between one to two kilos of bait fish. In total, the company spends Rp. 5 million per month on bait fish. The expansion of the fishing fleet will require

TABLE 36: Quantity of By-catch Received from Shrimp Trawlers by P.T. Usaha Mina, 1984

Month	Quantity
January	15,717
February	9,515
March	14,942
April	9,848
May	7,456
June	4,073
July	5,539
August	4,171
September	3,483
October	6,096

SOURCE: Personal interview, November 1, 1984 a dependable source of live bait, and this could be provided by local fishermen, given proper incentive.

3.4.3 Market Forecast for Shrimp and Tuna

It appears that the world market for shrimp will remain strong over the next several years. Demand is outstripping supplies, particularly for high value, larger species. Some market analysts believe the price elasticity of demand is highly elastic, implying that production of larger quantities of shrimp will directly increase revenues to producing nations.

In response, there is a strong movement in countries around the world, including Indonesia, to expand shrimp production. One key problem that Indonesia faces is meeting quality standards. While marine shrimp that are caught and processed on shrimp vessels fully meet FDA approval, tambak produced shrimp, that can be contaminated in the ponds by various means, have been rejected. The problem is compounded in handling throughout the distribution system from tambak to processor. This could be the primary negative factor affecting the export potential of Indonesian brackishwater shrimp.

World tuna prices are expected to remain low for a period of time. An ADB approved loan stated that Indonesia will be in a good market position to become a prominent industry member after the current world tuna industry shake-out. Some countries, like Mexico, are gearing up to increase production and their location will enhance their ability to exploit the U.S. market. This will effect investment in the tuna industry not only in Indonesia but throughout the world as well.

3.4.4 The Export Market for Canned Fish

There is a small tuna and sardine canning industry in Indonesia, with major canning plants located in East Java and Bali. Lemru, a sardine species found in the Bali Straits during certain seasons of the year, is canned near the production area because high oil content in the fish requires proper handling and quick chilling. The industry is well established and harvest of the stocks is controlled by the government.

Tuna represents the other major canning activitiy in Indonesia. A major tuna canning company is located on Bali, P.T. Bali Raya. The company obtains raw material from the state company P.T. Samudra Besar, also located in Bali. However, the company faces a shortage of tuna for processing, as tuna fishing activities have declined due to declining world prices. The plant has a capacity to process 30 mt per day, but currently, their operating capacity is only 10-14 mt per day.

Major tuna fishing activity in the eastern waters could supply this plant, but transportation costs from eastern waters to Bali are high, approximately Rp. 200/kg. At present, tuna can be shipped to Bangkok for less than shipping it to Bali, Rp. 100-150/kg, making shipment to Bali uneconomical.

In addition, transport costs from Bangkok, a major world supplier of tuna fish in the Far East, to the U.S. is currently US $1,500 per 20 ft container, less than the same container sent from Surabaya to the U.S., which costs US $1,900 (the plant in Bali must transport the product from Surabaya by truck, which adds US $800 per container).

The supply of tin plate is readily available from Jakarta although it is still being imported. It will not be until 1986 that tin cans will be made in Indonesia by Krakatau Steel. The cost per can is Rp. 85/piece-small (195 gr) and Rp. 547/piece-large (2 kg). For the smaller No. 2 can, the can represents 30% of processing costs; and for the 2 kg can, the can represents 23% of processing costs.

The tuna canning facility is modern and apparently well managed. Quality control seems high, and there seems to be no problem entering US or European markets. The greatest problem is tuna supply and it may be that improved catching technology is needed for local fishermen who are fishing in the Southern Indian Ocean.

3.4.5 The Export of Other Marine Products

The export value of frozen marine fish was approximately US $7.3 million in 1982, with the primary importing country being Hong Kong. Jelly fish alone earned approximately US $4.5 million in 1982. Major production areas for export are scattered throughout the country. Two companies that export marine fish are P.T. Tirta Raya Mina and P.T. Bali Raya. Both companies are involved in other fish processing activities as well as the export of marine fish. Prices for some of their products are listed in Table 37.

3.4.6 Imports of Fish and Fish Products to Indonesia

Imports of fish into Indonesia have been increasing (see Table 38). Fishmeal has become the major import item, surpassing canned fish in 1979. Since 1981, fishmeal imports have increased rapidly primarily because of government emphasis on livestock production which has increased the demand for fishmeal as a feed ingredient. Imports for 1984 are estimated to be in the range of 75,000 mt. The current world price is US $1,000/mt. Serious government discussions are being held on whether an import substitution policy with domestic production should be encouraged.

TABLE 37: Export Values for Marine Species by Two Companies; P.T. Tirta Raya Mina and P.T. Bali Raya

Product	Price
Lobster (cooked)	US $8-10/kg
Abalone to Japan	US $3.90/kg
Sea Urchins to Japan	US $4.60/kg wet weight
Seaweed (dried)	US $.45/kg
Squid (frozen)	RP 1.100/kg Jakarta
Tuna (whole frozen)	
frozen to 35 °F	US $1.380/mt
frozen to 55 °F	US $2,000-2,500/mt
Tuna (airshipped to Hawaii)	US $5.20/kg
(yellow fin or big eye)	

SOURCE: Personal interview, November, 1984.

TABLE 38: Indonesia's Imports of Fish and Fish Products, 1974, 1978 - 81

	1974	1978	1979	1980	1981
Total					
Quantity	6,980	27,099	31,018	39,517	58,989
Value	2,438	10,029	6,716	20,917	37,133
Salted, dried, smoked fish					
Quantity	221	36	16	92	20
Value	21	23	58	31	54
Crustaceans and molluscs					
Quantity	16	21	44	52	97
Value	35	88	264	194	780
Canned fish					
Quantity	6,393	7,528	2,202	1,763	1,080
Value	2,203	6,662	2,105	2,438	3,429
Fish oil					
Quantity	54	303	237	155	248
Value	25	240	264	255	263
Agar-Agar					
Quantity	78	96	62	159	41
Value	75	557	393	848	273
Fishmeal					
Quantity	0	18,948	27,957	34,194	50,341
Value	0	2,247	3,338	15,997	31,654
Other					
Quantity	218	167	500	3,102	7,162
Value	79	212	294	1,208	670

SOURCE: Indonesia, Directorate General of Fisheries (DGF), "Import Volume/Value of Fishery Product," unpublished report; DGF, International Trade Statistics of Fisheries Commodities 1979, pp. 16-19.

NOTE: Quantity = metric tons; Value - thousand U.S. Dollars.

3.5 Identification of Major Marketing Constraints in the Fishery Sector

The development of Indonesia's fishery sector is directly affected by the market conditions and constraints which hinder the exploitation of fish stocks. This section enumerates what are considered to be the major marketing constraints to further exploitation of fishery resources.

3.5.1 High Costs of Transportation and Impact of Seasonal Availability of Transport

The geographic nature of the archipelago presents certain logistical problems for the effective exploitation of fish stocks in specific production areas, particularly in eastern Indonesia where there are large and untouched stocks of pelagic and demersal species. The difficulty in exploiting these species is the high transport costs of shipping fresh and frozen fish from eastern waters to Java. The price of fish in Java is simply not high enough for some major species, e.g., tuna, to justify shipment to Java. The recent price increases for fuel exacerbate this problem further, lowering the profit of fishermen on the outer islands.

The problems presented by high transportation costs are particularly evident in the state fishing enterprises. The freight rates of state-owned vessels are approximately four to five times the transport charges of the traditional Boogie sail boats. The current load factor for steel hull boats is less than 50% (Far Eastern Economic Review, November, 1984) and higher fuel costs and the excess capacity of ships cause continued dislocation problems, including the curtailment of large shipments of fish from the surplus production areas in the east to deficit consumption areas on Java.

Several state-owned fishing fleets have carrier boats for transporting their fish. These state companies, which fish primarily for tuna, have difficulty disposing of their fish in either export or domestic markets. The weak demand for tuna creates logistical problems in bringing a carrier boat with 100 mt of tuna to Jakarta as it may take weeks to sell the tuna, thereby causing a long lay-over time for the ship.

Ports on Java are also not on major world shipping routes. Exporters of fish and shrimp complained that delays of months accrued before ships were available for transport of products to Europe or the United States. Processors in Palembang, Ujung Pandang and Bali also complained of the lack of availability of ships and increased transport charges.

3.5.2 Low Quality Control in Exported Shrimp

Concerns are being raised over the quality levels of shrimp being exported, particularly for shrimp from tambaks. Shrimp processed immediately on-board shrimp vessels and frozen have TPC (a measure of fish product quality) values of 8,000/gram, an acceptable level. By contrast, TPC values for shrimp from tambaks range between 300,000-500,000/gram. This contamination problem causes severe problems for shrimp exporters, particularly exports to the U.S.

This problem can only be solved through a combination of water quality and upland watershed management and a total effort on the part of producers, market agents and processors to ensure proper shrimp handling and processing.

3.5.3 Lack of Market Research and Development for Fish Export Products

Fish processors indicated that they received little government assistance in market research for potential fish export products. Information on current export prices was available from INFOFISH, but no research studies were available on potential new products, e.g., cooked shrimp, seaweed or flying fish.

Entrepreneurs in the private sector with venture capital need more assistance in finding out what opportunities are available in the fishery sector. The point is clearly evident in the tuna industry where there is great uncertainty over the future demand and price for tuna. Firms in the public sector, such as some of the state fishing companies, could benefit from government research bulletins.

The same constraint is present regarding market outlook at the provincial level for fisheries. Provincial staff have contacts with private sector firms, but government staff do not provide market information that would assist these businesses. Such information must be available in a timely and efficient manner in order to be of use to fish exporters. Such a capability could be developed in the DGF.

3.5.4 Impediments in Marketing Fresh Fish

Auction markets in the various provinces are in place, but they vary widely in their effectiveness, sanitation levels and operation. In addition, transactions take place either outside the auction or if they pass through the auction, the fish have already been sold. The auction then, only collects fees paid to the government agents. However, it is unclear whether or not these fees are being collected (ADB, 1984).

The use of ice was prevalent in some auction markets, indicating fishermen's awareness of its importance for maintaining quality. By no means, however, is the marketing of fresh fish satisfactory. Time in transit, especially for artisanal marine fish, is still great. A complete icing of fish is not done because fishermen leave ice in block form on their boat and only place fish on the ice. Techniques for improved handling of fresh fish should be encouraged.

The Indonesian government is placing emphasis on improving market infrastructure, e.g., ports, ice facilities and auction halls. However, traditional market channels still prevail with wholesalers in control of prices, distribution of the product, and payment schedules for the fish. Fishermen are often tied to a market agent because of credit obligations. These ties are difficult to break, and there is concern about whether government institutions could perform more efficiently than these agents or "middlemen." Caution should be taken in trying to wean fishermen away from ties to a wholesaler by attractive short term "fixes." Some studies indicate that the rents extracted by wholesalers are not that high compared to the "hidden" transaction costs in alternative government institutions.

3.5.5 Constraints in the Marketing of Dried Fish

Severe market constraints exist in the dried fish trade because the market is controlled by a very small group of traders who control the distribution system. The success of efforts to increase fish production in the outer islands for consumption on Java would be largely dependent on these traders unless alternative marketing mechanisms are developed. These traders have controlled this trade for a long period, and establishment of such an alternative system will be difficult. Only through government action of some sort can their control be lessened so that fishermen can participate more profitably in this important trade.

The level of quality of dried fish was found to be generally low. Visits to wholesale and retail processing centers found high deterioration levels with poor salting and drying of fish. Efforts to improve post-harvest technology need to be pursued. Some examples of testing of improved drying procedures were found in various provinces, but little impact on fish processing was taking effect.

Although the use of insecticides (particular Baygon) during the processing of fish is thought to be restricted to Java, there is a growing concern that this practice could become widespread. This could have a severe negative impact on the dried fish industry, which is an important outlet for small scale artisanal fishermen. Dried fish is also an important item in the diet of low and middle income consumers. Education about proper processing techniques is necessary.

3.5.6 Lack of Available Market Information

Currently, fishermen have little market information on which to base production and marketing decisions. Artisanal fishermen are dependent on wholesalers for setting prices, and they do not know what the value of their product is. Increased availability of market information might improve the operational and pricing efficiency in the marketplace. For example, in a recent study on implementing a market information system for secondary food crops, it was determined that a lack of market information causes:

- a weakness in the bargaining positions of farmers;
- imbalances in regional and seasonal price differences and excessive price fluctuations;
- increased market risks and discourages production; and
- impediments in formulating an effective and rational policy for farmers.

All these conditions exist for small scale fisherman. Better market information would assist fishermen in negotiating a "fair" price for their product through fish marketing cooperatives. Tambak producers could benefit through better information on which to base decisions about when to drain their ponds and harvest their product.

3.5.7 Lack of Grades and Standards

Some grades and standards exist for certain species, e.g., shrimp, but in most cases, they are non-existent. Improvements in information to producers on proper grades and standards for shrimp is occurring in some areas. Government established grades for other marine fish would likely be counterproductive because of the confusion that would be created.

3.5.8 Research on Consumer Demand for Fish on Java

Java is the most important market for fish in Indonesia, yet little analytical research has been conducted to determine the characteristics of this market. Government plans to encourage increased consumption of fish are designed without a solid understanding of which species are preferred and in what form. Efforts to improve the domestic market system require a better understanding of consumer preferences if government plans are to be meaningful and successful.

3.5.9 Market Pressures Increasing Exploitation of Limited Fishery Resources

Increased market demands for certain fish species, e.g., shrimp and macrobracium, are placing pressure on fragile and limited fishery resources. A good example of this is the macrobrachium resources in South Sumatera and Kalimantan which are being heavily exploited, including the harvest of females bearing eggs. This is causing a rapid depletion of macrobrachium stocks in important riverine systems. This problem is caused by fishermen trying to take advantage of high prices for macrobrachium and processors who are unable or unwilling to "manage" the resource effectively.

3.6 Involvement of Donor Agencies in the Fishery Sector of Indonesia

Some international lending agencies have made substantial long-term financial commitments in Indonesia's fishery sector. It is important to understand the nature of these investments as they address the marketing constraints identified in Section 3.5. In addition, it is important to find areas for involvement that will be effective, but which will not require large capital investments in marketing infrastructure or duplicate the efforts currently being undertaken by major donor agencies.

3.6.1 Asian Development Bank Activities

ADB is the largest donor involved in developing Indonesia's fishery sector. Total funding since 1972 has been approximately US $94.6 million (ADB, August, 1984). ADB has financed six projects and four of these have focused exclusively on marine fisheries. Two current projects, the Sumatera Fisheries Development Project located in Padang and the Brackishwater Aquaculture Development Project located on several islands, are involved with aquaculture. The ADB projects are listed in Table 39.

These ADB projects have traditionally been capital development projects. A recent Bank project evaluation found that five of the six projects have the following average breakdown: 37% for fishing vessels, 31% for contingencies and working capital, 22% for shore facilities, 7% for carrier vessels and 3% for consultants and training (ADB, 1984).

Two projects of interest are the current Irian Jaya II and Brackishwater Aquaculture projects. The two loans amount to US $99.5 million. Both projects are heavily capital intensive with large loans for boats and equipment. A second brackishwater project, currently in the planning phase, is expected to begin in 1986.

The primary focus of these projects is on increasing production of both marine fish from the eastern region and shrimp and milkfish from tambaks. The Bank's emphasis on production-oriented projects, however, neglects underlying marketing constraints which can be addressed through proper manpower development in key institutions.

ADB has been involved with two quasi-state enterprises, P.T. Tirta Mina (TRM) and P.T. Usaha Mina. Both companies are involved in marine fisheries with activities in the same marine areas of eastern Indonesia. It is feasible that better coordination between these two state enterprises could be possible to alleviate some of the distributional problems facing private enterprises who could benefit from access to these firms' carrier services.

TABLE 39: Asian Development Bank Projects in Fisheries and Aquaculture

Projects	Date	Description
Riau Ia/	12/72-7/77	Production of fish and prawns in Sumatera for export to Singapore
Irian Jaya Ia/	3/74-1/82	Pole and line (P&L) fishing and export of skipjack from Sorong, Irian Jaya
Java Ia/	7/75-12/84	Purse seining for small pelagic fish in the Java Sea and storage and distribution of fish in Java
Sumatera Ia/	5/81-12/86	Production of demersal and pelagic fish in Sumatera for local market and export
Irian Jaya IIa/	9/82-3/88	Production of tuna and skipjack for export and local marketing. Development of an artisanal fishing village in Sorong, Irian Jaya
First Brackishwater Aquaculture Projecta/	5/83-3/89	Production of shrimp and milkfish for export and local marketing
Second Brackishwater Aquaculture Projecta/	5/85-?	Study of the project in 1985 and expected loan signed in 1986. Areas covered will be East Kalimantan, S. Sulawesi, West Nusa Tenggara, South Kalimantan, West Kalimantan, West Part of Sumatera
Marketing Project b/	1985	Study of all aspects of fish marketing and prepare government strategy paper

a/ SOURCE: ADB Report No. INO: APR-91

b/ Information from Directorate General of Fisheries

The ADB has also proposed a tentative short-term project entitled "Fish and Fishery Marketing Study." The field work will be conducted in 1985 and will examine all aspects of marine and brackishwater marketing systems.

3.6.2 World Bank Activities

The World Bank has a major loan program in the fishery sector (Table 40). A list of their loans includes investment in commercial fishing, tambak development, training and market facilities. The majority of their loans are for outer-island development. Production loans are site specific, and marketing is not a focus of the projects.

3.6.3 Japanese Investment

The Japanese government has a large involvement in Indonesia's fishery sector, most recently funding a new port in Jakarta. New loans are being proposed to further develop that facility. A concern was expressed that the new port was too large and costly as a majority of marine fishermen still use Maure Angke. The Japanese are also involved in improving other port facilities in the archipelago. Construction on these sites will be done during 1985-1986.

3.6.4. USAID Activities

In 1986, it is anticipated that USAID will begin a US $19 million grant and loan project in Aquatic Resources Development. This project will focus on three areas: (1) the development and application of selected technologies that offer promise for increasing the production of specific fish and aquaculture resources, (2) institutional development, including provisions to strengthen professional skills and key institutions via technical assistance, training, and upgrading facilities, and (3) policy support, analyses, and studies in marketing and coastal resource management. In addition, USAID now has fisheries projects underway in brackishwater fisheries production, tambak irrigation, provincial government development, and small scale fisheries development.

3.6.5. Technical Assistance Grant Programs

A list of technical assistance projects is given in Table 41. Most projects listed are production oriented. The EEC project in Prigi and Bulu will market fresh fish in the interior of East Java. Fishing boats, shore facilities and transport trucks are all planned for the project. There are no projects to assist private sector export marketing firms. Furthermore, no projects address key constraints in improving the distributional problems of moving fish from surplus areas to deficit consumption areas.

TABLE 40: Financial Loan (Other than ADB) to the Government of Indonesia for Fishery Projects

Agency/ Country	Description	Location	Amount of Project	Time Period
1. BECF/Japan Japan	Jakarta Fishing Port	Jakarta	US $50 Million	Finished
2. BECF/Japan	Engineering Service	6 distribution centers	US $1 Million	1985-1986
3. World Bank Fisheries Development	Strengthening Infrastructure Development	Semarang	US $4 Million	
4. World Bank Fisheries Development	Strengthening Fishery Extension	Sorong, Ambon, Medan Singaradja, East Nusa Tenggara		
5. World Bank Fisheries Development	Development of Skipjack fisheries	East Nusa Tenggara		
6. World Bank Fisheries Development	Shore, facilities	Halmahere, Maluku Tomini Bay (Ampana and (Tilamutu), N. Sulawesi		
7. World Bank Fisheries Development	Brackishwater	Aceh, Riau, Jambi, Central Sulawesi and South Sulawesi		

TABLE 41: Technical Assistance Grant Programs to the Government of Indonesia

	Agency/ Country	Project Description	Location	Amount of Project	Time Period
1.	FAO	Seafarming	Lampung	US $1.3 Million	1984-1988
2.	FAO	Support to Extension Services on Outer Island	North, Southeast and Central Sulawesi, Maluku, East-Nusa Tenggara	US $1.2 Million	1984-1988
3.	Indonesia Fish Development Project (INFIDEP) Second Phase FAO/Canada	Description not available	Not known	US $250,000	1984-1985
4.	USAID	Small-Scale Fisheries	Several	US $3.4 Million	1980-1985
5.	West Germany /GTZ Second Phase	Small-Scale Fisheries - production - marketing - processing	West Nusa Tenggara	D.M. 3 Million	1983-1987
6.	European Economic Community (EEC)	Fresh Fish Marketing production and marketing of fresh fish	Prigi and Bulu Central Java	US $.8 Million	1984-1988
7.	Belgium	Artenia Culture	Jepara, Java	B.F. 19 Million	1982-1985
8.	Danish	Study on Fisheries	Ujung Pandang	US $300,000	
9.	Italy	Study on the Brackishwater Irrigation	Aceh Province North Sumatera	US $1.2 Million	1985-1986
10.	Denmark	Development of Fisheries Fisheries - Fishing	Pelabuhan Ratu West Java	(proposed)	
11.	Nordic Group	Shore Facilities and Expansion	West Nusa Tenggara (Lombok)	(proposed)	

A major assumption made in project proposals for marketing fresh fish on Java is that the problem is lack of available fish. Many commodities supplying protein compete with fish for the consumer's limited budget. Food demand surveys have not been done to accurately predict the potential for increased consumption of fish. This type of information is needed to adequately design these marketing projects.

3.7 Fishery Projects for Consideration

The fisheries areas suggested here as targets for the further development of aquatic resources were selected based on the description in Section 3.5 of key marketing constraints. These areas are also based on a division of Indonesia into three key marketing areas/zones that require different market development strategies. They are (1) the North Sumatera Region, (2) the Crescent Island Region (focused around Java), and (3) the Eastern Indonesia Region (see Figure 1).

3.7.1 Macro-Policy Analysis

It is recommended that the government's capabilities for advising on many aspects of national fishery development policy be strengthened. The Ministry of Agriculture, preferably the Secretary-General's office, might be in the best position to conduct policy research and analysis in this area.

One of the key policy analyses proposed includes the development of criteria for investment in fishery production projects. While the economic analysis of loan projects tends to be done by the lending agencies, Indonesian capability needs to be strengthened in this regard. Another area focuses on serious questions regarding continued tambak expansion. Appropriate economic analysis needs to be conducted on how these and other resources will be allocated in the future.

Consideration also needs to be given immediately to what development strategies are appropriate in each of the key marketing zones. Bottlenecks in the marketing system will require government policies on what steps will be taken to remove these constraints. A good example is the control of the dried fish trade in the "crescent area" (the economic sphere focused around Java).

The design of appropriate strategies for exploitation of the Eastern Oceans should encompass strategies that fit the long term objectives for this sphere of activities. Recent research by Marten et al. entitled "A Strategic Goal Analysis of Options for Tuna Longline Joint Ventures in Southeast Asia: Indonesia-Japan Case Study" is a good example of the kind of policy research that needs to be done for the eastern waters as well as the Exclusive Economic Zone (EEZ).

A study of the role of state fishing companies, private sector initiative and joint ventures in this area needs critical appraisal. Several state fishing companies are operating in this area and most at a loss. Assistance in coordinating the efforts of these state enterprises is needed.

3.7.2 Applied Market Research Capabilities

A program of applied market research is proposed as a mechanism to develop Indonesian capabilities in the analysis of domestic and international markets for fish and fish products. The AARD branch in the Ministry of Agriculture would be responsible for conducting thorough applied research on marketing problems at the international, national and provincial levels. Market research should be coordinated with university faculties in various provinces where marine science is being taught. The research would be conducted using state-of-the-art quantitative methods to examine marketing problems in the fishery sector. Also, Indonesian staff would be trained on how to conduct feasibility studies for marketing projects and the design and implementation of these projects.

General research areas requiring immediate attention are:

1) Examine strategies for private sector shrimp processors to diversify their export markets. This research would entail working with the processors on both export potential as well as improvement in delivery systems for shrimp from producers. Involvement of both processors and producers, marine and tambak, would encourage assistance to small-scale producers who could be at a disadvantage in supplying quality shrimp to processors.

2) Examine the potential for market development of new fishery products for export. For example, flying fish roe is a marine commodity that is attractive for venture capital investment. Several firms in Ujung Pandang are purchasing, drying, processing and packaging the product for export. The raw product is purchased for Rp.10-15,000 per kg and exported to Japan for US $25 per kg FOB. The market is unknown at this time, but potential seems good.

   Another marine product is seaweed. Inter-island trade statistics indicate a viable trade of seaweed from the Molucca Islands to Ujung Pandang for ultimate export. Potential for expansion of this trade could be examined with a possible seaweed project developing. There was a USAID project with the Cooperative League of the USA (CLUSA) several years ago in the Moluccas. The project had good potential but was stopped because of internal management problems.

   Sea urchins are another exotic marine commodity. Labor utilization is high because of the difficulty in retrieving the product from underwater, but the product is readily available. Many sea urchins were seen on a field trip to coral reef islands outside Ujung Pandang. The gonads of the sea urchin are the desired finished product. Information was limited because the entrepreneur was just developing a market. It is a high valued export product.

3) The shrimp processing industry is currently operating at less than 30% plant capacity. A challenging research program would be to look at new plant activities that could use the available cold storage capacity and underemployed labor. Diversification of product lines to include new products, e.g., macrobrachium, could be investigated. Plants might use cold storage space to provide ice for delivery to tambak producers to improve the quality of shrimp delivered. Research could be carried out on a distribution system including insulated boxes for delivery of higher quality shrimp. Price premiums could be paid to processors and producers, if product quality could be maintained.

3.7.3 Pilot Project for Implementing a Fish Marketing Information System

The lack of market information is pervasive throughout the fishery sector. Fishermen, whether tambak or marine, take prices as given by the wholesalers. In many cases, price discovery mechanisms are non-existent, with fishermen receiving cash for their fish after wholesalers sell the fish. (See Sullivan, 1981 for an analysis of the pricing system for milkfish and shrimp in Aceh Province.)

With the increase in the number of government-built auction facilities, more fishermen are selling through auctions, though many still sell outside established marketplaces. Better information at auction markets would inform both fishermen and wholesalers as to the value of the fish in nearby large consumption areas.

3.7.3.1 Design of a Pilot Project

A pilot project could be designed for implementation primarily in the "crescent" market area. Six markets are proposed for the pilot project. They are:

- Jakarta, Java
- Pekalongan, Java
- Surabaya, Java
- Ujung Pandang, South Sulawesi
- Banjarmasin, South Kalimantan
- Merringue, Lampung

The central clearing house for information would be in Jakarta, possibly at the new Jakarta Fishing Port. Major auction markets would be linked through short wave band radio. If radios need to be purchased, sets are available at US $5,000 per unit from P.T. Tirta Raya Mina.

Wholesale prices would be collected at these key markets for fresh, frozen and dried fish traded in the "crescent" area. The radio would be used to collect prices in Jakarta. Prices would be transmitted back to markets for display in the auction hall. Over time, spatial price relationships would be estimated to reflect changes in supply and demand conditions in relation to fishing season and time of year.

Increased market information would begin to break down some of the barriers preventing market efficiencies. The benefits could be long lasting if fishermen are able to improve their market position, even if only in small amounts.

3.7.4 Post-Harvest Technology

3.7.4.1 Shrimp Exports

Careful consideration should be given to improving the quality of Indonesia's shrimp exports. Interviews with major shrimp processors found this group eager for ways to diversify away from the dominance of the Japanese market. Exports to the USA and Europe are increasing gradually, but quality constraints still affect export potentials.

Because the processing industry is owned and operated by a small group of investors who are financially well-to-do, equity problems might arise. Thus, assistance could be given to shrimp exporters, but it is recommended that it be done only as a package that also benefits the aquacultural producer. The following proposal would seem feasible in that it helps both processors and producers.

1. Improve quality of shrimp from tambaks to processor through appropriate market facilities.

   - Develop portable insulated boxes that can be distributed by processors to middlemen and producers for transporting shrimp. These types of boxes have been tested by DGF and could be made available on a pilot project basis. Boxes would need to be easily transportable from remote tambaks to major collection points.

   - Technology could be examined that allows processors to utilize some of their idle cold room capacity to produce ice for distribution to tambak producers. One cold storage facility in Banjarmasin distributes ice to its collectors at lower than market prices to encourage its use.

   - Implement a pricing scheme for shrimp that reflects the use of ice as well as grading of shrimp. The grading standards used by processors selling to the world market need to be regularly established for purchases from producers. It was unclear whether the grading system was being used for shrimp from small scale tambak producers.

- A marketing project could be designed for Ujung Pandang that tests portable ice boxes and also institutionalizes a grading and quality system. If processors agree to participate in the project, then low-interest loans and technical assistance could be provided to the plant to upgrade the plant to, for example, FDA standards. Some of the costs for technical assistance need to be paid by the plant.

3.7.4.2 Improvement in Marketing of Milkfish

Milkfish is also an important food fish produced from tambaks. However, public attention has been diverted away from the problems of milkfish marketing because of the profitability of shrimp production. Recent research by Smith and Chong (1984) revealed that milkfish production will decline as the terms of trade shift in favor of shrimp.

Donor financing for both extensification and intensification of tambaks will place additional pressure on the efficient marketing of milkfish. In certain seasons of the year when marine harvests are abundant, the price may drop below breakeven costs. As long as world shrimp prices stay high, producers will treat milkfish as a residual product and view it as additional income from a polyculture system.

Large amounts of research have been done on processing milkfish. Milkfish traditionally are consumed fresh or are processed by smoking, boiling or steaming. The problem is that the shelf-life of the processed fish is not more than two weeks. Research has been done on increasing the shelf life of the product and needs to be continued.

A potential milkfish project could look at marketing this item from key production to consumption areas. Three project sites could be chosen in Northern Sumatera, Ujung Pandang and Java. These are areas where marketing will be a problem as production increases. A detailed market study could be done in each area that can then be used as guidelines for implementing production, processing, and marketing programs for milkfish in these areas. A model auction market for milkfish could be examined like the one at Gresik, East Java, where fish are weighed and auctioned. A food technologist and a marketing economist could assist in improving the marketing system for milkfish and examine alternative market forms.

3.7.4.3 Marketing of Fresh and Frozen Marine Fish

The marketing system for fresh and frozen marine fish products is relatively open to the entry of new firms. If the DGF is going to have a policy of concentrating on these products to the exclusion of marketing dried fish, then more research is needed on how to best implement such a program.

In the area of the "crescent islands," only Lampung and Kalimantan provinces are major supply sources for fresh fish to Java. The trade in fresh fish from Lampung is established, with most shipments by truck and ferry to Java.

A project to consider is improving the trade in fresh fish from islands in the "crescent" to Java with the use of small carrier boats. An investment in a small carrier boat (50-60 GWT) could be used to transport fish to Java, either to Pekalongan or the Jakarta Fishing Port. The boat would open up markets for fishermen's products that otherwise would receive very low prices during peak production seasons.

Many ice plants and fishing ports have shortwave radios in place. These could be used to coordinate shipments to Java. The project proposal needs further in-depth analysis, but possibilities exist as long as the logistical problems can be solved. Boats from the state fishing companies could be used on a trial basis.

3.7.4.4 Marketing of Dried and Salted Fish

There is a strong need for an experimental project to examine ways of improving the dried fish marketing system. A pilot village processing center has been established in Jakarta, which has created the facilities for dried fish processing. This project could provide valuable assistance by examining ways to penetrate the existing market for dried fish. The challenge will be to test ways to establish a better marketing system for the fishermen so they obtain a price closer to the final value of their product.

Establishing a similar pilot fish processing center in Ujung Pandang could also be considered. The level of traditional processing is poor there and the current site needs to be greatly improved. In order to promote the dried fish trade in the "crescent island area," shipments from South Sulawesi could be coordinated through the Jakarta center.

Consideration could also be given to establishing other processing sites in the "crescent" area. Potential sites include East and Central Java, Bagan Siapi-api, Kalimantan, and South Sumatera. Site selection could be done based on sources of major processing in the "crescent."

Such an involvement would meet several objectives, as processing of fish is more labor intensive than selling fresh or frozen fish. It is an employment generator in rural areas, especially for women. The quality of processed fish is generally low and improvement would directly benefit low income consumers. If this project was successful, then efforts could be made toward improving the total market system using these centers to counterbalance the enormous market power currently residing with a small number of wholesalers.

3.7.4.5 Research on Market Channels for Dried Fish

The potential for trade in dried fish for the "Eastern Waters" strategies is in large-scale commercial fisheries; however, opportunities may exist for processing of small pelagics for transport into the "crescent area." The Aru Islands is a major area for processed fish, however, there was not enough time to research this idea in great detail. Some shipment of dried fish to Surabaya from Irian Jaya is occurring. A broker in Surabaya did say that if large quantities of dried fish could be stockpiled, he could arrange for a boat to pick up fish for shipment to Java. The estimated cost of transport was Rp. 75 per kg. During certain seasons of the year, this could be very competitive for particular species. The broker said he would need a minimum order of 100 mt to justify sending a ship.

It is suggested that if a project for dried fish marketing in the "crescent area" is undertaken, then the feasibility of extending the project to the "eastern waters" could be studied. What is generally lacking are good data on the dried fish trade; thus, a systematic research project needs to be carried out.

3.7.5 Development of Community Organizations Focused Around Market Facilities

An evaluation of an ice plant at Maringgai found the plant operating at about 60% capacity (5 ton/day) because only one engine was in service. Spare parts are being ordered to put the other machine in operation.

Dinas Perikanan officers believe that the ice plant has been successful in providing ice to fishermen who otherwise would not have it. The demand for ice is outstripping daily output. Officers believe actual demand to be about 12 tons per day. Even at full capacity, there would still be a shortage of ice.

Interviews were conducted with both fishermen and cooperative personnel who represent the fishermen using the ice plant. The cooperative has grown by approximately 400% since the ice plant was installed. This is partly due to the establishment of a transmigration village near the plant.

Economic development has been enhanced in the area with greater market outlets for producers' fish. Officials believe that properly iced fish sell for Rp. 300/kg more than non-iced fish. Several wholesalers frequented the landing site which has an auction facility. Fresh fish are even transported as far away as Jakarta. The foundation has been set for sustained development in this area. Officials are already interested in ways to expand the entrance to the landing which is currently congested with boat traffic. Furthermore, officials would like to expand the ice plant to meet increased demand.

Some concern was raised about whether the plant was adequately providing contingency funds for repair, maintenance and replacement. In particular, the price being charged for ice does not cover all depreciation expenses on the machinery, because the primary strategy adopted was to make sure fishermen used the ice by keeping prices low. Consideration needs to be given to how the plant can now become a sound business activity. The pricing scheme currently in operation needs to be analyzed to look at an alternative to the flat rate price to everyone: fishermen in the cooperative, fishermen not in the cooperative and wholesalers.

Consideration should be given to a project focused in the "crescent area" that looks at existing ice plants and ways to improve the total development of the fishing communities around them. Assistance could be provided to enhance the viability of this nucleus of fishermen activities. This would allow a holistic view of marine resources management, which is extremely critical at this time. The areas around ice plants are also labor intensive fish processing areas. Through a comprehensive project, efforts could be made to generally improve all aspects of the fish marketing system.

The following questions should be addressed during site selection:

1) Is the site already a major point of exchange between fishermen and market agents?

2) Is the road to the site all-weather?

3) Is the landing place a year-round market?

4) What are the long-term plans for the coastal area? Particular species of fish coming into market need to be monitored to determine if the fish are primarily for local consumption or traditional processing.

5) What is the social-economic environment of the community? Are ancilliary activities and support functions for general improvement in quality of life in place?

6) Who is most likely to benefit and will benefits be equally shared, particularly by low income artisanal fishermen?

7) Is there an opportunity for other users of ice such as tambak producers in the area? If so, be sure to increase estimated tonnage figures.

8) Are there any "dynamic" leaders among fishermen who can act as catalysts for development projects centered around the plant?

9) What are the possible negative impacts on participants?

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3.9 Professional Contacts

Person	Company	Subject Matter
Mrs. Indarwati	P.T. Pumar Phone 636608 Jakarta	Manager of shrimp processing and exporting company.
	INFOFISH Kuala Lumper Malaysia	An FAO project to collect and disseminate marketing information to Southeast Asian countries.
Muhammad Eidman	Bogor Fisheries Dept.	Discussed academic and research agenda for socioeconomic analyses.
Mr. Sahad	Head of Economics Department, Bogor	Discussed socioeconomic studies on marketing problems for fishery sector.
Mr. Ayoup	Economics Dept. Bogor	Discussions held in concert with Mr. Sahad.
Dr. Chie Chi Chong	Economist, IADS Applied Agric-ulture Research & Development (AARD) Bogor	Discussed current economics research being conducted. Toured the dried fish market in Bogor.
Mr. Peter Arifes	Accountant/Econo-mist, Port of Jakarta	Toured new fishing port and visited and inspected several shrimp exporters with processing units.
Mr. Suprato	Manager, P.T. New Pioneer, Palembang	Discussed problems in obtaining raw materials for plant-shrimp and macrobracium. Currently operating at 15% capacity.
	P.T. Marco Ujung Pandang	Process and export shrimp, macrobracium, flying fish roe, and sea urchins. Discussed quality control problems for entering new export markets.
	P.T. Maprodin Ambon	Joint venture with Japanese for shrimp trawling and processing. Exports to Japan only.

Mr. Matubara	Director, P.T. Perum Perikanan Maluku State Enterprise	Provides infrastructure to local fishermen besides having a pole and line tuna company.
Dr. Sutanto	Economist Directorate General Fisheries, Jakarta	Counterpart from DGF that works in foreign investment division.
Ms. Enny Sutopo	Head, Foreign Investment Divisions, DGF	Counterpart in Semarang and knowledgeable about USAID involvement in fishery sector.
Mr. Hoediono	Project Director West Sumatera Project, Jakarta	Project Manager who has known about marketing system on West Sumatera coast.
Mr. Arief Djohan	Director, P.T. Bali Raya Denpasar, Bali	Tuna canning factory and exports seaweed and other fish commodities.
Ir. Ibnu Hajar Zain	Chief of Fisheries Surabaya, East Java	Gave overview of fishery activities in East Java Province.
Sawami Amtan	Oqnwe, P.R. "Hidup Bersama" Pusat Surabaya, East Java	Transport broker for "boggie" traders shipping inter-insular trade routes.
Mr. Priyono	P.T. Samodra Besar Denpasar, Bali	Tuna long line company fishing in eastern and southern Indonesia waters - collects and exports tuna.
Mr. Farid	Director, Balai Pengembangan Penangkapan Ikan (BPPI)	Discussed current stock assessment projects funded by FAO.
Mr. Richard Dudley	USAID, Contract Personnel, Balai Pengembangan Penangkapan Ikan (BPPI)	Design of methodology for statistical data collection for marine fisheries.
Mr. Sukotjo	Chief of Fisheries Dinas Perikanan Semarang, Central Java	Discussed marketing constraints for fishery development in Central Java.
Clerical Staff		Collection of data on inter-insular trade of processed fish to Java.

Johnny Mariarty	Marketing Director Tirta Raya Mina Pekalongan, Central Java	Inter-insular trade in frozen fish with carrier boats and retail marketing of fish in Central Java.
Ernest B. Hamley	Fishery Advisor (Coops.) UK/ODA: QTA-23 Project Dept. of Cooperative Semarang, Central Java	Discussed role of cooperative development for fish marketing in Central Java. New project sites are being considered.
Ivor Clucas	Team Leader/Fish Technologist UK/ ODA-23 Project Dept. of Cooperating, Semarang Central Java	Discussion on cooperatives' role in fishery development.
Ir. S. Siregar	Chief of Subdirectorate Production Inputs DGF, Jakarta	Supervises production and inputs into fisheries. Travelled in Lampung on field trip.
Ir. Patadongan	Chief of Subdirectorate Fish Marketing DGF, Jakarta	Has information on market intelligence at DGF office.
Hamid Umar	Officer of Quality Control & Marketing Dinas Perikanana, Lampung	GOI Manager of USAID ice plant in Marringai. Assisted with field work in Lampung.
Mr. Nanan Rudayat	Chief of Fisheries Lampung, Province Lampung	Assisted in field work of marketing consultant while in Lampung.
Ir. Hendrik Sihombing	Chief of Fisheries Dinas Perikanan	Discussed fisheries activities in his province and the marketing problems which are present.

4.0 MARINE RESOURCES AND FACULTY DEVELOPMENT

The purpose of this section is to assess the quality and quantity of Indonesia's trained manpower resources and professional training facilities, to identify deficiencies in them, and to suggest steps to fill existing or expected gaps. Specifically, this section covers the following items:

1. major training initiatives now underway,
2. suggested improvements in present programs and facilities,
3. preparation of a research agenda describing major research yet to be undertaken in the area of marine sciences and fisheries management,
4. identification of incremental research and manpower requirements associated with government development plans in the marine fisheries sector, and
5. assessment of the strengths and weaknesses of institutions involved in marine research and/or instruction in light of government development objectives, and the provision of specific recommendations on steps to be taken to strengthen existing programs.

Each of these topics and recommendations on them are summarized below and are discussed in greater detail in the remainder of this section.

There are ten state supported institutions of higher education that carry out training programs in fisheries and one which is about to initiate a program. Four of these were selected for site visits based on past experience, recommendations of Indonesian fisheries scientists, and available literature. Each program is described in Section 4 in terms of faculty, student numbers, organization by specialty, curriculum and facilities. In addition, recent literature describing five of the six other operational programs was reviewed and descriptions based on that information are included here.

The following points summarize the conclusions reached for these institutions in terms of the target areas listed above:

- Suggested improvements to present programs include two recommendations of general relevance and one of relevance to each of the four institutions visited. The two general suggestions are that:
  1) funds be provided to initiate a small grants program to develop equipment, research, and professional development, and

2) a short course program be provided for further academic development of Indonesian fisheries faculties.

- The four specific suggestions are that:

    1) funds be provided to equip new laboratories at the Institute Pertanian Bogor (IPB),

    2) modest equipment and research funds be provided to fisheries faculty at Diponegoro University (UNDIP),

    3) a resident faculty participant and research support be provided to fisheries faculty at Hasanuddin University (UNHAS), and

    4) a resident faculty participant as well as equipment and research support be provided to fisheries faculty at Pattimura Universty (UNPATTI).

The research agenda suggests programs in each of the following areas:

- Primary productivity of ocean ecosystems,
- Exploratory fishing on the continental slope,
- Experimental fishing for underexploited species,
- Stock assessment for exploited species,
- Fish processing and marketing,
- Fish aggregation devices,
- Small scale mariculture,
- Coastal ecosystem function, and
- Social aspects of near shore fishing.

Incremental research and manpower requirements are described in terms of the Indonesian government's development plans. These plans are not very specific for research requirements, but are quite specific concerning manpower needs. It appears that current rates of S-1 degree production in Indonesian universities will equal or exceed that required for government manpower development plans.

Strengths, weaknesses, and recommended steps to be taken to strengthen existing programs are described for the National Institute of Oceanology, the Department of Fisheries, the Environmental Centers of the Ministry of Environment and Population, the Agency for Agricultural Research and Development, and major aspects of regional university programs not covered above. The recommended steps include:

- National Institute of Oceanology (LON)

    1) develop expertise in remote sensing techniques applicable to analysis of photosynthesis rates in Indonesian seas,

2) assist development of staff and techniques for monitoring marine pollution, and

3) provide advanced training opportunities for LON staff in physical oceanography.

- o Environmental Centers of Ministry of Population and Environment (MKLH)

  1) These centers operate at universities. Strengthening their programs is recommended through the establishment of a small research grants program in the Ministry of Education.

- o Ministry of Agriculture, Department of Fisheries (DF)

  1) Consider analyzing subsurface geology at Jepara to see if deepening existing wells could secure a reliable and adequate source of fresh water for the Brackishwater Aquaculture Center.

- o Ministry of Agriculture, Agency for Agricultural Research and Development (AARD)

  1) Develop an assistance package in which trawling equipment would be provided for a stock analysis research ship if AARD could solve problems that limit this ship's operational year to less than 240 days at sea.

- o A Marine Fisheries Center at Ambon (AARD, LON, DP and University of Pattimura)

  1) Establish a center for marine fisheries research by placing two or more research participants in Ambon laboratories, negotiating an agreement of interinstitutional cooperation and shared use of equipment, and providing funds for equipment and research support.

4.1 Major Training Initiatives

There are ten government supported universities in Indonesia that have training initiatives in fisheries. These include the Institute Pertanian Bogor (IPB) and the Universities of Diponegoro, Hasanuddin, Pattimura, Riau, Sam Ratulangi, Gajah Mada, Brawijaya, Padjadjaran, and Lembung Mangkurat (this last university is not described here). Another institution, Mulawarman, is expected to initiate a fisheries program soon (Muhammad Eidman, IPB, 1984; pers comm.). Four universities were visited based on past experience, advice from Indonesian scientists, and sites identified in the literature (McNabb, 1981; NAS, 1983) as important: IPB and the Universities of Diponegoro, Hasanuddin and Pattimura. The fisheries programs of these four institutions are described below.

4.1.1 Institute Pertanian Bogor (IPB)

The fisheries program at IPB is in a School of Fisheries under the Deanship of Muhammad Eidman (Ph.D., Texas A+M). This school graduates 100-125 S-1 degree holders in fisheries each year. The school has five faculties and 79 faculty members distributed as follows: aquatic resource management, 38; aquaculture, 13: fisheries resource exploitation, 13; fisheries economics and management, 9; and fish technology, 6. Forty-four of the faculty have advanced degrees or are studying for such degrees from universities in Europe, Japan and the United States; 66 of the faculty have at least one degree from IPB itself.

The five departments share a common curriculum for the first three semesters, but have different curricula in semesters three to eight. The curricula are rigid and extensive, with 28-30 required courses in each and electives in only one. This curricular rigidity has been the subject of constructive criticism in earlier reviews of Indonesian fisheries education (McNabb, 1981).

The School of Fisheries is housed in several buildings on the downtown Bogor campus, but will soon move to a modern building (currently in use as a dormitory) on the suburban Darmaga campus. In addition, the school has field facilities in Darmaga (20 freshwater experimental ponds plus two small laboratory buildings) and in Ancol near Jakarta (a substantial building with teaching laboratories and a caretaking staff but with no equipment, other than microscopes). Few of these teaching laboratories are equipped; none are equipped to modern standards.

4.1.2 Diponegoro University (UNDIP) - Semarang

The fisheries program is in a Department of Fisheries within the Faculty of Animal Husbandry. The department has a faculty of 39, at least eight of whom have received advanced training abroad, most in the United Kingdom (at least three are currently there) but a few in Japan and the USA as well. The department graduates 45-60 S-1 students in fisheries each year, and this number is expected to go up slowly in the coming years.

The department offers specialization in seven areas: fishing technology, post harvest technology, aquaculture, fisheries sociology and economics, marine biology, oceanography and limnology, and biometry. There are plans both in the department and at the Vice Rector level for the department to become a faculty within a year. If this happens, current plans are for each specialty to become a department.

In the current curriculum, all specialties share the first three semesters of 24 courses and an additional 31 (84 semester) credits of required courses. In addition, S-1 students must take four to six electives (12 semester credits) in fisheries. Not surprisingly, this degree program takes more than four years to complete; in fact, it usually takes six years. Thus, UNDIP has not moved as far toward the four year curriculum required by the Directorate General for Higher Education as has IPB. The Department Head defends the six year curriculum by emphasizing the fact that UNDIP students are better prepared than those of IPB, and seems unimpressed by suggestions that their additional year of training may account for this.

An unusual feature of the UNDIP fisheries curriculum is the plan to offer week-long laboratory experiences in six courses (ichthyology, fisheries biology, marine biology, marine aquaculture, algology, and advanced oceanography) at the UNDIP marine laboratory at Jepara beginning in January 1985. This innovation is made possible through support by the British Overseas Development Agency (ODA) for the UNDIP-University of Newcastle program. This program has built, minimally equipped, and encouraged the use of a small marine laboratory about 70 km from Semarang. The innovation is striking in the Indonesian context because few universities are able to offer practical laboratory work to their students; most only offer fisheries literature reviews for coursework. The adequacy of the Jepara facilities stands in stark contrast to the inadequacy of fishery laboratory facilities on the main UNDIP campus. UNDIP will move to a new campus within five years, but the Head of the Fishieres Department is not sure if his unit will move to the new campus, stay where it is, or move to Jepara where a new teaching facility and a Fishing Polytechnic are scheduled for construction.

4.1.3 Hasanuddin University (UNHAS) - Ujung Pandang

The fisheries program at UNHAS is the Department of Fisheries within a Faculty of Animal Husbandry. The department has a faculty of 21 with the expectation of three new appointments at any time. Seven of these faculty members have received, or are receiving, advanced training abroad (three each in France and the Philippines, one at Auburn in the U.S.). The department graduates fewer than ten S-1 students each year, but has admitted over 100 students in each of the last two years. If these students encounter no problems completing their degrees, they will produce a major jump in S-1 output. The department offers specialized training in four areas: aquaculture, management of aquatic biological systems, fisheries management, and socio-economics of fisheries. These four areas share curricula only for ten general basic courses. Thereafter, they diverge to require 13 courses (38 semester credits) of special basics, 33 courses (85 semester credits) of required courses, and two to four electives (6-12 semester credits).

The facilities now occupied by the department are inadequate for even their pre-1983 level of training, but by May 1985, the department will move to a new 11,500 ft2 building on the new campus. This campus is being built with an Asian Development Bank (ADB) loan, and the same funds will be used to equip the

Fisheries Department. Consultants from the University of Australia will advise on equipment for the new building. In addition, the provincial government has made undeveloped land available for experimental field facilities. These lands include a coral island near Ujung Pandang, 50 hectares of tambaks 200 km from Ujung Pandang on the east coast of Sulawesi, and 20 hectares of ponds on the west coast of Sulawesi about 60 km from Ujung Pandang. The last site will be used for construction of a Fishery Polytechnic in about 1987.

More significantly, however, UNHAS has an opportunity to cooperate with the Coastal Aquaculture Research Institute of the Agency for Agricultural Research and Development (AARD) in developing an aquaculture program at the AARD site in Maros. This site, only 30 km from Ujung Pandang (45 minutes by car) is being developed with a World Bank loan and will have two large laboratories, a library, shops, and almost 50 hectares of experimental ponds supplied with sea water through a canal and fresh water through a 120 m deep well. The close proximity, excellent facilities, and well trained staff of this new institute strongly suggest that UNHAS field efforts should focus there before any major efforts are made to improve their undeveloped field sites. The team was assured that the new AARD laboratory would have space for UNHAS research and teaching and that encouraging such use of AARD facilities is the policy of that agency.

4.1.4 Pattimura University (UNPATTI) - Ambon

The fisheries program at UNPATTI is currently a department within a Faculty of Animal Husbandry and Fisheries, although a government order authorizing formation of a Faculty of Fisheries has already been obtained. The department has 25 faculty members, although many of them have not been placed on the university's regular payroll (the appointees are working without pay, some for more than two years, due to delay in their government appointments). Three of the regular faculty have been at UNPATTI for some time, but the others have returned only recently, 15 from training at IPB. Twelve other students from Ambon are now in training at IPB and some of these are expected to return and take appointments on the fisheries faculty. Several staff had short term training abroad (e.g., Universities of Washington and Guam) and others have had US type training in the USAID-funded aquaculture project that operated at Ambon between 1979 and 1983.

The Fisheries Department will graduate about 16 students this year, but admitted about 100 students in 1980. The 84 others are waiting for faculty who can assist them with their theses. The number of graduates should increase slowly as new faculty are authorized to direct them. There are two areas of academic specialization within the department: Management of Aquatic Resources and Fish Processing.

The Fisheries Department curriculum requires that students take five semesters (37 courses, 94 credits) before specializing in one of the two specialty areas. Each specialty requires 64 additional credits (20 courses) but only six to seven hours (two or three courses) of electives.

The facilities occupied by the Fisheries Department include one aquaculture laboratory (well equipped for research and advanced training); one general biology and food processing laboratory refurnished with UNPATTI funds, but almost devoid of equipment; and access to adequate classrooms and laboratories in the new Environmental Science Center. Funds for construction of a new fish processing laboratory have been secured from the Governor, but UNPATTI will have to provide equipment funds. New facilities for fish processing and chemical research will soon be available about 4 km away at the National Institute of Oceanology (LON) laboratory. Research staff of both these facilities are in the Fisheries Department, and advanced students use these facilities for work on their theses. Conscious development of these inter-institutional arrangements is clearly the quickest way for UNPATTI to develop the quality of its fisheries education program and solve the lack-of-completion problem encountered by students.

4.2 Other Institutions with Fisheries Programs

Five of the six other government supported universities with operating fisheries programs have been visited by U.S. environmental scientists since 1980 (McNabb, 1981; NAS, 1983). To enhance the coverage of this report, synopses of earlier visitors' observations are included below.

4.2.1 University of Riau (UNRI) - Riau

Dr. Cal McNabb of Michigan State University visited UNRI in November 1980 and recorded his observations in McNabb, 1981. The fisheries program is located in a Fisheries Faculty founded in 1964. In 1980, the faculty had 32 members, none with Ph.D.s, but three with M.S. degrees from overseas universities. Another 20 faculty members had the S-1 degree, ten from UNRI itself.

In 1980, the curriculum had just been revised and the number of students admitted to each class had risen from 25 to 80. Reports from other fishery scientists suggest that the 1984 figure is about 100 students/class. The new curriculum in use in 1980 had four specialties: fishing technology, aquatic products technology, aquaculture, and fisheries economics. Each specialty shared a 70-credit core of basic courses and each had 63-69 required credits and electives to bring the total credits to 79. Students were expected to complete this program plus a special program within five years. In 1980, the facilities for the fishery faculty were "poor," with teaching and laboratory equipment in "very short supply" (McNabb, 1981), although new facilities for aquaculture (ponds and an adjacent laboratory) were being constructed.

4.2.2 University of Sam Ratulangi - Menado

Dr. Nelson Marshall of the University of Rhode Island visited the University of Sam Ratulangi in May 1983 and recorded his observations in NAS, 1983. The fisheries program is a Faculty of Fisheries with 30 members (half were away studying for higher degrees in 1983) and about 200 total students. The fisheries interests appeared to focus on near shore artisanal fisheries, although the area is important for tuna. Coral reefs are easily accessible to the campus through a neighboring Nusantara Diving Center and its environmentally-oriented operator, Mr. Locky Herlambang. Dr. Marshall does not mention curriculum, faculty subspecialties, or facilities.

4.2.3 Gajah Mada University - Yogyakarta

The fisheries program of Gajah Mada University was visited by Dr. Marshall in May 1983, and by Dr. Hans Paerl of the University of North Carolina in September 1982. Their observations are recorded in NAS, 1983. The fisheries program is a department in the Faculty of Agriculture. In 1983, there were nine faculty members (five studying at other universities) and a total of 45 students in the upper levels of an S-1 program. M.S. and Ph.D. degrees were also offered. Faculties include a brackishwater research station and poorly equipped laboratories. Dr. Paerl was very favorably impressed with the quality of the faculty he met, and rated Gajah Mada as a good site for cooperative U.S./Indonesian research.

4.2.4 Brawijaya University (UNIBRAW) - Malang

UNIBRAW was visited by Cal McNabb in October 1980 and by Hans Paerl in September 1982. The fisheries program is in a Faculty of Animal Husbandry and Fisheries. In 1980, there were 24 full time and four part-time faculty training about 45 students per class. The curriculum required 150 semester credits for graduation with a common first two years shared by the five specialties of hydrobiology, aquaculture, fish catching, fisheries socio-economics, and food technology for fisheries. Facilities were very poor in both 1980 and 1982. Some laboratory courses were taught in the modern biology laboratory, but even there, teaching and laboratory equipment were very limited. The development plan for the campus includes a new building for the fisheries program.

4.2.5 University of Padjadjaran - Bandung

The fisheries program of the University of Padjadjaran was visited by Nelson Marshall in May 1983. The program is in a department within the Faculty of Agriculture. There were 17 faculty members (all but five were seeking higher degrees at other universities in 1983), and about 30 total students. The department grants S-1, M.S. and Ph.D. degrees, but likes to operate with students getting at least some of their training in foreign institutions. Several members of the faculty are distinguished: one, G. Satari, was formerly Rector (he was appointed Director of the Agency for Agricultural Research and Development on November 1, 1984), and another, Otto Soemarwoto, is a member of the board of ICLARM.

4.3 Possible Improvements in Present Programs and Facilities

Indonesian universities with major training programs in aquatic resources are poised for a great leap forward. Two of these universities (IPB and UNHAS) are about to move their aquatic resources programs into new and larger buildings: UNDIP is about to embark on a major new program of field work for students in its core courses, and UNPATTI has just had 25 young faculty members return to its campus after advanced training at IPB. These events are occurring at a time of increased government emphasis on living aquatic resources as a source of dietary protein and foreign exchange earnings. Thus, Indonesia has an unusual opportunity to undertake actions that could dramatically amplify the impact and effectiveness of training programs in fisheries, and ultimately, the wisdom with which Indonesia develops its living aquatic resources.

4.3.1 Suggestions That Will Improve All Training Programs

All Indonesian university training programs share certain problems, such as: 1) a great scarcity (or absence) of scientific equipment and supplies for teaching and research; 2) a tradition of older faculty being absent from campus at times other than those of scheduled lectures; 3) young faculty who have recently returned from advanced training overseas and whose academic behavior patterns have not yet been established; and 4) an almost total ignorance of academic developments at other universities. A conscious program to develop equipment, research and professional activity would have significant positive impact on all these schools' training programs.

1. Suggestion: A small grants program could be devised for the development of equipment, research initiatives, and professional activity of Indonesian university fishery faculties. Indonesia has only modest experience with the benefits that faculty could derive from extramural funding for equipment, research, and professional activity. No large-scale general program of extramural funding for these activities exists in Indonesia at this time, although the Ministry for Population and Environment funds its university-based

Environmental Studies Centers for these purposes. The effects of both the absence and presence of extramural funding are apparent. Indonesian senior faculty have developed non-university activities for extra income, laboratory facilities remain unequipped and largely unused for research, and inter-university professional activity levels are low. On the other hand, staff of the Environmental Studies Centers are generally active in pursuing grants and professional contacts because experience has shown them that their own enlightened self-interest can be served by extramural professional activity and funding. This is certainly the case in the USA and other developed countries.

A small grants program for fisheries could be established to serve as a model for similar developments in other fields. A program operated by panels of peers would directly stimulate professional interactions. Such panels could formulate specific plans for university equipment development by deciding the relative priority of necessary analyses. Equipment and supplies kits for these analyses could include the needed instruments, glassware, chemicals and instructions (it is likely that they would have to be imported to Indonesia) and technical assistance should be provided for their establishment. Other panels could review research proposals and rank them on the basis of scientific merit, while others could plan short workshops to stimulate professional interaction. Such a small grants program could be administered by the Director General of Higher Education, whose office has expressed willingness to supply counterpart funds.

2. Suggestion: A program of short courses in Indonesia could be implemented for fisheries faculty development. The General Participant Training Program is an extremely important mechanism for developing trained manpower. Fisheries staffs should be specifically encouraged to apply. Unfortunately, the TOEFL requirements of this program and graduate programs in U.S. universities limit the utility of this program as a mechanism for rapidly developing a specific area such as fisheries. An alternative could consist of in-country short courses on topics of general interest to fisheries faculties (coral reef ecology, mangrove ecosystem contributions to coastal fisheries, the role of estuaries in tropical fisheries, coastal fish aggregation devices, non-trawler methods for harvesting near shore demersal fish, non-traditional species of potential value for coastal mariculture, tambak design and operation, traditional fishing knowledge and regulation mechanisms, population dynamics as applied to potential fishery species, stock assessment techniques adaptable to hand calculators and micro

computers, etc.). Short courses (one to two weeks) on these and other topics could infuse new ideas and techniques into fisheries faculties throughout the country, and participation in such courses would increase professional activity and the educational development of faculty.

4.3.2 Suggestions for Specific Programs

1. Equip new fisheries laboratories at the Institute of Agriculture/Bogor: IPB.

   IPB's fisheries faculty is the best developed in Indonesia. Fifty seven percent of its 79 members have advanced degrees from foreign institutions.

   IPB is the place in Indonesia to which other fisheries faculties send their young colleagues for advanced training. IPB's fisheries faculty is about to move to the facilities on the new Darmaga campus. These facilities are not yet equipped with laboratory equipment, and even the present laboratory's equipment is inadequate for current needs.

   The provision of equipment for these new laboratories would provide practical experience for the largest number of best prepared fisheries students in Indonesia. A list of needed equipment totaling US $241,400 has been recently prepared by IPB faculty and other equipment and supplies for hydrobiological analyses have been suggested by Professor Cal McNabb (at a total cost of US $201,225). These lists could be used as the basis for negotiating a useful and affordable complement for establishing laboratory and research capabilities where none now exist.

2. Provide modest equipment and research grant funds for fisheries faculty at the University of Deponegoro (UNDIP).

   UNDIP's fisheries faculty has benefited greatly from the Overseas Development Assistance (ODA) funded program of marine program development. Several young faculty members have been trained by this program and have returned to find very little equipment or research support. The overall impact of the ODA support cannot be assessed yet, but it is clear that some equipment and research support would be beneficial and non-duplicative of ODA programs. This support could be provided by the small grant mechanism suggested above.

3. Provide a faculty participant and research support to the University of Hasanuddin (UNHAS).

   UNHAS has a strong head of the fisheries department, seven young faculty members trained abroad, immediate prospects of moving to a new building to be equipped through a loan from the Asian Development Bank, and real prospects of mutually beneficial academic interaction with the new Coastal Aquaculture Research Institute Laboratory being built at Maros (22 km from the new UNHAS campus). A faculty member with interests and experience in brackishwater aquaculture could greatly assist effective utilization of the diverse new opportunities available at UNHAS. In addition, UNHAS faculty should have access to research funds of the sort suggested above as a general program.

4. Provide a faculty participant, equipment and research support, and curriculum development advice to the University of Pattimura (UNPATTI).

UNPATTI has made good use of past development assistance. It now has one well equipped laboratory and a growing tradition of active faculty research that is unusual among Indonesian universities. Many problems remain, however. The potential solution to many of them may lie in university cooperation with program developments in the new Marine Fisheries Research Institute and National Institute of Oceanology laboratories nearby. A faculty participant at UNPATTI could help solve present problems of more students being admitted than can be effectively trained at the S-1 level by directing theses and providing advice on non-thesis degree options.

4.4 A Research Agenda for Major Research Yet to Be Undertaken in the Area of Marine Science and Fisheries Management

Although scientific observations of marine phenomena and fisheries in what is now Indonesia have been recorded since 1705 (Rumphius, 1705) much modern research needs to be carried out in marine and fisheries science. In a country with over 80,000 km of coastline and at least 62% of its territory being ocean (Polunin, 1983), a potential research agenda is almost infinite. This is especially true of biological aspects of Indonesian waters because these waters are known to have the most diverse shallow water marine biota anywhere on earth (Ekman, 1953). An agenda of major research needed to define and manage the marine fisheries of Indonesia should include the following program elements:

1. Primary Productivity of Ocean Ecosystem

Ecological food chains are based on organisms that convert simple chemicals and energy into the complex organic chemicals that characterize living things. These organisms are called primary producers and carry out photosynthesis using the energy of sunlight and simple chemicals (nutrients) from their environments.

In the ocean, this process occurs to depths extending to 150 m. Most open ocean areas have low rates of primary production because nutrients occur in low concentration in the lighted environments. In some areas, however (about 0.1% of the total ocean), physical phenomena cause mixing of water deeper than 150 m from the surface, and these upwelling areas support about 50% of the world's fishery harvest. The extent of upwelling in Indonesian seas is not known, but the monsoonal shifts in wind and water currents make conditions suitable for seasonal upwelling in many areas. Some of these areas (the Bali Straits, the Indian Ocean side of Java, the Arafura Sea) are well known (Polunin, 1983), but many others remain to be studied. The Shellius II expedition (currently underway) is extending our knowledge, but a continuing program of primary production studies is needed to define the base of marine fisheries food chains. These studies could benefit greatly from the use of existing remote sensing techniques to identify areas worthy of detailed study. Such a study might be mounted by the National Institute of Oceanography (LON).

2. <u>Exploratory Fishing on the Continental Slope</u>

Most of the fishery resources of Indonesia's coastal and continental shelf waters are known in at least general terms. These resources can be exploited as technology and markets dictate, but the resources of the continental slopes of Indonesia's internal seas need to be explored for potential fishery populations. Experimental trap catch of shrimp from continental shelf depths near Ambon show harvest rates of up to 5 lbs. of shrimp per trap per night. Such an exploratory fishing program might be mounted as university research, and where justified by preliminary results, carried out more extensively by the Marine Fisheries Research Institute.

3. <u>Experimental Fishing for Underexploited Species</u>

Known populations of fish do not become fishery stocks unless there are practical methods by which they can be caught. Much of the estimated potential for increasing Indonesia's marine fishery harvest is based on the assumption that practical methods can be developed to catch populations of small pelagic fish and all sizes of demersal fish. Such methods can probably be developed by experimenting with current Indonesian techniques or adapting methods in use in other areas. Such a project seems like a logical component of a State Fishing Enterprise program, especially the program at Ambon where boats, gear and trained personnel already exist.

4. Stock Assessment for Exploited Species

Once a fish population begins to be harvested, it, by fishery science definition, becomes a stock and therefore capable of being assessed by existing stock assessment techniques (Gulland, 1984). Assessment of skipjack stocks is a regular feature of Fisheries Service activities in Ambon. However, other harvested stocks are not yet being formally assessed, and there do not seem to be plans to initiate stock assessment programs as a regular feature. Preliminary analyses by Garth Murphy (World Bank fisheries consultant) suggest that shrimp stocks in the Arafura Sea are being fished at rates close to their maximum sustainable yield (MSY) despite Fisheries Service projections that harvests from the Maluku and Irian Jaya seas can increase by 2.5 times current levels. The demersal fish caught along with the shrimp (by-catch) show evidence of over fishing, as indicated by qualitative changes in the species that make up the catch (Garth Murphy, personal communication).

Stock assessment programs can and should have many components. The simplest to mount involves the analysis of fish catch to determine catch per unit of effort and catch per recruit in order to detect changes in these parameters while there is still time to adjust regulations to prevent overexploitation. A more active approach involves estimating fish stocks by acoustic techniques and then catching the remotely sensed fish to determine the relationship between acoustic signal and actual catch. Once established, this relationship allows rapid stock assessment by acoustic surveys. The Marine Fisheries Research Center has a vessel equipped for acoustic surveys, but it appears not to have the capacity to trawl (mid-water or bottom) to provide the essential catch data for calibrating the acoustic results. In addition, the vessel appears to be limited to 60 days at sea per year.

5. Fish Processing and Marketing

Fish stocks, even if discovered, caught, and landed may not be economically exploitable unless a product can be processed and marketed. Therefore, processing and marketing studies should be part of any fisheries development research agenda. The need for such programs is well understood by the Indonesian government, and the new laboratory being built at Ambon for the Marine Fisheries Research Center will have major program emphasis on the processing aspects of new fishery development. Additional emphasis probably should be placed on research in both domestic and export markets. In addition, university faculty should be encouraged to add fishery economic research to the specialties of their economics faculties; also, both traditional and modern fish processing studies should be supported. A diverse program of research on processing and marketing is needed because possible fishery development may include aspects as widely divergent as super seining for yellow fin tuna, industrial development of crude carrageenan extraction from algae, and traditional processing of eastern Indonesian small pelagic fish for marketing in Java and other population centers.

4.5 Research for Enhanced Small Scale Fishing

Most aspects mentioned in this research agenda require technically complex measurements or analyses that will benefit medium to large scale commercial fishermen. However, small scale fishermen account for about 5% of Indonesia's work force (over 3 million people). In a country where social equity is an important national goal, research designed to aid the small scale fisherman has an important role.

4.5.1 Fish Aggregation Devices

Most small scale fisheries in Indonesia operate close to the coastline, i.e., within 3 miles. Most of the resources of this zone are overexploited in areas near human population centers. There are, however, ways to increase fish habitat either by concentrating existing fish for easier catching, or by providing habitat for fish that might otherwise be preyed upon by something other than man. A program of research to develop, test, and assess the ecological impact of near shore fish aggregating devices should be carried out. Such a program need not be expensive, as devices must be cheap if they are to be used by small scale fishermen. Nonetheless, the analysis must be skilled because the use of such devices has the potential for exacerbating any existing problem of overfishing. Examples of fish aggregating devices currently being studied include RUMPON (anchored palm thatch structures that attract fish during the day, so that they can be more efficiently caught by light fishing at night), artificial reefs (currently made from used tires), and brush parks (near shore anchored piles of brush which provide small fish with refuge from non-human predators). Other fish aggregating techniques are part of traditional fishing in the Indo Pacific. A program to identify these techniques and test their utility in Indonesia could be mounted in university fishery faculties.

4.5.2 Small Scale Mariculture

Although brackishwater tambaks will be a major source of cultured aquatic resources (shrimp and milkfish), no major research seems needed other than what is already planned by the coastal Aquaculture Research Institute of AARD. Small scale mariculture should not be ignored, however, since it may hold promise of improving the lot of the small fishermen. A program of small scale experimental culture techniques could be encouraged among university fishery faculties. A diverse array of culture techniques are in use in Asia, and their potential for application to Indonesian situations should be tested. Examples include rabbit fish pen culture as experimentally being tried in Ambon, giant clam aquaculture that is being applied in Palau and elsewhere in the Pacific, marine algae culture as practiced in the Philippines (especially if coupled to processing and marketing studies of industrial grade carrageenan or studies of biotechnologically enhanced agar production), and algae, oyster, scallop, and sea cucumber polyculture as practiced in the Peoples' Republic of China.

4.5.3 Coastal Ecosystem Functioning Studies

Continued traditional harvests from the coastal zone as well as enhanced harvests that might result from use of fish aggregating devices or mariculture will depend on food, support, and habitat provided by coastal ecosystems. If no efforts are made to stimulate the productivity of these systems, increased harvests can only result from more efficient channeling of existing productivity into desirable or manageable species. To channel productivity rationally will require an understanding of natural ecosystem function as well as the impact of channeling procedures. Examples include studies into the ecological processes that may link mangrove habitat with near shore fish catch, the ecological role of reef flats, and topographic upwelling in Indonesian coral reefs. These topics may be addressed in a new ASEAN-Australian Cooperative Program in Marine Science--Living Resources in Coastal Areas, but citable plans for that program have not yet been developed. In any event, other aspects of coastal ecosystem function important to coastal fishery development are readily apparent to any marine ecologist. A program of research support for studies in this area would elicit large numbers of proposals and could focus scientific attention on near shore fishery ecology problems.

4.5.4 Social Aspects of Near Shore Fisheries

In many areas of Indonesia, traditional knowledge of fishing technology and traditional laws governing fish catch are being replaced with technical innovation (light fishing with Coleman lanterns) and poorly enforced fishery regulations. These replacements are not always good for the fishery, yet much traditional knowledge of fishing and fishery regulations is being lost as the old people who still hold this knowledge pass away. Some aspects of traditional knowledge and fishery conservation law (sasi) are understood by scientists at Pattimura University's Environmental Study Center, but no conscious program to preserve this fast disappearing knowledge has been undertaken. Such a program has the potential of bringing cultural anthropologists and other social scientists into fisheries issues, a cross field fertilization that should be mutually beneficial.

4.6 Research and Manpower Requirements Associated with Government Development Plans in the Marine Fisheries Sector

The Republic of Indonesia's plans for marine fisheries development include rapid increases in harvest rates. While harvests vary for different portions of Indonesian seas, in 1981 the average percentage catch of total estimated harvest potential was 23.5, 11.0, and 62.8 for pelagic, demersal and shrimp, respectively. Plans of the Director General of Fisheries would have those percentages rise to 49.5, 27.5 and 98.3 by 1994. These increases would result in changed total harvests as summarized below:

	Estimated Potential Harvest (metric tons)	1981 Harvest	1994 Harvest (Planned)
Pelagic	3,961,800	930,939	1,962,100
Demersal	2,595,000	285,224	1,089,200
Shrimp	69,900	43,391	68,700

The research implications of these harvest increases differ in different areas of Indonesian seas. For example, 1981 shrimp harvest in North Sumatera, and North and South Kalimantan was estimated to be 100% of potential whereas those of South Java and Maluku-Irian Jaya were only 21.4 and 40.9% of potential, respectively. The ban on trawling makes estimation of potential trawler catches academic in all areas except the Arafura Sea, but here separate research is needed to confirm government estimates of potential harvest. Estimates based on preliminary stock assessment calculations (Garth Murphy, World Bank fisheries consultant) indicate that 1984 harvest rates approach or exceed maximum sustainable yield (MSY). Conventional wisdom of fisheries science is consistent in support of the idea that underexploited living resources inhabit the seas of eastern Indonesia, that the North Java coastal fishery is overexploited, and that official government estimates of potential harvest are not scientifically reliable. This suggests that an incremental research program should be based on attempts to improve estimates of potential fishery harvests, especially in areas where reliance on existing estimates could lead to faulty investment decisions. An agenda for such incremental research is described in Section 3 of this report. Indonesian government plans for research in Repelita IV are not drawn with the specificity of the research agenda presented in Section 3, although it is clear that increased fisheries research will be conducted in 1985-1990.

Manpower plans, on the other hand, are specified in some detail in Repelita IV and the specific agency plans which lead to it. Although only summary tables appear in the completed report, sectoral and agency submissions provide detailed information on specific requirements. The major requirements for fishery specialists will be in the Director General of Fisheries (DGF) and the Central Fisheries Research Institute (AARD). The agricultural sector summary table summarizes the total number of new persons to be planned for addition to these agencies, as extracted below:

	Agriculture Sector Summary - Persons to be Added					
	1984/85	85/86	86/87	87/88	88/89	Total
Fisheries Service	1,000	1,750	2,250	2,850	3,000	10,800
Central Fisheries Research Institute (AARD)	280	300	320	340	360	1,600

These estimates clearly include many types of employees other than fishery specialists. Agency plans suggest that the number of fishery specialists needed is about 3,300 in the Fisheries Service (about 2,200 S-0 degrees; 1100 S-1 degrees), including the Directorate General Central staff, the district offices, the State Fishing Enterprises, and extension specialists. The Institutes of the Central Fisheries Research Institute of AARD will together require about 210 new technically trained fisheries specialists including 47 with the S-0 degree, 67 with the S-1, 77 with M.S., and 20 with Ph.Ds. In addition, these institutes plan to have at least 17 of their present staff attain M.S. degrees and nine attain Ph.D.s during the 1985-1990 period. These agency plans are viewed skeptically by faculty members in university fisheries faculties. All interviewed faculty essentially scoffed at the numbers presented in the plans and all stated that Repelita staffing plans had failed to materialize in the past. Nonetheless, it is interesting to compare the estimated needs of government agencies with estimated production of S-1 degree holders from universities in the 1985-1990 period:

Estimates of Manpower Needs and Training - 1985-1990

Estimated Needs for S-1 Degree Holders in Fisheries - 1200
(Fisheries Service + Central Fisheries Research Institute)

Estimated Production of S-1 Degree Holders
(10 of 11 Universities with Fishery Degrees) 1500-2750

This comparison is based on detailed plans of the two major fisheries agencies (corrected for the Repelita IV ratio of S-0 to S-1 degree holder hirings for the Fisheries Service) and the academic S-1 degree production (current level, low end of range; 1990 levels, high end of range). Of course, some fisheries specialists will also be required by the Agency for Education, Training and Extension, as well as in Mass Guidance (BIMAS) and the universities themselves; but the total manpower in these units is small, so their requirements for newly trained fisheries specialists will also be small. It seems apparent, insofar as these estimates warrant confidence, that Indonesian and donor agency projects to develop trained fishery manpower should be directed at improving the quality of graduates rather than continuing recent increases in class size. Continued provision of advanced training for selected M.S. and Ph.D. students will also be necessary because Indonesian universities produce few graduates with these degrees. This situation seems unlikely to change in the 1985-1990 period.

4.7 Strengths and Weaknesses of Institutions Involved in Marine Fisheries Research

4.7.1 The National Institute of Oceanology (LON)

The Lembaga Oseanologi National (LON) is a national research institution under the Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science). It was established by Presidential Decree in 1970, but has a continuous history back to establishment of the "Visscherij Station" in 1904. LON operates two major laboratories (one near Jakarta at Ancol, the other in Ambon), a field station in the Pari Islands in Jakarta Bay, and one medium sized and several small research vessels.

- Strengths:

  LON is a functioning institution for oceanographic research with an international reputation. This statement may seem unworthy of mention; but getting men, ships and equipment to sea for effective scientific measurements is a non-trivial task in developed countries, and to accomplish this task in a developing country is a feat worthy of note.

  LON has an effective and internationally esteemed Director in Aprilani Soegiarto.

- Weaknesses

  LON is ill equipped for some of its tasks, especially in measuring rates of biological and chemical processes in the sea and in analyzing environmental levels of heavy metals and other pollutants.

  LON's program in physical oceanography is not as effective as it should be considering the controlling role that ocean currents have on all other marine phenomena.

  LON's program may become duplicative of some aspects of other agency missions; for example, its skipjack stock assessment in Ambon will duplicate work to be conducted at the new Marine Fisheries Research Institute, and LON's mariculture programs may be duplicative of programs to be carried out by the Coastal Aquaculture Research Institute.

- Recommendations to strengthen programs

Remote Sensing and Primary Production

LON has established a well respected small program in the measurement of primary production. The large extent of Indonesian seas limits the coverage of this program. Satellite remote sensing techniques developed to state-of-the-art levels at the Indonesian National Institute of Aeronautics and Space (LAPAN) can be used to help identify areas of unusually high productivity. LAPAN staff are more than willing to assist with this process. A specific program of short term training for a few LON and LAPAN staff members in oceanographic applications of remote sensing techniques would be an excellent start. Such short term training could probably be arranged at leading U.S. or other centers of remote sensing of the ocean. Such joint training would establish connections between LON and LAPAN staff that would continue upon their return to Indonesia.

In addition, this training would pay dividends in providing a nucleus of trained manpower to take advantage of microcomputer analysis of landsat data tapes, a prospect being explored by UNESCO-Jakarta and the new ASEAN-Australia Cooperative Program in Marine Science. Remote sensing techniques offer the only realistic chance for synoptic data collection across all of Indonesia's seas. LAPAN has outstanding technical capabilities for producing data products. This situation presents and opportunity to make a small manpower development investment that could pay dividends throughout the remainder of this century.

Marine Pollution Monitoring

LON has responsibility for monitoring the pollution levels in Indonesian seas. This is a huge task, made even more difficult by the technical difficulty of precise chemical measurements in the ocean. LON has made a courageous start in measuring pollution and hopes to establish a U.S. style "Mussel Watch" type monitoring network. These developments could be stimulated through the provision of short term training for a few chemists and biologists from LON at a center for mussel watch measurements. This training might have to be followed up with some equipment provision, but such an investment would be worthwhile in light of the obvious pollution sources and current inadequacy of monitoring marine pollution in Indonesia. It is not inconceivable that Jakarta Bay may harbor a health related pollution problem similar to that of the infamous Minamata Bay in Japan.

Advanced Training in Physical Oceanography

LON's physical oceanography group has no staff with training beyond the M.S. degree in physics. Such training is hoplessly inadequate for operating a modern program of physical oceanographic research. Many of LON's physical oceanographic staff are bright and hard working, and some seem reasonably skillful in their use of English. Therefore, the opportunity for them to obtain advanced training in the USA or other countries seems excellent. Many institutions could provide such training, but some effort should be expended to select a university with programs in near shore research using techniques that could reasonably be made available in Indonesia. However, modern open ocean physical oceanography requires instrument complements that will be beyond likely Indonesian and donor agency investment levels.

4.7.2 Environmental Centers of the Ministry of Population and Environment (MKLH)

The Environmental Centers of MKLH are operated at universities throughout Indonesia. Some base budgetary support for these centers is now provided by MKLH, and buildings have been erected at several universities. MKLH does not, however, have any of its own research staff in these centers. The Ministry, therefore, supports research and instruction, but does not actually carry it out.

- Strengths

  The major strength of MKLH as a research institution is its status as an agency without in-house capabilities. Such agencies can serve as "honest brokers" in distributing research funds without the taint of possible favoritism to its own in-house programs.

- Weaknesses

  Regretably, the same status that is MKLH's major strength is also its major weakness. It cannot assure, by executive direction, that any particular research program will be carried out expediciously or with any given level of competence. It can and does choose its investigators wisely; and if serious problems arose, it could probably replace senior investigators who did not perform. However, without executive control over its investigators, it cannot manage research with the same precision as line agencies can.

- Recommendation to strengthen program

  MKLH represents a mechanism of great potential value in accomplishing certain programs. Were a small grants program in fisheries research designed to include national institutes and line agencies as well as universities, MKLH would be one of the best places to locate such a program.

  It does not appear that 1984 is the proper time to recommend a program extending beyond universities but, if the previously recommended university oriented small grants program is tried and proves successful, expansion of such a program may be advantageous.

4.7.3 Ministry of Agriculture, Department of Fisheries

The Department of Fisheries official mission does not include research, although it operates five centers which apply the results of research to fisheries problems and provides extension activities. These five centers are:

Freshwater Fisheries Center in Sukabumi
Marine Fisheries Center in Lampung
Quality Control Center in Jakarta
Fishing Technique Center in Semarang, and
Brackishwater Aquaculture Center in Jepara.

- Strengths

  The Brackishwater Aquaculture Center has an excellent reputation for work in developing shrimp and milkfish aquaculture in tambaks. It gives the appearance of being a first class operation, and many senior fisheries students from universities on Java have "voted with their feet" and come to Jepara to conduct their thesis research. Thus, this center is performing an important instructional function for universities as well as its defined function as an extension education unit.

- Weaknesses

  The Jepara sight has a major problem in securing fresh water. As a result, the tambaks become more saline than is optimum for shrimp growth. A "deep well" was drilled recently, but it became salty after only three months of use. As a result, the Jepara facility extends knowledge that is less than state-of-the-art.

- Recommendation to strengthen program

  Someone should analyze what is known about the subsurface geology of the Jepara site. If reliable supplies of fresh water could be tapped with an economically feasible well, such a well should be drilled. The surface geomorphology does not bode well for such a plan, however, because the Jepara site is at the end of a narrow peninsula extending into the Java Sea. Past declines in sea level may, however, have left fresh water-saturated formations under both the peninsula and the sea. The importance of the Jepara Center justifies an effort to find a reliable fresh water supply.

4.7.4 Ministry of Agriculture-Agency for Agricultural Research and Development (AARD)

4.7.4.1 Coastal Aquaculture Research Institute

- Strengths

The new center to be built at Maros on Sulawesi will have many excellent features. The facility is being built with funds from a World Bank loan and will have laboratories, equipment, a library and housing at Maros as well as 50 hectares of experimental ponds near the coast about 10 km from Maros.

- Potential weaknesses

The site of the experimental pond is still about 5 km from the open sea. Sea water will be provided by a canal. The quality of that water will probably be adequate for research on shrimp and milkfish growth. It is not likely to be adequate for hatching shrimp and milkfish eggs or for maintaining the pre-stocking sizes of these animals.

One persistent concern about shrimp produced from tambak aquaculture is the likelihood of microbiological (particularly *Salmonella*) contamination. *Salmonella* contamination is the predominanat (almost exclusive) reason why Indonesian shrimp are refused entry to the U.S. market by the Food and Drug Administration. Microbiological contamination of traditional tambaks is unavoidable because of the use of freshwater runoff and the usual use of manure from warm blooded vertebrates as a source of nutrients. Both practices would have to be changed to eliminate microbiological contamination. It is possible to kill the microbial contaminants before packaging the shrimp, but this practice is known as "sterilized filth" in the food processing field and discovery of its use would also result in FDA prohibition of product entry into the U.S. These facts are widely recognized in Indonesia, but plans for tambak quality control procedures have developed with what appears to be a gap in this area. Research to intensify the productivity of tambaks is being administered by the Coastal Aquaculture Research Institute. This program includes an environmental quality component, but only for heavy metals. Research on microbial aspects of fisheries products will be carried out in another institute (the Marine Fisheries Research Institute's post harvest program). This separation of authority seems to open the prospect that microbiological contamination problems will not be addressed as effectively as if they were an integral part of the Coastal Aquaculture Research Institute program.

o Recommendation to strengthen program

Nothing should be done about the identified weaknesses until or unless some appropriate role is identified through AARD agreement.

4.7.4.2 Marine Fisheries Research Institute

o Strengths

This institute has a small core of well trained staff and a Director with a Ph.D. from Dalhousie (Canada). It also has the continuing services of a competent expatriate advisor in Dr. Garth Murphy (formerly of University of Hawaii and CSIRO). It also has a carefully thought out program of research for the 1985-1990 period. All of these factors combine to give the impression of an intellectually effective organization.

o Weaknesses

Unfortunately, the facilities and budget status of this institute stand in sharp contrast to its personnel. The facilities are old, run down, and inadequate for a modern national research program in a sector as important as marine fisheries. In addition, although the institute has two research vessels of over 100 tons displacement, neither has a budget that can support more than 60 days at sea per year (about 1/4 of minimum economic operation). Adding to the ship problem is the fact that the largest vessel, although well equipped for modern acoustic surveys of fish distribution, has no trawling capacity so it cannot catch the fish being remotely sensed by acoustics. As a result, techniques developed to sense cod in the North Atlantic are being used to sense something (potentially pelagic crabs) off Indonesia. This system is not an effective stock analysis tool as it is currently configured.

o Recommendation to strengthen program

The government should first consider negotiating an assistance package that would provide the trawling gear needed for the research vessel Bawal Putih, and second, provide a budget for operating this vessel at least 240 days per year. One effective research and experimental fishing vessel is essential to analyze and assess fish stocks during a period of expanding production. The Marine Fisheries Research Institute has a small staff which could make effective use of such a vessel were it available.

4.7.4.3 Marine Fisheries Center at Ambon

Although not a single institution like the others described in this section, there is a growing center for marine and fishery science at Ambon in Maluku. This center includes the Ambon station of LON/LIPI, the Ambon station of the Marine Fisheries Research Institute, Pattimura University, the Fisheries Service and its State Fishing Enterprises, and several private Indonesian and joint venture fishery firms. This combination of institutions in the geographic location of Indonesia's major underexploited fish stocks provides a number of opportunities to better utilize these institutions.

- Strengths

  The strength of the Ambon Center is the strength of diversity backed by cooperation based on enlightened self-interest. There is a growing community of marine and fisheries scientists in Ambon, and a tradition of field research is well established. The Marine Fisheries Research Institute, now under construction, will provide scientists with new experience and equipment. The Fisheries Service and industries provide a ready source of practical experience. The fishing traditions of Maluku provide a supportive social context. The expanding fisheries harvest of eastern Indonesia provides the investment rationale.

- Weakenesses

  No program is perfect, and Ambon has its share of problems. Although close to the fisheries, Ambon is far from the amenities and social structure of Java. This isolation does not have the compensation of reduced living costs; land, housing, and food are all expensive. It is, in fact, an isolated post. Personnel assigned there may not choose to stay indefinitely; but, for budding fisheries research workers, opportunities for creative research can more than compensate for reduced creature comforts during the early stage of their careers.

  There are also problems in inter-institutional coordination. There does not seem to be an entrenched rancor, but there are verbalized concerns about program duplication and past slights that clearly will have to be overcome if an effective multi-institutional center is to flourish. There are also problems with individual institutions: LON seems effectively operated, and the Marine Fisheries Research Institute is only partially complete; but UNPATTI has administrative problems with rudimentary infrastructure (reliable electricity and water), administration (two years' delays in new faculty appointments), and its academic program (supportable expansion of the student/faculty ratio).

- <u>Recommendations to strengthen program</u>

There are a number of opportunities available to make these three major institutions more than the sum of their parts. Program coordination can be mutually beneficial, and will stimulate a community of scholars like those multi-institution centers in Seattle, LaJolla, Miami, and Woods Hole in the United States. Therefore, the following steps are recommended:

1. Place a research participant with expertise in primary production and food chain dynamics at LON-LIPI.

2. Place a research participant with expertise in population dynamics and fish stock assessment at UNPATTI.

3. Place a research participant with expertise in microbiological assessments of aquatic product quality at the Marine Fisheries Research Institute.

4. Provide equipment, supplies, ship time and assistance suitable for each participant to develop research on topics consciously selected as of interest to the permanent staff of all three major institutions.

5. Require the research participants to meet regularly to discuss program development and identify gaps that can be filled in overall program design.

6. Provide specific funds for staff development, especially funds for degree training abroad, but including funds to support participation in short courses in Indonesia and short-term training wherever appropriate.

7. Provide funds to support individual research projects of investigators without regard to their institutional affiliation.

8. Conduct a feasibility study of Ambon as a site for a fisheries polytechnic to be built by the Director General of Higher Education.

9. Require major program development review after 3, 5, and 7 years.

4.8. References

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Ekman, 1953. Zoogeography of the sea. London: Sidgwick and Jackson, XIV + 417 pp.

Gulland. 1984. Basic aspects of fishery stock assessment. FAO report. New York: Wiley.

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5.0 TECHNICAL ASSISTANCE TO THE UNIVERSITY OF PATTIMURA

In November 1984, Dirk Frankenberg of Resources Development Associates visited the University of Pattimura (UNPATTI) in Ambon. The purpose of this visit was to advise UNPATTI faculty and administration on steps to be taken to improve their teaching and research programs in marine and fisheries science. The specific tasks were:

- to assist the Vice Rector and Dean to plan medium and long term faculty development,
- to formulate a specific plan for the development of the university's marine science and fisheries program,
- to assist new staff in curriculum and lecture plan development,
- to assist staff in designing a research program and research project descriptions, and
- to review, with the Vice Rector, potential candidates for advanced training and establish criteria for selecting them.

This section describes the activities undertaken to accomplish these tasks. It includes a review of UNPATTI's general development plan and a description of a specific plan for the development of marine and fisheries science. The specific plan was formulated by Frankenberg and senior staff and administration of UNPATTI. It recommends the development of faculty expertise and research in the following areas:

- o coastal fisheries ecosystems, especially coral reefs, mangroves, and coastal areas of high primary production;
- o social aspects of fishery regulation and development, especially analysis of traditional law (sasi) and fishing lore for their relationship to regulation and natural history of fisheries;
- o stock analysis including population dynamics of unfished species and stock assessment of small scale fisheries not otherwise being assessed;
- o fish aggregation and location techniques;
- o aquatic resources culture, especially of species cultured elsewhere in the Indo Pacific but not yet in eastern Indonesia (algae, giant clams, oysters, etc.);
- o fisheries science as related to the fishing industries of Ambon and Maluku;
- o traditional and non-traditional fish processing techniques; and

o marketing strategies for Maluku fisheries products.

The faculty and infrastructure development implications of each program are described in this chapter.

This section also describes a faculty training plan linked to program development. This plan includes the following targets for faculty size and training levels at 2, 5, and 10 years into program development.

Target Year	Faculty Size	% Ph.D.	% MS (Advanced Training)
0 (present)	25	0	20
+5 Years	30	10	33
+10 Years	45	20	50

The implications of these targets for faculty advanced training are summarized below:

Term	Faculty in Advanced Training	Faculty in Ph.D Training	Population/Stock Assessment	Added S-1 Faculty
0-2 Yrs.	4 (2/yr)	1	1 (Ph.D)	2 (1/yr)
2-5 Yrs.	9 (3/yr)	2	1 (Ph.D)	6 (2/yr)
5-10 Yrs.	15 (3/yr)	6	0	10-12 (2/yr)

Summaries of Frankenberg's efforts in assisting young faculty with curriculum and lecture plan development, and all faculty with the research program and research project description are provided in separate sections. Finally, a brief review is provided of potential candidates for advanced training as well as a more detailed description of the criteria agreed to by the Vice Rector as appropriate for selecting candidates for advanced training opportunities that might arise in the future.

5.1 Assist Vice Rector and Dean to Plan Medium and Long Term Faculty Development

Faculty development in all universities should take place within the context of university and program development plans. In recognition of this fact, the first two days of Frankenberg's visit to Pattimura University were devoted to review and discussion of the university's development plans and the projects proposed to implement those plans for the Fisheries Department.

The University of Pattimura's development plan is based upon general goals for university development promulgated by the

Director General of Higher Education. These goals are all meritorious, but their generality provides little practical guidance for faculty development. For example, the goals for educational programs are to:

1. increase the relevance of the programs,
2. increase the variety and flexibility of programs,
3. increase the quality of the teaching and learning process,
4. develop the quantity and quality of teaching personnel,
5. increase the variety of teaching personnel,
6. increase the quality, quantity, and variety of support personnel,
7. develop an education management system,
8. increase the educational interaction of faculty and students, and
9. increase the output of scholarly work.

UNPATTI has used the general goals of the university development plan to frame projects designed to develop the faculty of the Fisheries Department and other faculties with marine science interests. These implementation projects have two aspects: public service through research and institution building. The public service component consists of plans to survey the aquatic resources of coastal Maluku to find species of economic importance among both pelagic and demersal populations, and to describe the coral, mangrove, estuarine, and bay ecosystems of Maluku.

The institution building component states general plans for faculty development (retain best students for faculty, bring in visiting faculty, send faculty abroad for Ph.D. training, send faculty elsewhere in Indonesia for M.S. training, have faculties participate in short term training activities); infrastructure development (obtain equipment, a data processing center, laboratories, teaching aids, technicians, library materials, etc.); and curriculum development (restructure advanced courses in the Fisheries Department, make syllabi for each course, develop teaching materials, etc.).

The development plan and implementation projects are useful steps in the evolution of a strategy for developing fisheries and marine science at UNPATTI; however, a greater level of specificity seemed needed to guide specific decisions about faculty and program development. Frankenberg provided a list of suggestions for potential program development. These were revised during discussions with the senior UNPATTI marine ecologist (Mr. Bob Wenno), the head of the Fisheries Department (Mr. Nanalohe), and the Vice Rector (J. L. Nanere) and his senior staff. The faculties of fisheries and the Environmental Studies Center were then interviewed in small groups to assess the fit of present faculty to the suggested program development plan. This plan was then further revised to provide an agreed upon basis for the Vice Rector and Dean of the faculty to plan medium to long term faculty development and establish priorities for selecting candidates for advanced academic training. The suggested program development plan is described below. Each section includes a discussion of scientific rationale and implications for faculty and infrastructure development.

5.2 Program Plan

This section presents a plan for the development of the marine science and fisheries program at Pattimura University.

5.2.1 Environmental Studies Center—Coastal Fisheries Ecosystems Program

1. Coral Reef Projects

UNPATTI already has expertise in coral reef ecology and fisheries. This expertise can be applied to important problems of fisheries. One such problem would be developing knowledge of the role of topographic upwelling (upwelling of nutrient-rich deep water into the lighted surface regions around islands, which stimulates unusually high rates of photosynthesis) on natural fish aggregations. Preliminary observations suggest that this role is significant, but the generality of the effect and its potential relevance to fisheries needs to be studied. Existing expertise at UNPATTI could also pioneer the use of inductive scientific reasoning in Indonesian marine science by consciously designing experiments that test specific hypotheses about coral reef ecology. Manipulative experiments are easily conducted on coral reefs and the scientific rigor required in their design could have useful lessons for Indonesian science generally.

Faculty Development Implications - The present faculty can start on these projects; however, training abroad for Dickie Sahetapy is recommended. He should study with an experimental coral reef ecologist.

Infrastructure Implications - Most of the boats and instruments needed for the suggested program are available at UNPATTI, but project implementation would be speeded by making available submarine thermisters and polaragraphic oxygen electrodes. Experimental studies will require caging material and anchor bolt attachment devices. Chemicals for nutrient chemistry analysis will be necessary in the medium term.

2. Mangrove Project

UNPATTI scientists understand the ecological importance of mangroves, and their efforts at replanting destroyed areas have won national environmental awards. This capability can be developed further by focusing on the ecological role of mangrove detritus. Such a program could be developed by three UNPATTI scientists (Mr. Ferdinandus, an expert in coastal forests; Bob Wenno, a new faculty member interested in the ecology of marine plants; and John Tatalepta, a new staff member with interests in marine food chains).

Faculty Development Implications - The young staff members may require some encouragement from in-house or resident research participants in mounting this project. If these young scientists show promise, they should be considered for extramural advanced training in the medium to long term. Mangrove ecosystems are sufficiently important to fisheries so that developing faculty expertise in this area may require a new hire.

Infrastructure Implications - A start could be made on this project by estimating mangrove detritus production (collecting fallen leaves) and fate (litter bag studies to estimate decay rates), fish observations, and feeding experiments (to estimate use of mangrove detritus as food). However, better optical equipment and some materials for litter bags, cages, and quantitative fish sampling would enhace the staff's capability to mount this project.

3. Primary Production Project

The measurement of photosynthesis rates in aquatic ecosystems is an essential step in assessing a system's capacity to support the harvest of plants and animals. Coastal artisanal fishermen of Maluku depend on production from relatively productive coastal ecosystems. Photosynthesis in such systems can be measured by dark and light bottle techniques. Expertise in this technology should be developed and applied at UNPATTI.

Faculty Development Implications - Someone should be sent for short term training in techniques of primary production measurement. Mr. Bob Wenno or Mr. John Tatalepta might be appropriate candidates, although Mr. Wenno would be well suited for such training if he can be spared from UNPATTI for a four to six month period. Bob Wenno has the ability to master the techniques of primary productivity measurement by use of Carbon 14 radioisotope tracer techniques. These techniques must be used in low productivity tropical waters.

Infrastructure Development Implications - Dark and light bottle methods require glass stoppered bottles, temperature controlled incubators or *in situ* suspension apparatus, and a good Winkler titration procedure and/or a spectrophotometric method for dissolved oxygen (Duval et al., 1974; J.Fish Bd of Canada 31:1529).

4. Social Aspects of Fishery Development Program

The UNPATTI Environmental Studies Center already has expertise in social aspects of fisheries. This expertise needs to be directed to fisheries development as eastern Indonesia is called upon to provide fisheries protein and foreign exchange (shrimp) during Repelita IV. Protein harvests will depend in part on the harvest of non-traditional species, raising questions of social acceptance, and may place further pressures on coastal resources currently regulated by poorly enforced fishery regulations and detriorating traditional law. Studying the social impact of the interaction of traditional and modern resource allocation systems will be important to coastal resource management.

Faculty Development Implications - Frankenberg is a marine scientist and could not assess these implications. It is clear that staff of the Environmental Studies Center (Mr. Papelaya, Mr. Sahetapy and Mr. Wenno) are familiar with sasi's role in Maluku. If one of them is not appropriate for formal training, perhaps an anthropologist could be asked for professional advice.

Infrastructure Implications - Unknown.

5.2.2 Fisheries Department - Aquatic Resource Management Group

1. Stock Analysis Program

Aquatic resource development in eastern Indonesia will be based on increased harvests of natural stocks during Repelita IV. This fact demands that stock analysis programs be mounted as soon as possible. The Marine Fisheries Research Center being developed in Ambon will have a program in stock assessment and the National Institute of Oceanography has projects on assessing population structure of skipjack. However, UNPATTI should develop a complementary program because much important work must be done, and near shore artisanal fisheries assessments are not involved in other agencies' plans. Other examples upon which a UNPATTI program could focus include fish caught along with shrimp (by-catch), pre-recruitment aspects, and analysis of potential fishery stocks. The importance of shrimp by-catch as a source of human protein and/or feed stock for fish meal plants suggests stock assessment of populations that comprise the by-catch. Qualitative changes in the by-catch plus estimated catch rates of 4 tons per shrimp boat per day (Garth Murphy, pers. comm.) indicate that maximum sustainable yield of by-catch species may be exceeded by current catch rates. As is normal in fishery agencies, no attention is being paid to the dynamics of fishery populations in the pre-recruitment stage of their life cycle or to stocks of potential fisheries importance. Increasing the fishery harvest during Repelita IV will surely be based in part on species (especially small pelagics) that are not currently caught in large numbers and for which no information on potential stocks is available. These gaps should be filled by a UNPATTI program.

Faculty Development Implications - The faculty of the Aquatic Resources Management Group consists almost entirely of young staff who have returned to UNPATTI within the last few months after completing S-1 degrees at IPB. None of them appears ready to take a leadership role in a stock analysis program. Therefore, UNPATTI should seek a senior level appointee in population dynamics. If this is not possible, a research participant should be brought to UNPATTI on a long term basis. Miss Elizabeth Ferdinandus has advanced training at the University of Washington in electro-phoresis identification of stocks. This expertise can be effectively utilized in a stock analysis program.

Infrastructure Development Implications - There are so many important problems awaiting study that specific infrastructure implications of a stock analysis program are hard to predict. It is clear that enhanced data processing and data handling facilities will be needed. Otherwise, many problems can be approached by analysis of harvests landed at Ambon, and by applying such simple techniques as swept area analysis to the shrimp grounds. Electrophoresis equipment should be provided for Miss Ferdinandus' stock identification research.

2. Fish Aggregation and Location Technique Program

UNPATTI has already made important steps towards developing practical techniques to increase fish aggregation, thereby making the fish more accessible to small scale artisanal fishermen. UNPATTI has built artificial reefs of car tires that have developed exploitable reef fish faunas within two months. UNPATTI scientists have developed experimental structures (rumpon) that attract fish during daylight so they may be caught by night lights. UNPATTI staff have developed artificial refuge areas of brush that enlarge areas for fish development to profitably exploitable size. These efforts should be continued and expanded by new faculty. In addition, traditional methods of fish location (listening through paddles and boat hulls) and management (sasi-traditional law) should be studied for clues to scientifically unknown aspects of coastal fish behavior and natural history.

Faculty Development Implications - Current young faculty should be directed into studies of coastal fish attraction and location techniques. These techniques have real promise for public service to artisanal fishermen of Maluku, and reasonable projects can be developed with local knowledge and materials. Bob Wenno, Mary Kayadoe, Bob Latumeten, Agus Tupamahu, and Mrs. Salamony could easily form research teams to explore various facets of this project. Mrs. Salamony's interest in traditional fishing boats suggests that she might appropriately focus her research into studies of traditional fish location techniques. In the medium term, the most promising of these young investigators should be selected for advanced study.

Infrastructure Development Implications - Small amounts of locally available supplies will be needed to build experimental aggregation devices. Modest amounts of travel funds will be needed for interviews with experienced traditional fishermen. Some of the best interviewees are apparently quite old, so time is of the essence in starting this project.

3. Aquatic Resource Culture Program

Although traditional Javanese and Sulawesi tambak culture of shrimp and milkfish does not seem feasible on Ambon, the potential for pen culture and mariculture techniques should be explored by UNPATTI faculty. Pen culture of commercially valuable rabbit fish (Siganus Caniculatus) should be studied, and the application of mariculture techniques from other areas of Asia should be examined for possible use in the waters of Maluku. Examples of the latter include algae culture as practiced in the Philippines, giant clam (Tridacna) culture as being experimentally practiced on Palau and in Micronesia, and algae, scallop, oyster, and sea cucumber polyculture as practiced in Tsingtao in the Peoples' Republic of China. The utility of these techniques to Maluku should be evaluated by an experienced UNPATTI scientist before experiments are initiated.

Faculty Development Implications - Mr. Bob Wenno should be supported for a period of short term training and visits to mariculture centers throughout Asia. Mr. Wenno is the most experienced marine ecologist on the UNPATTI faculty and his interest in marine organism culture makes him the obvious choice for such training and experience.

Infrastructure Development Implications - Impossible to estimate before completion of a feasibility study by a UNPATTI scientist.

4. Fishery Science

UNPATTI is uniquely located in the midst of developing fishery grounds. New discoveries in fish distribution patterns and fish catching techniques will be important to this development. Young UNPATTI staff such as Mary Kayadoe have research interests in fisheries oceanography, and older staff, such as Bob Wenno, have interests in gear development. These interests can be developed through association with scientists at the Marine Fisheries Research Institute, the National Institute of Oceanology, the Fisheries Service, the Fishing School, and the State Fishing Enterprise. Potential research topics in this program could include the effect of ocean thermal fronts on pelagic fish aggregation, the effect of topographic discontinuities on demersal fishes, and the use of dissolved oxygen anomalies in locating fish schools.

Faculty Development Implications - Several of the current faculty at UNPATTI have interests in this area although these interests have not come together to form a coherent program. This is an area in which academic leadership from Bob Wenno and modest in-country training of young staff would pay great dividends for program development. The advanced training need not occur immediately, but two staff members should be encouraged to take it within the next five years.

Infrastructure Development Implications - Little infrastructure is required for the initial stages of the program because UNPATTI staff can utilize data and training opportunities available in nearby laboratories and industries. Full development of a fisheries science program may require a modest outfit of oceanographic instruments.

5.2.3 Fisheries Department - Fish Processing Group

The current UNPATTI Fish Processing Group is made up of one experienced and well trained senior scientist, Mrs. Charlotte Nanere, and five or more young scientists at IPB. The infrastructure for modern fish processing research is completely lacking; there is no functional autoclave, nor is there a freezer, refrigerator, oven, cooking equipment, drying oven, muffle furnace, or basic instruments of chemical analysis (fiber, fat, protein, etc.). As a result, the group has concentrated on learning about traditional food processing techniques, and has recently sponsored a national symposium on that subject.

The current development of a World Bank funded laboratory of the Marine Fisheries Research Institute of AARD within 50 km of the existing fish processing laboratory at UNPATTI suggests the possibility of mutually advantageous coordinated program development. University faculty and students are already using the AARD food processing facilities, and increased use of these facilities is being encouraged by the AARD administration. In addition, US $60,000 has been promised to UNPATTI by the Maluku Governor to build a new fish processing laboratory. Thus, in the medium term, prospects look good for developing the Fish Processing Group at UNPATTI. In the short term, however, it seems reasonable to expect continued focus on traditional fish processing techniques. This focus is appropriate and valuable, especially as modern instrumentation is brought to bear on such problems as microbial contamination, deterioration rates, and chemical characteristics of traditional products.

1. Marketing Studies of Traditional Products Program

The traditional product emphasis of the Fish Processing Group needs to be augmented with a marketing specialist to assess both local and inter-island export markets for these products. This program is especially timely at the beginning of an emphasis on Maluku fish in the national protein and international exchange situations.

Faculty Development Implication - Frankenberg did not meet the young person who teaches marketing in the food processing curriculum. If this person is promising, he or she should be considered for immediate advanced training either in Indonesia or abroad. If this does not seem advisable, a new staff member with marketing expertise should be recruited to the faculty.

Infrastructure Development Implications - Not assessable in light of current uncertainty regarding facilities.

2. Non-traditional Fisheries Product Program

The development of eastern Indonesia's marine aquatic resources will clearly depend in part on the exploitation of non-traditional fisheries products. Active studies of fish meal are underway by the Ministry of Agriculture in an effort to explore the feasibility of Indonesian fish meal production as a substitute for imports (US $70 million of fish meal was imported in 1982, and the total must increase as more fish meal is used in poultry and shrimp food). The Fisheries Service's Ambon office estimates that 64% of the potential harvests of the Maluku and Irian Jaya seas is small pelagic fishes (mackerals, skad, auxis, etc.). These fish, although smaller than yellow fin and skipjack tuna, are reputed to be highly prized on Java; and studies of processing and marketing techniques to bring supply together with demand are needed. Marine algae are an important export product in the Philippines, and although the market for food grade carrageenan may be softening due to the development of soybean based alternatives, the demand for crude (industrial grade) carrageenan may justify Indonesian entry into that market.

Faculty Development Implications - The current faculty of the Fish Processing Group is too recently arrived at UNPATTI to sensibly assess their potential for advanced study. The two young people Frankenberg interviewed were bright and were well into developing research and teaching. If others show similar promise, medium term selection of one or more for advanced training is likely to be advisable. In the short term, serious consideration should be given to hosting visits by outside experts in processing and marketing of the products mentioned here and others that may be identified in the future.

Infrastructure Development Implications - Impossible to assess in light of current uncertainty regarding facilities.

5.2.4 General Program Development Suggestions

UNPATTI has two major problems in developing its marine science/fisheries programs: infrastructure and student/faculty imbalance.

Infrastructure problems include the absence of equipment, glassware, chemicals and laboratories for routine teaching and research activities. UNPATTI shares these problems with almost all other universities in Indonesia. However, it appears unique among the provincial universities visited by Frankenberg in that it lacks reliable electric power and freshwater supplies for its campus in Poka. These problems will have to be solved before the specific infrastructure developments identified by the program above can be effectively implemented.

Student/faculty imbalance problems result from an apparently uncontrolled growth of students (from 16 to 100 per class) in the early 1980s without equivalent changes in faculty, facilities or degree requirements. The result is that 100 students enter the UNPATTI Fisheries Department each year, but fewer than 20 graduate. The others either drop out or wait patiently (seven years are allowed for S-1 completion) until one of the senior faculty can help them with the required thesis. The few senior faculty are overworked with this job, the young faculty are not certified to do it, and pressure is growing for fundamental change in some part of the student/faculty/degree requirement equation. The following two general suggestions are made in an effort to contribute to the solution of this critical problem.

1. A Work Study Program in Marine Fisheries

   Ambon is the site of many activities related to marine fisheries. All of these activities have trained personnel and the need for assistance such as could be provided by bright college students. If the trained personnel could be given adjunct status on the UNPATTI faculty, they could direct student theses while students worked under their supervision on fisheries-related topics. This could correct the student/faculty imbalance and UNPATTI students would get uniquely practical experience.

2. An Advisory Program and Associate Degree in Fisheries

   UNPATTI has developed, and will continue to develop, research results with public service implications. There is no extension agency currently operating in Maluku that can extend these results to those who most need them. An advisory/extension program administered by UNPATTI could provide that service; and, if coupled to student training in an extension of the tradition of Kuliah Kerja Nyata (K.K.N. = volunteer service in rural areas), might provide an option to the present thesis requirement.

5.2.5 Faculty Training Plan

The program development plan described above will require that UNPATTI embark on a conscious program of staff educational development. This program was discussed with Vice Rector Nanere and his senior staff, and the following numerical targets were agreed to:

Target Year	Faculty Size	% Ph.D	% M.S. (Advanced Training)
0 (present)	25	0	20
+5 Years	30	10	33
+10 Years	45	20	50

Achieving these targets will require rapidly initiated and continuing programs of staff development. The minimum requirements of such a program are described below:

Term	Faculty in Advanced Training	Faculty in Ph.D. Training	Population/Stock Assessment	Added S-1 Faculty
0-2 years	4 (2/yr)	1	1 (Ph.D)	2 (1/yr)
2-5 years	9 (3/yr)	2	1 (Ph.D)	6 (2/yr)
5-10 years	15 (3/yr)	6	0	10-12 (2/yr)

The training program described above is based on some expected (and desireable) turnover of S-1 staff, and expected losses of one M.S. staff member each year and one or two Ph.D. staff over the decade. Losses greater than these would require that greater numbers of UNPATTI staff be trained during the development period.

Priorities for initial staff training were discussed briefly with Vice Rector Nanere. It was agreed that advanced training in primary production techniques and for an economist in fisheries resource economics were the highest initial priorities, with the attraction of a Ph.D. faculty participant with training in population dynamics/stock assessment of equally high initial importance. Priorities after the initial stage must be set after considering opportunities and previous actions.

5.3 Assist New Staff in Curriculum and Lecture Plan Development

Frankenberg met with new faculty members both individually and in groups during his time in Ambon. These meetings presented an opportunity to provide assistance with curriculum and lecture plan development. These opportunities were rarely taken, however, because young UNPATTI faculty members were not about to admit to any reservations regarding their ability to teach adequate courses in their area of specialty. All new staff had just completed several years of study at the best fisheries institution in the country. All had completed a thesis in the area in which they were teaching. All were among the top 3% of students in their age group (the percentage of university age students that attain entrance to universities in Indonesia). The young staff is bright and well prepared by Indonesian standards. They were polite in the face of Frankenberg's inquiries about the need for assistance and equally polite in declining the offer.

5.4 Assist Staff in Designing a Research Program and Developing Descriptions for Research Projects to be Submitted for Potential Grants

The staff at UNPATTI consists of three general types: 1) new staff who have just (within two months) returned from IPB where they completed their S-1 degree; 2) staff who have studied abroad and who have returned within the last few years to begin teaching at UNPATTI; and 3) senior staff who have been at UNPATTI for several years after having been trained abroad. Frankenberg met with 25 faculty members during his visit to Ambon: 14 of these fell into group 1; 4 fell into group 2; and 7 fell into group 3. Group 1 faculty had begun their teaching and had ideas for research but weren't prepared to discuss proposal preparation. Group 2 faculty discussed proposals, as described below. Group 3 faculty had successfully prepared proposals (most of these faculty were in the Environmental Science Center) and clearly knew more about preparing successful proposals for submission within Indonesia than Frankenberg did. Frankenberg's efforts in assist in designing a research program for the Marine Science and Fisheries program are summarized in section A of his report.

The four faculty who Frankenberg assisted with research program and proposal development were:

1. Miss Elizabeth Ferdinandus - recently returned from M.S. training in fisheries genetics at the University of Washington. Frankenberg discussed with her the utility of electrophoretic techniques in identifying the unity (or absence thereof) of fish stocks being assessed by stock assessment techniques, and pointed out references useful for documenting this fact in proposals.

2. Mr. Dickie Sahetapy - recently returned from short term training at the University of Guam. Frankenberg discussed with him the importance of traditional knowledge and conservation law (sasi) in providing clues to aspects of fish behavior and natural history not known to science and suggested this and topographic upwelling near Banda Sea as potential research proposal topics.

3. Mrs. Charlotte Nanere - short term training in food technology at the University of Washington. Frankenberg discussed with her the value of shelf life determination and microbiological studies of traditionally processed fish products. Mrs. Nanere described her plans for using Marine Fisheries Research Center facilities for microbiological analyses of these products, although it was not clear to her where she might submit such a proposal once it was prepared.

4. Agus Tupamahu - recently returned from S-1 training at IPB, but has already initiated research on the effects of traditional treatment of cotton nets with bark extract on the longevity and strength of nets. Frankenberg suggested solutions to the problem of no string tensile strength testing equipment, i.e., a homemade weighted strength test. Frankenberg also described the existence of small research funds available through UNPATTI from the Director General of Higher Education, a subject described to him earlier by Bob Wenno. Mr. Tupamahu indicated his intention of preparing a proposal for submission by the Fisheries Department.

5.5 Review with Vice Rector Potential Candidates for Advanced Academic Training and Establish Selection Criteria

Potential candidates were briefly reviewed with the Vice Rector, and it was determined that those candidates scoring more than 550 on the TOEFL examination were all more than 40 years of age. Other candidates for advanced, but non-degree training, were reviewed with the agreement that Dickie Sahetapy and Bob Wenno were prime candidates. It was agreed that the new faculty should establish themselves at UNPATTI before being recommended for advanced training.

Criteria to be applied when selecting faculty for advanced training were established. These criteria involve grading each candidate on the following criteria:

1. Academic ability, as judged by past academic performance and scores on competitive achievement tests - 5 points (maximum).

2. Importance of candidate's area of specialty to UNPATTI development program - 3 points (maximum).

3. Contributions to UNPATTI program of teaching, research and service - 2 points (maximum).

Thus, any candidate could achieve a total of 10 points when evaluated on this scale. Frankenberg suggested that each candidate be reviewed by the Vice Rector, the Dean, and the Chairs of the person's department for years 0-5 of the development plan, and by the same group plus the Ph.D. faculty in years 5-10.

6.0 AQUACULTURE DEVELOPMENT IN INDONESIA

Indonesia's aquaculture tradition extends at least as far back as the end of the Majapahit empire when refugees who were banned to the swampy north coast of Java developed milkfish culture in conjunction with salt production during the rainy season.

Carp culture was introduced to Javanese fish farmers in the colonial era, when it was found that the native Java carp, *Puntius javanicus*, or tawes, was suitable for pond rearing. Tilapia (*Serathrodon mossambica*), native to Central Africa, found its way to the country during the late 1930s and other species of the tilapias, particularly *T. Nilotica*, have been successfully cultured in both fresh and brackish water.

The expansion of the husbandry of these and other species has depended upon either the ready availability of fish fry from natural sources or, as in the case of freshwater fish, the relative ease of inducing reproduction in ponds or tanks.

Total aquaculture production in 1981 reached 191,140 tons. Brackishwater ponds produced 113,000 tons, or 59% of the total. Compared to the marine catch of 1,490,300 tons, aquaculture accounted for 9.5% of fisheries production. A total of 423,000 households were involved in some form of fish rearing during 1981. About 15%, or 63,000, of these families produced milkfish and shrimp in brackishwater ponds (tambaks). The overwhelming majority of these households are small-scale operators. Eighty-five percent of brackishwater ponds are under 5 hectares and only 3.4% are over 10 ha. The same situation holds true for freshwater fish farmers: 75% of households work 0.1 ha or less and only 3.7% have ponds greater than half a hectare.

6.1 Species Cultured in Indonesia

A brief description of the species cultured in Indonesian fresh and brackish water ponds, raceways, lakes and the sea is provided to indicate the wide range of fish and crustaceans actually being produced by aquaculture in the country. Summary information on technology, markets, geographic distribution, present state of culture (intensive vs. extensive), problems and potential for expansion is provided. Table 42 summarizes the production and value of these species.

6.1.1 Freshwater Species

Common Carp (Cyprinus Carpio)

In 1982, the total production of carp (ikan mas) in Indonesia reached 19,800 tons. Most of this was from Java (72%), with Sumatera second in importance. Ikan mas can be cultured in ponds, sawah, raceways and cages. The primary market is for live fish, which bring the highest producer price. Ikan mas is consumed primarily on ceremonial occasions or in restaurants.

Carp culture consists of six phases: brood stock rearing and maintenance, spawning, fry production, fingerling production, and grow out to market size. It is unusual to find a vertically integrated farm carrying on all of these phases. Instead, small operators specialize in each phase and may work independently or in association with a farmers' group (kelompok tani) or cooperative.

There is considerable potential for the expansion of carp culture, particularly in combination with rice farming. Rice-cum-fish farming involves two steps, rearing fry to fingerling size in combination with rice and culturing to market size between rice crops. Obviously, the system is limited to irrigated regions. However, if rice-cum-fish culture is to spread, a number of technical constraints need to be overcome. First, improvement of brood stock is necessary due to the extensive inbreeding that has occurred. Three strains are currently bred and their genetic integrity must be ensured. Second, more fry must be made available to padi farmers by both improving the productivity of existing private hatcheries and encouraging the establishment of new enterprises. Improved techniques for both sawah fingerling production and palawija fish culture need to be spread through extension. Fry mortality in the sawah or "mina padi" phase is particularly high, ranging from 20% to 50%. Water management, use of compatible pesticides, and the development of appropriate feeds can increase sawah fingerling production. An increase of fingerling supply would also encourage raceway and cage culture. Palawija carp culture can be spread through the multiplication of demonstration centers in irrigation districts.

Java Carp - Tawes (*Puntus javinicus*)

The culturing of tawes is widespread in Java. It lends itself readily to very small scale culture in "backyard" ponds and because of its low price, this fish can be promoted for mass consumption. Tawes spawn naturally in small ponds, from which fry are collected and transplanted to grow-out ponds. A number of fry production centers, such as those at Pandaan, Jawa Timur and Ngrajek, Jawa Tengah, are operated by the provincial Dinas Perikanan and sell fry to small-scale producers at concessionary rates. In addition, many private hatcheries are in operation. In 1982 about 700 million tawes fry were produced, 75% of which came from Java. Small farmer groups (*kelompok tani*) sometimes operate tawes ponds and unproductive sawah are often converted to tawes ponds. Total production in 1982 was about 12,000 tons, with 92% originating from ponds on Java. Expansion of tawes production in Java is probably limited by fry and land availability. However, fry production can be stimulated as marginal sawah is converted to tawes culture. There appear to be few technical impediments to the spread of this system. Tawes is also an ideal candidate for polyculture with freshwater prawns, since it is a surface feeding herbiverous fish and the freshwater prawn is a bottom-dwelling omnivore.

TABLE 42: Production and Value of Selected Cultured Fish and Shrimp, 1982

1982	Production (tons)	Total Value (Billion Rp)	Rp/ton
Ikan mas	19,800	25.8	1.300.000
Tawes	11,900	9.7	813.000
Mujair	13,700	7.6	554.000
Ikan Nilem	7,400	5.6	761.000
Nila	5,300	3.9	747.000
Gorami	3,700	5.3	1.406.000
Lele	600	0.6	883.000
Bandeng	73,300	57.5	783.000
Udang Windu	8,800	38.9	4.425.000
Udang Putih	10,600	16.1	1.510.000

SOURCE: 1982 Statistical Year Book
Directorate General of Fisheries
Ministry of Agriculture

Tilapia - Mujair (*Serathrodon mossambica*)

Mujair is an exotic species introduced into Indonesia during the 1930s. It is a prolific breeder and spread rapidly throughout the archipelago. It can now be found in almost every stream, swamp and brackishwater pond in Indonesia. Although it is a pest in fish ponds and tambaks, mujair is harvested as a by-product and sold at low prices for popular consumption.

The main problem with mujair stems from its prolific breeding, which produces stunted fish, usually not over 100 grams. Techniques have been developed to overcome this habit. These include polyculture with a carnivorous fish such as the snake head (*Ophiodon elongatus* or *O. striatus*), which controls the population by preying on fry. Sex reversal at the fry stage can be achieved by application of methyltestosterone. Certain interspecific hybrids also result in fast growing all-male offspring. Tilapias are primarily nest building fish, so culturing in concrete raceways or cages prevents nest building and egg development and results in larger fish. For the present, the expansion of tilapia culture is restricted by its low market price and abundant supply from tambaks.

Common Carp - Ikan Nilem (*Cyprinus carpio*)

Common carp are cultured in ponds and cages in canals and rivers. They are hardy and can be grown at high density. However, due to their lower price, they are not as popular with fish farmers as ikan mas.

Fry production and grow out systems for these fish are similar to those of ikan mas. Common carp culture is widespread, but production in 1982 was only 7,400 tons, a decline of 22% from 1981.

Nila Tilapia - Nila (*Serathrodon Nilotica*)

Like the mujair, nila can be cultured in either brackish or freshwater ponds or raceways. Production in 1982 was 5,281 tons, down slightly from 1981.

New tambaks in North Sumatera are used for the culture of nila. An initial stocking of 300 to 1,000 brood stock is the only input required other than labor. Yields of up to 6 tons per year of 500 gram fish can be achieved. Reproduction is controlled by predatory fish that enter the tambak as it is filled during high tide. Tambak rearing of nila will probably develop only in areas where milkfish production is limited by the availability of fry.

Nila are also cultured in raceways, particularly in West Java. Three steps are involved: hatchery fry production, growth to stocking size in sawah, followed by planting in the raceway. Farmers involved in the different phases may organize themselves in a kelompok tani. The technology of nila culture is relatively simple and adaptable to the means available to farmers' groups. As its price is competitive with common carp, nila seems to have limited potential for expansion, but production should increase as new tambaks are opened up in North Sumatera.

Gourami (Osphronemus Gourami)

The gourami is a highly esteemed fish, frequently sold in restaurants. It is an anabantid and can breathe air, which allows the gourami to inhabit stagnant water. This is advantageous during transport from pond to buyer.

As with other freshwater fish discussed above, the gourami's reproductive behavior lends itself to small-scale fry production. Brood stock are kept in small ponds, where they spawn in nests. The nest with its adhering eggs is transferred to a special hatching tank. Fry are reared to a market size of about 3 cm. Gourami can be cultured in very small ponds, and only occassional manure spreading or fertilizing is required. Although gourami are slow growing, taking up to three years to reach market size of almost 1 kg, few inputs are required. Existing channels for the development of gourami culture seem adequate. According to national statistics, gourami production actually fell from about 4,100 tons in 1981 to 3,700 tons in 1982.

Walking Catfish - Ikan Lele (Clariaus Batrachus)

Due to its high price (not reflected in 1982 statistics), the culture of ikan lele is spreading rapidly. Production increased from 540 to 610 tons between 1981 and 1982. Ikan lele is often marketed alive and can live out of water for several hours if kept moist. It is adaptable to rearing in small ponds and can provide supplementary income to farmers. Private hatcheries are developing to meet the increased fry demand. Hatchery technology is very simple and fry are hearty and easy to raise. Various provincial fisheries services provide fry to interested farmers and are disseminating hatchery technology. Financing for pond construction is probably the major constraint to further development at the present time.

Cat Fish - (Pangasius Pangasius)

Pangasius culture is undeveloped, but offers great potential, particularly through the encouragement of river cage culture in provinces such as Sumatera Selatan, Jambi and Riau. Pangasius is an omnivore, readily consuming vegetable wastes. It can be kept at high density in floating cages.

As catfish are not separated by species in the national statistics, it is impossible to get any indication of their present production. However, fishermen receive 3,000 Rp. per kg for them, placing this catfish among the most expensive freshwater fishes consumed in Sumatera.

Pangasius culture is very successful in Thailand and with the market potential that exists in South Sumatera, Jambi and West Java, it should be possible to duplicate this success in Indonesia. However, since it is a new activity, several constraints must be overcome so that the private sector can develop. The two primary inputs that will be required will be fish fry and technical assistance to fish culturists. Opportunities exist for the development of small private hatcheries as well as grow-out operations.

Floating cage culture should be suitable as a household enterprise, to be carried out by families dwelling along or having access to river frontage. In fact, there is every indication that Pangasius culture could become independent of government support within a short time.

Giant Freshwater Prawn - Udang Gala (Macrobrachium Rosenbergii)

Udang gala culture is in its infancy in Indonesia, but shows prospects for future development as both an export commodity and for local consumption, particularly in areas with heavy tourist traffic.

Present exports are almost exclusively from capture fisheries in Sumateran rivers. These prawns are destined for processors in Medan and Palembang who are operating far below capacity due to the trawler ban. Current prices are around Rp. 6,000 per kg (compared to tiger prawns at Rp. 6,500 to Rp. 7,500/kg). With such high prices, it will not be long before wild stock are depleted. Domestic markets are slowly developing in Bali and Yogyakarta and potential markets exist in all major urban centers.

At the present time, udang gala fry can be supplied by several government hatcheries operated by provincial fisheries services. However, small scale hatcheries are feasible and could be developed as pond production expands. The main constraint now is market development, both domestic and for export.

As mentioned above, udang gala can be cultured with tawes and also with carp, so that the large number of small pond operators in Java could polyculture freshwater prawns and carps. The large freshwater resources of the lower river basins of Sumatera also offer potential for development.

6.1.2 Brackishwater Fish and Crustacean Culture

Tambaks (brackishwater pond culture) have a centuries old tradition in Indonesia. For most of this time, fish and shrimp rearing was carried out with few inputs; often, the only fish and shrimp fry stocked in the tambak were brought in by the rising tide. A process of intensification took place where wild fry were captured and stocked at controlled rates. Water management was improved and production maximized with available water and seed stock resources.

During the past several decades, more intensive culture technology has evolved in the Philippines, Taiwan, and Latin America. However, due to the very weak economic position of Indonesian tambak farmers, they have been unable to bear the costs of needed improvements and additional inputs. At the same time, advances in other countries have drawn attention to the enormous potential of existing tambaks, if some way could be found to bring additional inputs to the tambak farmer. The trawler ban and resulting decline in earnings from shrimp exports has further increased both private sector and government investment in shrimp culture in an attempt to increase production from tambaks.

A glance at the areal extent of tambaks and present production levels of milkfish (bandeng) and shrimp (udang) quickly reinforces the impression of latent potential. Total tambak area in Indonesia is 209,000 ha, with 27,000 in Sumatera (mostly Aceh), 110,500 in Java and 66,300 in Sulawesi (predominantly South Sulawesi). Average yields of milkfish and shrimp by region are shown in Table 43.

There appears to be a growing processing industry producing smoked bandeng ikan presto and pindang, a salt processed fish. Canning may have potential for expanded domestic and even export sales. A few preliminary trials in this area are being undertaken by private processors.

Increasing production would depend upon improved fry supplies, tambak irrigation, and improvements in tambak construction that would allow continuous culture and the introduction of supplementary feeding.

TABLE 43: Yields of Milkfish and Tiger Prawns in kg/ha/year by Region

Region	Milkfish	Tiger Prawn
Sumatera Utara	384	40
West Java	205	14
Java Tengah	326	13
Java Timur	320	40
Sulawesi Selatan	380	75

SOURCE: ADB Brackishwater Aquaculture Sector Analysis

Tiger Prawn - Udang Windu (Penaeus Monodon)

Of the species now being cultured in Indonesia, tiger prawns probably have the greatest potential for increasing the earnings of tambak farmers, improving export earnings and increasing private sector involvement in aquaculture. Although new tambaks are being developed, the ecological consequences of such radical alteration of the coastal ecosystem can be avoided by concentrating on increasing production from existing tambaks, which will require increased supplies of shrimp fry, improved tambak irrigation, better pond management and more sanitary product handling.

There has been a strong response to the government's emphasis on improving shrimp production for export. This is reflected in the construction of 37 new private shrimp hatcheries in the last 18 months and increased demand for fry on the part of tambak farmers. Nuclear estates, financed by private capital, are being promoted in West Java and Sumatera, and there is rapid development of new tambaks on the west coast of the Bay of Bone, South Sulawesi, Jailolo, Halmahera and even the Aru Islands.

The potential for increasing production can be appreciated if maximum yields of these products obtained in other areas are considered, provided that adequate water, fry, fields and fertilizers are available. Tambaks in the Philippines yield up to 1,500 kg of milkfish, while up to 2,000 kg are produced per hectare in Taiwan. Intensive culture of tiger prawns in these countries produces 8 to 12 tons per year under continuous cropping.

Milkfish - Bandeng (Chanos Chanos)

Bandeng production totalled 73,300 tons in 1982, compared to 61,000 tons in 1981. However, in some areas, stagnating prices (unit value increased only 1.5% over this period, not enough to keep pace with the inflation of input costs) are affecting farmers' capacity to purchase additional fry, fertilizer and pesticides required for increased production. Unless demand can be stimulated by increasing per capita consumption or expanding the market for bandeng, there will continue to be no incentive for increasing production.

Milkfish culture depends entirely on wild fry (nener). Although localized shortages may occur from time to time, there are unexploited fry resources outside the major tambak areas. Further improvements in fry supply could be realized by improving fry handling and transport methods.

White Shrimp - Udang Putih, Udang Jari (P. Merguensis, P. Indicus Longirostris)

The majority of tambak shrimp production consists of species other than tiger prawns. According to 1982 statistics, out of a total harvest of 30,600 tons, 21,800 tons (71%) were white shrimp or other species.

In contrast to tiger prawn, fry of white shrimp are often very abundant and are therefore the basis of traditional tambak shrimp culture. Unlike tiger prawns, white shrimp do not survive well in the tambak environment after about three months of age and must be harvested before that. White shrimp grow to 25 cm within three months, which is an adequate market size. With proper management, two crops per year are possible. Improved management, including predator control, water management and tambak improvements, is the prerequisite for increasing white shrimp yield from traditional ponds. While it is possible to stock tambaks with hatchery produced seed, there is little incentive to do so at the present time. As tiger prawn culture spreads, interest may increase in controlled stocking of white shrimp fry. The potential for shrimp polyculture should be investigated.

Other Marine Species

Mollusc and seaweed farming is undeveloped in Indonesia. The external demand for certain species of seaweed has led to the development of several seaweed farms, but a much larger potential exists than is currently utilized. There has been almost no research on the development of seaweed farming for domestic consumption.

From an environmental viewpoint, enormous potential exists for the development of mussel, clam and oyster farming. Lack of any readily identifiable domestic market will probably hinder the commercial development of mollusc culture for some years to come. Little is known of natural seed resources and good growing areas have yet to be identified. In the case of oysters, species and their distribution are poorly known.

Marine fish farming, particularly of herbivorous fish, such as the siganids and scats, could be developed in areas where coral reefs have been heavily damaged by dynamiting. There is a mariculture project at Serang, West Java funded by the Japanese government, but considerably greater effort will be needed in this area, particularly for product development and marketing.

6.1.3 Selected Commodity Groups or Species

Section 6.1.2 indicated the diverse character of aquaculture in Indonesia. The production of almost all of the species discussed above is expanding to some extent. Many of the freshwater fishes are cultured with very simple technology, well developed over many decades. These (gourami, tawes, lele) existing facilities, both public and private, appear adequate to meet the demands of the present rate of expansion. It is not likely that outside assistance could have much impact on the improvement or dissemination of the existing technology for them.

Three commodity groups or species were selected as having potential for further study. The criteria used to select these groups or species are listed under each.

1) Carp (Cyprinus Carpio) and catfish (Pangasius Pangasius)

- culture technology is adaptable to small scale production and can be expanded over a wide geographic area,
- local market demand is strong,
- physical inputs are all locally available,
- bottlenecks exist in development, and
- existing programs should be expanded.

2) Penaeid Shrimp

- the GOI has placed strong emphasis on increasing shrimp production, particularly Peneus monodon, from existing tambaks; the shortage of fry to stock tambaks at higher levels is the principal input shortage,
- the export earning potential of the end product is substantial,
- technology currently used by both private and public producers is inappropriate and inefficient,
- large numbers of small scale producers of the end product require increased input of fry as an essential element in increasing productivity, and
- shrimp fry production can be used as a mechanism for strengthening producer groups and stimulating small enterprise development.

3) Freshwater Prawn

- Polyculture with tawes and carp can be developed over wide areas of Java, increasing the incomes of very small scale farmers and production systems can be based around farmers' groups,
- while steps have been taken toward improving fry production, poorly developed markets have restrained the expansion of prawn culture,
- existing government hatcheries are overproducing due to the slow development of culture; this surplus fry production can supply the essential input for increasing pond production,

- as production expands, opportunities for small business involvement in hatchery development will arise, and

- physical inputs are locally available.

6.2 Aquaculture Development Alternatives

A rational framework for project implementation could be developed within a geographical perspective. In the case of shrimp fry production and freshwater prawns, several alternatives are suggested to provide as wide a range of choices as possible. Three projects are suggested for consideration as individually viable alternatives. These projects, which are discussed in Section 6.3, are as follows:

- Freshwater aquaculture development - Sumatera.

- Small scale penaeid hatchery development and tambak intensification - East and Central Java/South Sulawesi.

- Freshwater prawn production and marketing - Central Java (Yogyakarta) and South Sumatera.

The remainder of this section discusses freshwater aquaculture development in Sumatera; the market potential, technology, and constraints to the development of four types of cultures (rice-cum-fish), river cage, freshwater prawns, and artemia); and penaeid shrimp hatcheries and tambak intensification.

6.2.1 Sumateran Freshwater Aquaculture Development

The freshwater resources of the northeast coast of Sumatera, particularly the provinces of North Sumatera, Riau, Jambi and South Sumatera, include the waters held periodically in the sawahs of North Sumatera, Lake Toba and the extensive river systems of the other provinces. A diversification of species is required to implement a freshwater aquaculture development project with the widest possible impact. Consequently, recommended project components include the following:

- Intensification and expansion of rice-cum-fish culture in North Sumatera.

- Limnological and fisheries studies on Lake Toba to assess the potential for and effectiveness of restocking.

- The development of integrated catfish cage culture in the river systems of Riau, Jambi and South Sumatera provinces.

6.2.1.1 Fish Demand and Production in North Sumatera

While fish production in North Sumatera is currently dominated by marine fisheries, there is a strong demand for increased fish production from freshwater fish culture. Table 44 shows that from 1978-1982, total fish production in North Sumatera decreased 12% from 164,500 to 144,400 mt. However, between 1978 and 1982, consumption increased from approximately 148,800 to 156,500 mt (Table 45), suggesting a turnaround in "trade" in North Sumatera from a net outflow of 15,700 mt to a net inflow of 12,100 mt. It is generally felt that because increased catch from marine fisheries and increased production from open water fisheries is unlikely, a demand exists for increased cultured fish production.

Table 46 shows this demand, based upon projected population increases of 2.5% per year, a government per capita fish consumption target of 18.6 kg per year, and sustained marine and open water fishery production of 140,000 mt/year. The total projected demand for fish culture in North Sumatera, therefore, will grow from 167,770 mt in 1983 to 199,430 mt in 1990. In 1982, there were approximately 5,600 mt of fish produced through fish culture in North Sumatera, of which about 5,200 mt were from freshwater fish culture. These figures suggest that there will be a strong demand and need to increase the production of fish from aquaculture in North Sumatera in the years ahead.

This conclusion is further supported by several factors: first, government programs have actively campaigned to increase public awareness of the importance of fish for human nutrition. Second, along with an increasing population, income per capita in the region is also going up. It is projected that per capita income in North Sumatera will rise from Rp. 235,030/yr in 1980, to over Rp. 600,000/yr by 1985. Third, because the price of meat is about the same as that for fish, it is expected that fish will compete effectively with meat as a source of protein for human consumption.

Market channels for the distribution of freshwater fish in North Sumatera are well established and in general appear to be able to support the distribution and marketing of increased fish production with only small amounts of increased investment. What follows is a general description of the market, market chain and fish prices.

Most of the freshwater fish culture in North Sumatera is based on common carp (ikan mas) production (nearly 87%), which is a "food" crop with ceremonial value. There are a number of different market channels for common carp distribution, but all involve, to various degrees, the farmer, a "collector," wholesalers, retailers and consumers. Table 47 shows these channels. In general, the greater the physical distance between producer and consumer, the more collectors/middlemen are required. For instance, catfish produced in Aceh province and marketed in Medan may go through as many as five steps between producer and consumer.

TABLE 44: Fish Production in North Sumatera (mt)

Year	Marine Fisheries	Open Water Fisheries	Fish Culture	Total
1978	142,500	17,900	4,100	164,500
1979	135,400	9,200	5,700	150,300
1980	148,300	7,200	6,500	162,000
1981	126,900	5,500	6,900	139,300
1982	134,300	4,500	5,600	144,400

TABLE 45: Fish Consumption in North Sumatera

Year	Population	Metric Tons Consumed	kg per Capita
1964	6,984,000	77,937	12.8
1973	6,920,330	122,196	17.2
1977	7,952,000	148,349	18.6
1980	8,360,000	149,320	17.8
1981	8,577,000	140,800	16.4
1982	8,800,000	156,490	17.7

TABLE 46: Projected Demand for Fish Culture in North Sumatera

Year	Projected Population (million)	Govt. Target for Consumption Per Capita (Kg)	Demand (100 mt)	Marine Production (Est. 1000 mt)	Open Water Fish Prod. (Est. 1000 mt)	Shortage (1000 mt)
1982	8.8	17.7	155.76	134.3	4.5	16.96
1983	9.02	18.6	167.77	135.0	5.0	27.7
1984	9.25	18.6	171.97	135.0	5.0	31.97
1985	9.48	18.6	176.27	135.0	5.0	36.27
1986	9.72	18.6	180.67	135.0	5.0	40.67
1987	9.96	18.6	185.19	135.0	5.0	45.19
1988	10.21	18.6	189.82	135.0	5.0	49.82
1989	10.46	18.6	194.56	135.0	5.0	54.56
1990	10.73	18.6	199.43	135.0	5.0	59.43

It is worth noting that because carp is sold to consumers live, it requires facilities for holding live fish at all steps of the market chain. Because of this requirement for holding facilities, it is possible that in time of low demand, fish can be held before moving them through the market chain. This brings them to market at the time when prices are highest. Therefore, while carp requires special marketing facilities, those facilities are such that they also generate an opportunity to hold and then market fish during the non-peak fishing season.

Generally, for common carp, there is a price mark-up of around Rp. 100-200/kg at each stage. In addition, the price for carp to consumers varies depending on the season and day of the week. At present, carp sells at retail markets for Rp. 2,000-2,600/kilo on weekdays and Rp. 3,200-3,500/kilo on weekends due to the ceremonial value of the fish on the weekend. Table 48 illustrates various fish prices to consumers and producers during selected months in 1984. The mark-up for carp tends to support the assertions that at each marketing stage, there is about a Rp. 100-200 mark-up. Table 49 is a snapshot of prices in Medan in November, 1984.

These prices figures show that carp is generally very competitive with beef and goat, and less competitive with marine fish. However, due to its ceremonial value and the seasonal availability of marine fish, carp demand is strong. Other freshwater fish, particularly catfish, are very competitive with meat and chicken, and also with marine fish. As demand increases, and assuming that marine fish production stays relatively constant, it is likely that the competitiveness of freshwater fish will increase.

While prices vary with a variety of factors (marine fish availability, seasonal production, number of holdings, etc.), the market channel shown in Table 50 is indicative of the mark-ups for carp in North Sumatera. The end price (in Table 50) of Rp. 2,500/kilo is for carp of size four tails/kilo and the consumer's price is Rp. 3,500/kilo. These margins and mark-ups are relatively small and indicate that increased "marketing" costs would only be possible if consumers can absorb increased costs or if supply increased enough to lower the price.

In 1981, it was estimated that there were 32 collector agents, 17 wholesalers and 74 retailers operating in North Sumatera, although some of these figures overlap because individuals may perform more than one function. In addition, some of these marketers are working at more than one job. While is very difficult to obtain marketing costs from various wholesalers and retailers, however, some general estimates can be made.

TABLE 47: Market Channels for Carp

Producer	Producer	Producer	Producer
Collector at Pond	Collector at Pond	Collector	Producer Groups
Collector at Market			
		Retailers	Wholesaler
Wholesalers	Wholesaler		Retailer
Retailers	Retailer	Consumer	Consumer
Consumer	Consumer		

TABLE 48: Price Data in Nelayan (Medan)

	Feb. 84		March 84		Oct. 84		Nov. 84
Marine fish, fresh	(1)	(2)	(1)	(2)	(1)	(2)	(2)
Tuna	500	1,000	550	1,000	550	1,000	1,000
Spanish Mackerel	750	1,200	750	1,300	800	1,500	
Grouper	800	1,500	800	1,500	-	-	
Rastrelliger	500	1,000	500	1,100	500	1,000	800
Sea Bass	800	1,500	800	1,500	-	-	1,300
Sakes	400	800	350	800	-	-	
Crebs	300	600	300	700	-	-	
Mackerel	300	600	300	600	-	-	
	350	750	350	750			
Salted Fish							
Slipmouth	450	600	450	700	-	-	
Mackerel	350	800	400	1,000	-	-	
Rastrelliger	750	1,200	750	1,300	-	-	
Freshwater Fish							
Carp	1,800	2,300	1,800	2,350	2,000	2,800	2500-3000
Walking Catfish	750	1,500	800	1,700	1,250	1,800	1,500
Corned							
Mackerel	1,400	1,500	1,400	1,500	-	-	
Sardine	1,200	1,400	1,200	1,400			
Others							
Red Meat	3,500	3,750	3,500	4,000	3,500	3,750	3,600

(1) Price to Farmer
(2) Price to Consumer

TABLE 49: Medan Pasar Central 11/6/84

Fish Name	Price	Characteristics	From
Carp	Rp. 3,500/kilo	1 tail/kilo	Pematang Siantar
Carp	Rp. 3,000/kilo	2 tails/kilo	Pematang Siantar
Carp	Rp. 2,600/kilo	3 tails/kilo	
Carp	Rp. 2,500/kilo	4 tails/kilo	
Sea Bass Kakap	Rp. 1,300/kilo		Marine
Milkfish	Rp. 1,000/kilo		Aceh
Tilapia	Rp. 1,000/kilo		Tambaks
Kembung (Rastrelliger)	Rp. 800/kilo		Marine
Tongkol (Tuna)	Rp. 1,000/kilo		Marine
Savid	Rp. 1,300/kilo		Marine
Catfish	Rp. 1,500/kilo		Marine
Mudfish	Rp. 2,000/kilo		Marine
Small Shrimp	Rp. 2,300/kilo		Marine
Meat/Beef	Rp. 2,600/kilo		-
Village Chicken	Rp. 2,000/kilo		-
Bred Chicken	Rp. 1,250/kilo		-
Goat	Rp. 2,800/kilo		-

TABLE 50: Example Marketing Margins for Pematang Siantar to Medan (11/84)

	Priced Received	Margin	% Mark-up
Producer	2,000/kg		
Producers' Group	2,100/kg	Rp.100	5
Agent Price			
Wholesaler	2,300/kg	Rp.200	9.8
Retailer	2,500/kg	Rp.200	8.7

During interviews, the team found the following:

<u>Marketing Costs to Medan from Simalungung</u>

Transport	Rp. 10,000/ton (Rp. 10/kilo)
Ice	10 blocks ice/ton (Rp. 24/kilo)
Handling/Overhead	Rp. 24,000/ton (Rp. 24/kilo)
TOTAL COST	Rp. 58,000/ton (Rp. 58/kg)

If one assumes an average marketing cost of Rp. 60/kg and an average wholesale mark-up of Rp. 200/kg, then the wholesalers clear Rp. 140/kg. If they market one ton of fish per month, this produces an average annual income of Rp. 1,680,000. Without knowing the exact costs for retailers, it is safe to say that their average income would not likely exceed this figure. If one assumes that an average family requires Rp. 200,000/month (2,400,000/yr) for a minimum living standard, then the "middlemen" are not left with anything to invest. This suggests that while market channels exist, investment in increased capacity may be required to handle increased production, and that credit may have to be made available to make that investment.

There are various other types of fish culture in North Sumatera, including the marketing of Tilapia Nilotica from newly developed tambaks. The market channels for Tilapia Nilotica follow the same general pattern as that of carp. However, one difference is that the group to which farmers belong appoints one of its members to act as a collector and to sell to the wholesaler. Table 51 shows the mark-ups and margins for this cultured fish. In comparison with carp culture mark-ups, this suggests that when a strong farmer group exists, such as that dealing in tilapia culture, the group itself retains the greater part of the overall mark-up.

TABLE 51: Marketing Margins for Tambak Tilapia Nilotica (11/84)

	Price Received	Margin	% Mark-up
Producer	700 Rp./kilo		
Producer Group's Agent	850 Rp./kilo	150 Rp.	21
Wholesaler	950 Rp./kilo	100 Rp.	12
Retailer	1,000 Rp./kilo	50 Rp.	5.3

The above analysis shows that there will be an increasing demand for fish culture in North Sumatera. Existing channels for marketing that fish are in place and there do not appear to be any "abuses" of the marketing system such as those that are seen in the marine fisheries sector. However, with increased production will come an increased volume of fish which must be moved through market channels and, as such, collectors and wholesalers may have to increase their facilities to accomodate that increased volume. This may mean some increased ice availability, more storage facilities for live carp, investment in trucks, and more intense marketing efforts directed at still developing markets.

6.2.1.2 Fish Marketing in South Sumatera: Demand, Production and Marketing

The population of South Sumatera is currently estimated to be about 4,647,000, with expected growth to nearly 6,300,000 by 1990. At present, the provincial Dinas Perikanan estimates that South Sumaterans consume an average of 17.7 kg of fish per year, slightly below the national target of 18.6 kg. Table 52 predicts the increase in total demand for fish in South Sumatera based solely on population projections and without consideration for rising income. If increasing income is considered, then the demand for fish would rise even faster (data on per capita income in South Sumatera were not available in statistical yearbooks).

TABLE 52: Population and Fish Demand in South Sumatera

	Population	Consumption/Capita	Demand (tons)
1981	4,647,000	17.7 kg	82,252
1982	4,944,300	17.7 kg	87,514
1985	5,423,000	18.6 kg	100,869
1990	6,285,000	18.6 kg	116,901

Demand and Supply a/ (tons)

	Demand	Total Production	Marine	Inland	Culture
1981	82,252	94,957	56,456	38,501	1,166
1982	87,514	99,766	62,471	35,592	1,303
1985	100,867	101,500	65,000	35,000	1,500

a/ Assumes marine production will level off at 65,000 tons/year and that open water fishery production will level off at 35,000 tons/year.

Table 52 also suggests that if open water fishery production (which is currently decreasing annually) levels off at 35,000 tons/yr (this is unlikely because it will probably continue to decrease) and that marine fishery production can be sustained at a level of 65,000 tons/yr (again, an optimistic estimate given current reports that catch-per-unit-effort is decreasing in the area), then a local shortage of fish is likely to develop in the near term. In particular, the demand for freshwater species such as catfish will be very strong. This is also supported by the relatively high price for catfish in local markets (Rp. 3,000 - 4,000/kilo). Based in part on these figures and serious concerns expressed by the Dinas Perikanan that production from marine and open water fisheries had perhaps reached its peak, it seems that the demand for freshwater fish culture will grow.

Current production from freshwater fish and river cage culture in South Sumatera is quite low -- about 1,300 tons/yr. However, the potential for this type of farming in South Sumatera is quite high due to the tremendous number of rivers and streams in the area. South Sumatera alone has over 80,000 sq km of river catchment areas, and Riau and Jambi together add another 80,000 sq km. The potential for fish production from river cage culture is, therefore, enormous.

Because there is so little current freshwater fish culture production, marketing channels have simply not yet developed. As such, any project in this area will require, as a component, the development of marketing channels. If, as envisioned, river cage culture is developed on a small scale basis, one could imagine the development of small "farmer" groups who would join together for fish marketing purposes. They might appoint a collector to take their product to wholesalers, or collectors might develop who would act as agents between the farmer and wholesaler. These marketing channels have developed for open water fisheries in South Sumatera and there is no reason to think that they wouldn't develop around freshwater fish cage culture.

The increased production of carp and other freshwater species will also create increased demand all along the production chain, including the demand for brook stock, fry and fingerlings. All along the production chain, as well as the market chain, increased demand will increase market opportunities. The team calculated that the demand for carp fry in North Sumatera alone could reach 154 million fry and that the demand for carp fingerlings could reach 90 million fry. At a price of Rp. 3/fry and at a price of Rp. 10/piece for 3-5 cm fingerlings, Rp. 20/piece for 5-8 cm fingerlings and Rp. 30/piece for 8-12 cm fingerlings, markets on the order of Rp. 450 million for fry and Rp. 2,000 million for fingerlings could develop.

6.2.2 Rice-Cum-Fish Culture

6.2.2.1 Production and Potential

Rice-cum-fish culture in North Sumatera requires the integration of three operations: hatchery fry production (*Pembenihan*), fingerling culture (*mina padi*), and growout to market size in an intercropping system (*palawija ikan*).

In 1983, the 27 government hatcheries in North Sumatera, with a total area of 25.6 hectares, produced 12 million fry. Private hatcheries had a total area of 181 ha and turned out over 69 million fry during the same period. Production per ha was 382,000 in the private sector and 470,000 at government hatcheries. The total value of fry production was about Rp. 203 million. The concentration of private hatcheries in two *kabupatens* (districts) is apparent from Table 53. Also of note is the great variation in productivity.

There are no data available on the production, area and number of farmers involved in the nursery phase of rice-cum-fish culture. There would be considerable overlap with figures for palawija carp culture, since many farmers carry out both activities. Figure 2 shows 1979-1983 trends in production, area under culture and production in tons/ha. The sudden drop in the area under culture resulted from the introduction of government policy regarding double cropping of rice in Simalungan District. It is also noteworthy that productivity remained almost constant during Repelita III.

Carp are also cultured in ponds in North Sumatera and production trends from 1979-1983 are depicted in Figure 3. Productivity decreased in 1983, probably due to a shortage of fry and fingerlings.

The concentration of both ponds and palawija fishculture is partly related to rainfall and irrigation development, and if the potential area for palawija is compared to the present situation (Table 54 and 55),there is considerable scope for expansion into other districts, particularly Tapanula Selatan and Dairi. At the present time, about 27,000 people are directly involved in sawah carp culture in North Sumatera, or 75% of all such farmers in Sumatera. Targets for expansion of rice-cum-fish culture during Repelita IV are extremely modest, amounting to only 3% of the total potential area (Table 55).

A shown earlier, based on a government consuption target of 18.6 kg per capita per year and estimated trends in marine and freshwater capture fisheries, the present estimated shortage at 27,700 tons will increase to about 45,000 tons by the end of Repelita IV. If the targeted expansion of 2,800 hectares is reached, fresh fish supplies would be increased by 1,271 tons. This would represent an increase of 37% over 1983 production from sawah carp culture, but would make only small progress toward meeting local demands.

TABLE 53: Private Hatcheries in North Sumatera by District, 1983

District	Total Area(ha)	Fry Production	Production/ ha
Langkat	15.2	962,800	63,340
Deli Serdang	12.5	755,000	60,400
Asahan	1.2	80,000	66,670
Labuhan Batu	3	300,000	100,000
Tanah Karo	7.5	780,000	104,000
Dairi	7	2,000,000	285,740
Simalungan	54	35,000,000	648,150
Tapanuli Utara	50.5	28,827,000	570,830
Tapanuli Tengah	0	-	-
Tapanuli Selatan	30	450,000	15,000
Nias	0	-	-
TOTAL	180.9	69,155,000	382,280

SOURCE: Dinas Perikanan
Sumatera Utara

FIG: 2 PALAWI JA CARP PRODUCTION TRENDS
1979 – 1983
SUMATRA UTARA

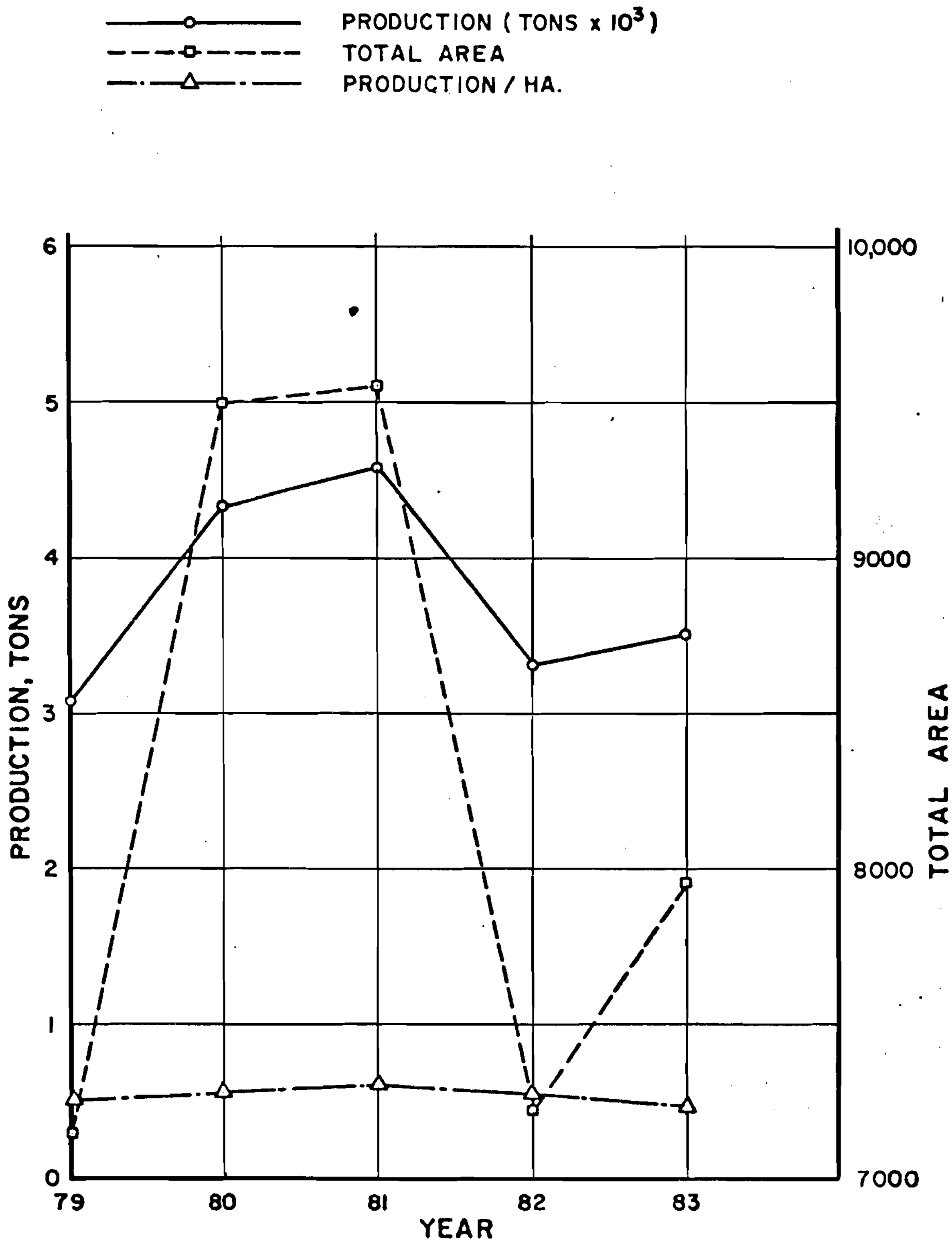
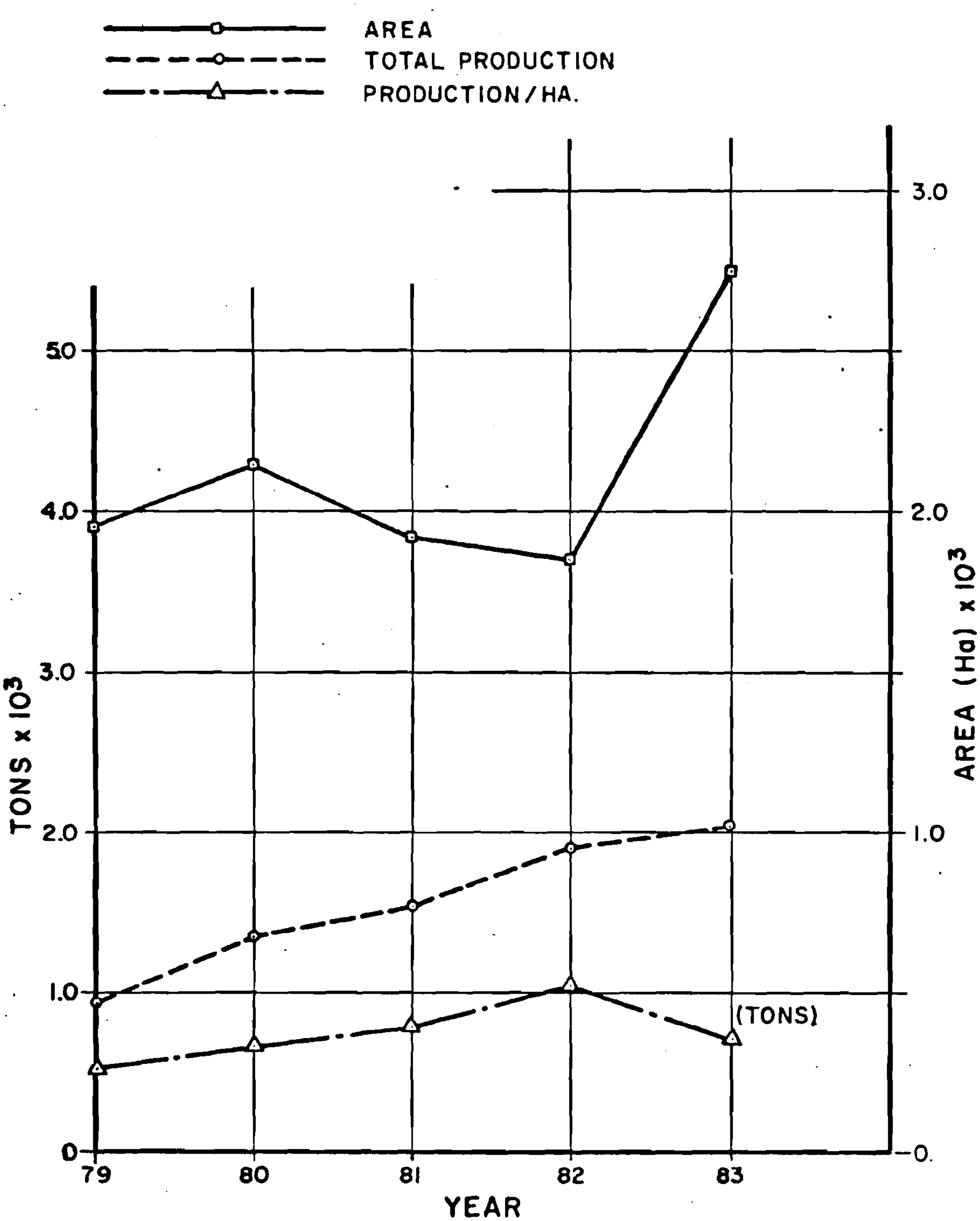


FIG: 3 SUMATRA UTARA
POND CARP CULTURE PRODUCTION
TRENDS, 1979 - 1983



Fry production by private hatcheries will have to be increased from the 69.2 million produced in 1983 to 154 million. The existing productivity of 356,000 fry per ha must be raised to about 778,000. Brood stock productions must also be improved if fry production in the private hatcheries is to reach target levels. These hatcheries will require an annual supply of 6,300 kilos.

6.2.2.2 Biotechnology - Status and Constraints

Three distinct operations are involved in rice-cum-fish farming; (1) carp or nila fry are supplied by hatcheries, (2) to farmers who rear the fry to fingerling size, (3) and rearing to market size.

Carp hatcheries in North Sumatera are of the traditional type developed in Java and are well suited to operation by small producers. Intensive carp hatcheries, such as those found at the Ambarita station on Lake Toba, are much more efficient in terms of space and cost per fry. However, they require large capital investments and sophisticated management. Furthermore, existing capacity in the province is considered to be sufficient to meet the increase in fry demand contemplated under Repelita IV.

Constraints on improving the productivity of existing hatcheries are as follows:

1. Quality brood stock is in limited supply, which results in declining egg production and fry viability.

2. Existing brood and fry ponds cannot be operated at full capacity due to the limited supply of quality brood stock.

3. Fry pond management, mainly feeding, water supply and fertilizing, has to be improved to increase fry survival.

Fry from hatcheries are stocked in paddy fields about two weeks after rice has been planted and are harvested as fingelings when the paddies are drained. These fingerlings may be sold to other farmers for rearing to larger fingerlings or to market size. The marketing of fingerlings is quite complex and the products move all over North Sumatera, the movement being related to differences in rice planting cycles between different districts.

The spread of rice-cum-fish culture is hindered by some institutional as well as technical factors:

1. Extension facilities, particularly demonstration plots, are very limited. More agents need to be trained.

TABLE 54: Distribution of Freshwater Ponds and "Palawija" System Sawah in 1983, in Hectares and Percent of Total, by Province

District	Ponds (ha)	%	Palawija (ha)	%
Langkat	114	4		
Deli Serdang	336	12	600	6
Asahan	120	4		
Labuhan Batu	80	3		
Karo	160	6		
Dairi	127	5	260	3
Simalungun	596	22	5,100	53
Tapanuli Utara	393	14	3,599	38
Tapanuli Tengah	164	6		
Tapanuli Selatan	630	23		
Nias	33	1		
TOTAL	2,753	99.0	9,559	100

SOURCE: Dinas Perikanan, Dati I Sumatera Utara

TABLE 55: Potential Area for Expansion of Pond and Sawah Carp Culture and Targets under REPELITA IV by District, Sumatera Utara

	PONDS			PALAWIJA		
District	Potential(ha)	Repelita IV(ha)	% Potential	Potential(ha)	Repelita IV(ha)	% Potential
Langkat	189	25	13	6,291		
Deli Serdang	405	235	58	600		
Asahan	1,464	42	3	1,464		
Labuhan Batu	10	63	63	–		
Karo	36	65	18	4,344		
Dairi	127	127	100	8,724		
Simalungan	80	596	75	12,620	2,000	16
Tapanuli Utara	6,551	357	5	51,415	600	1
Tapanuli Tengah	170	30	17	–		
Tapanuli Selatan	3,000	400	13	11,000	203	2
Nias	40	13	33	–		
TOTAL	13,206	1,953	15	96,458	2,803	3

SOURCE: Dinas Perikanan Propinsi Dati I, Sumatera Utara.

2. Credit facilities may be inadequate to enable interested farmers to acquire inputs.

3. Government policy (Pola tertib tanah) on rice culture in Simalungan Province changed the traditional intercropping system and caused a decline in rice-cum-fish culture. However, techniques have been developed to overcome this constraint. Applied research followed by extension through demonstration will be required.

4. High mortality affects the mina padi stage (culturing) in fingerling production. Research on disease, nutrition and management is required to pin-point the causes of early mortality.

5. Extension efforts need to be intensified in the area of pesticide use to ensure the use of chemicals that are compatible with fish rearing. Coordination with irrigation authorities is required to ensure adequate water supply to sawahs. Holding pens in irrigation canals or minor diversions could also be used to hold fingerlings, which would also require the cooperation of those departments concerned with irrigation allotments.

6.2.2.3 Costs and Earnings for a Typical Enterprise

Sawah in North Sumatera fall into three size categories: 500 m2, 1000 m2 and 1500 m2. One thousand square meters was chosen as an example, in part due to the availability of data. Estimates of costs and earnings are given for fingerling rearing using improved methods, mina padi, and intercrop culture of fingerlings to market size palawija ikan (Tables 56 and 57). Both operations can be done by the same farmer and because stocking rates are lower, surplus fingerlings can be sold either for further rearing to 8-12 cms or to other palawija farmers. Mina padi can substantially improve farmers' income, while the returns for palawija fish culture are excellent compared to other intercrop alternatives.

The systems described above also lend themselves to the culture of other herbivorous fish, particularly nila (Serathrodon nilotica). At the present time, however, ikan mas dominates the fresh fish market and because its position is so strong, project success is most likely if efforts are directed at expanding its production.

6.2.3 River Cage Culture

This form of aquaculture is still poorly developed. In Sumatera, production is limited to Jambi and Bengkulu Provinces and totaled only 139 tons, consisting of common carp, talapia and nial. Common carp make up 57% of total production. According to national statistics, as of 1982 there was no cage culture in Sumatera Selatan and Riau.

TABLE 56: Cost and Earnings for 1,000m^2 Sawah. Mina Padi, Per Crop, Fish Cultured for 2.5-3 Months.

Costs (Rp.)	Mina Padi	Rice Only
Rice culture inputs (seeds, a/ fertilizer, labor, pesticide)	20,000	20,000
Fry, 5,000 b/	15,000	
Feed	16,000	------
Sub Total	51,000	20,000
Revenue:		
Rice	100,000	100,000
Fingerlingsc/	62,500	-------
Sub Total	162,500	100,000
Income	111,000	80,000

% increase in income: 39
Benefit/Cost: 2.2

al/ Costs of rice production were estimated at 20% of production.
SOURCE: Agricultural Census 1979, Bureau of Statistics.

2/ Fry are stocked at 5/m^2.

3/ Production consists of mixed sizes 5-8 cms and 8-12 cms. Prices are Rp. 20 per fish and Rp. 30, respectively. An average price of Rp. 25 was used to estimate revenue from fingerlings. Fifty percent mortality is assumed.

SOURCE: Dinas Perikanan, Simalungan, Sumatera Utara

TABLE 57: Palawija Carp Culture, Rearing Period of 2 Months, Stocking 8-12 cm Fingerlings and Stocking Density of 4,000 Fish/Ha. Example for a 1,000 m2 Sawah

Costs (Rp.)	
Fingerlings 8-12 cm	12,000
Production	56 kg
Revenue a/	112,000
Income	100,000
Benefit/Cost:	8.3

a/ Product is carp of 3-5 per kilo selling at Rp. 2,000/kilo. Survival is 80-90%.

SOURCE: Dr. De La Cruz, USAID.

6.2.3.1 Biotechnology

Pangasius pangasius belongs to the catfish family. It is highly adaptable to cage culture, being tolerant of crowding. Pangasius is an efficient food converter and can be fed a variety of agricultural wastes, including rice bran, peanut cake, waste from the manufacture of soy sauce, silage, etc. The larvae are easy to rear, although hormone injection is required to induce spawning. The technology of Pangasius cage culture is well-developed in Thailand, so that a Pangasius project would deal with the transfer of culturing methods from Thailand to the particular environmental, social and economic conditions of Indonesia.

An integrated culture system involves hatchery fry production coupled with cage grow out. Brood stock are maintained in cages, either by the hatchery or are obtained from farmers. However, a hatchery is a centralized facility and, while not overly complex, is probably beyond the capabilities of most fish farmers to operate.

Initial development of cage culture would, therefore, be stimulated by fry supplied by a public hatchery. But if properly constructed and operated, it could serve as a model and training center for private hatchery development, either through entrepreneurs, cooperatives, or perhaps farmers' associations.

The growout phase is very suitable for small scale production because the basic unit is one 7.2 m3 cage constructed from locally available materials.

6.2.3.2 Costs and Earnings

Cash flows for a typical hatchery and cage unit are shown in Tables 58 and 59. Both show high rates of return on investment, indicating economic viability. If the producer price dropped by 60%, the IRR for cage culture would still be over 120%.

6.2.3.3 Constraints

Constraints to the development of Pangasius cage culture relate to its being a new activity. These constraints might be broadly categorized as technical, institutional and manpower.

1. <u>Technical constraints</u>

   Adequate numbers of fry must be available to supply demonstration and training centers to interested farmers. This will require the establishment of a moderate sized hatchery in each major project area and the simultaneous development of brood stock.

2. Institutional constraints
The lead agency for development would be the provincial Dinas Perikanan (Fisheries Service) which at present lacks adequate facilities. Although a field station exists at Palembang, it would require upgrading.

A demonstration and training program would have to be organized and budgetary allocations accordingly increased. Appropriate programs would have to be developed in credit institutions that normally supply funds to small producers.

3. Manpower constraints
Because a new aquaculture activity is being contemplated, there would be a severe shortage of qualified extension agents, university staff and scientists available to help develop cage culture. The development of a staff with "hands on" experience would have to be a high priority.

Aside from the constraints listed above, Pangasius culture shows several advantages. First, market demand for catfish is strong, particularly in the face of declining capture fisheries. Second, marketing would present no obstacle to the development of catfish cage culture. Third, the interference of cages with navigation should pose no problem because the lower rivers of the provinces suggested for project implementation are broad, often over one kilometer wide and cages would be operated along the river banks.

6.2.4 Freshwater Prawn Culture

The development of freshwater prawn culture is in its infancy in Indonesia and is facing constraints, primarily in marketing. The first prerequisite for prawn farming in Indonesia was the establishment of hatcheries to supply juveniles for stocking ponds because they are rarely available in nature. Hatcheries were initially established by the Indonesian government and several were subsequently improved. In fact, there is now excess production from government hatcheries due to lack of farmer interest.

There are interesting possibilities for polyculture using freshwater prawn and tawes, which is a low priced fish. The extensive development of small fish ponds throughout Java offers facilities for spreading prawn culture and improving the income of small farmers. Pond culture could also be integrated into the activities of small farmers' groups, which that seem to be common on Java.

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TABLE 58: Pangasius Cage Culture with Bamboo Cage - Cumulative Cash Flow and IRR during Seven Year Project Period

	YEAR						
Source	1	2	3	4	5	6	7
Fixed Costs							
Cage and Floats	30,000	2,030,000	30,000	2,700,000	30,000	2,700,000	30,000
Variable Costs							
Fingerlings	180,000	180,000	180,000	180,000	180,000	180,000	180,000
Rood	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Labor	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Harvest Cost	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Total Costs	615,000	585,000	615,000	585,000	615,000	585,000	615,000
Revenue	1,350,000	2,030,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Income	735,000	1,445,000	2,085,000	2,115,000	2,085,000	2,115,000	2,085,000
Cumulative	735,000	2,180,000	4,265,000	6,380,000	8,465,000	10,580,000	12,665,000

IRR>100%

1. Estimated production during years 1 and 2 at 50% and 75% capacity. Full capacity is 900 kg/year.
2. Present producer price in Palembang is 3,000Rp./k.
3. Proposed project is a family enterprise. Labor represent opportunity cost.

TABLE 59: Annual Costs and Earnings for a Model Small-scale Pangasius Hatchery, in 1,000 Rp.

Costs	
Fixed a/	
Land	15,000
Hatchery	4,000
Equipment	1,000
Brood stock cages	1,000
Vehicle	10,000
Sub Total	31,000
Operating	
Labor	
Manager	6,000
Technicians	3,600
Utilities	2,400
Feed	100
Chemicals	500
Brood stock	400
Depreciation	5,100
Sub Total	18,100
Revenue	
360,000 fry x Rp. 300	108,000
Tax, 5% of revenue	5,400
Income	84,500

Benefit/cost: 4.7
(Operating/income)

a/ Land and buldings depreciated over 7 year project period. All other equipment over 5 years.

6.2.4.1 Macrobrachium Demand, Production, and Marketing

Macrobrachium rosenbergii or giant freshwater prawn (udang galah) is a relatively new commodity in Indonesia. At present, there is very little production of giant freshwater prawns in Indonesian freshwater ponds, although on the order of 3,400 tons of giant prawns were caught in inland open water fisheries. The potential for culturing is great, as the demand for shrimp for export is extremely high. Shrimp processors are interested in all types of raw material, even a species which is less popular for export than the tiger prawn.

Most buyers, in particular those in the U.S., prefer headless shrimp. The giant freshwater prawn is about 60% head, so a primary market for these prawns is more likely to be in Singapore and Malaysia where "heads-on" shrimp are preferred. It is difficult, however, for major processors to compete with small peddlers in North Sumatera and Aceh for that particular market. In spite of this, the market for giant freshwater prawns is strong in Sumatera, where processors have paid up to Rp. 7,500 /kg. In addition, they have shown up for the first time in United States trade statistics as an import from Indonesia, with a selling price to U.S. consumers of up to $14/kg. This is only marginally less than prices paid for the tiger prawn in the U.S. ($16/kg). It is clear that while a demand pull situation is not occurring for giant freshwater prawns the way it is for tiger prawns, there seem to be excellent possibilities for market development.

Three key market areas could be explored and developed including export markets in Japan, S.E. Asia and the U.S.; a domestic "luxury" market for large population centers such as Jakarta, Surabaya and Medan; and a domestic market for groups such as the military, hospitals, police, etc. It seems that the export market is already developing, as witnessed by the prices processors are willing to pay in Medan and Palembang in North Sumatera.

Production of giant freshwater prawns in ponds is currently very limited and has yet to catch on in many areas. The key reason is that government hatcheries producing fry are located in areas (Central Java and Yogyakarta) where the price for catfish or carp are as high or higher than for fresh water prawns. As such, farmers focus on carp or catfish culture. Where the price for giant prawns is higher than that for carp and catfish, and where fish farmers should be interested in culturing the giant prawn, there are no fry. Table 60 shows this price comparison.

TABLE 60: Comparative Prices, Giant Freshwater Prawns, Catfish and Carp

	N. Sumatera	Java
Giant Freshwater Prawn	6,000-7,000 Rp./kg	2,500-3,000 Rp./kg

Catfish	4,000-5,000 Rp./kg	3,000-4,000 Rp./kg
Carp	4,000-5,000 Rp./kg	2,500 Rp./kg

In Java, as well as in North Sumatera, the possibility of cultivating carp together with giant freshwater prawns is excellent. In Java, it is a matter of convincing farmers that prawns can be more profitable than catfish, because catfish and giant prawns cannot be cultured together. In this way, farmers could produce a food fish (carp, tawes) together with an export fish, and potentially maximize their situation.

There are currently over 650,000 people involved in freshwater pond culture and there are over 54,000 ha of ponds now in Indonesia. Many of these farmers are fish farming only part time and are also engaged in land farming and/or livestock. Many of these farmers are in a position to benefit from the polyculture of carp and giant freshwater prawns.

The development of freshwater prawn hatcheries in Java seems to be working well and producing fry. However, there is not yet enough demand from processors and consumers on Java and, therefore, not enough demand among fish farmers for the fry. As such, the fry are almost literally "rotting" in the hatchery and farmers have little economic incentive to produce giant freshwater prawns.

There is, however, a developing market for the freshwater prawn in North Sumatera, as discussed earlier. The problem is that there are simply no marketing channels developed that would enable shrimp cultured in Java to be sold in North Sumatera. In addition, the channels for distributing fry to pond farmers throughout Java and perhaps to North Sumatera also need to be further developed. The key problem, then, in the development of freshwater prawn culture is the development of market channels and the extension of freshwater prawn culture to fish farmers.

As an example of what can be done, the Dinas Perikanan in Yogyakarta has arranged with a state processing company (P.T. TRM) to buy shrimp and process it for export. In addition, a shrimp "collector" has been established to collect shrimp and sell them to hotels in the Yogyakarta area. These programs may provide a basis for further marketing efforts. At the same time, the Dinas Perikanan is supporting extension programs to introduce freshwater shrimp to pond farmers by providing fry free of charge for one year. Finally, the Dinas is supporting hatchery development. As such, development work is being done at a minimum level at all stages of the production and marketing chain. Building on (or up) this activity will be an excellent way of using what appears to be a strong provincial commitment to freshwater prawns.

6.2.4.2 Biotechnology

Controlled breeding and juvenile production technology is well developed and has been successfully adapted to Indonesia. However, work is needed on the adaptation of culture techniques to the small ponds typical of Java. Excellent results have been obtained by CLUSA in demonstration ponds at Klaten and this type of work should be extended to other provinces. In addition, polyculture systems with tawes need to be worked out and appropriate feeds developed. Private producers are using local waste products, but nothing is known of their cost effectiveness.

Additional hatcheries would not be required during the first phase of project implementation. Existing capacity at the Prigi and Samas hatcheries operated by the DGF would be sufficient to stock approximately 40 ha of double cropped ponds. This would be over 400 ponds of 1,000 m2 average size. Production of prawns from such an extent of pond area could range from 60 to 120 tons per year.

6.2.4.3 Costs and Earnings

Assuming an average ponds size of 1,000 m^2 (lha), costs and earnings per crop have been estimated as shown in Table 61. The return on operating costs is .34. Two crops per year are possible with proper pond management.

A manageable small scale hatchery would produce four to five million juveniles per year and at the present concessionary price of Rp. 8., such a hatchery would be profitable, as shown in Table 62. If the fry price increased to Rp. 20, the hatchery would be even more profitable and the 1,000 m2 pond culture enterprise would remain economically viable.

TABLE 61: Costs and Earnings for 1,000 m^2 Freshwater Prawn Pond, Per Harvest with Six Month Growth Period. Projections are Given for Two Costs of Juveniles

Costs	Rp 8./Juvenile (Rp.)	Rp. 20/Juvenile (Rp.)
Fixed		
Paddle Wheel	30,000	same
Aerator		
Harvest Seine	25,000	same
Miscellaneous		
(Ice box, bukcets, etc.)	50,000	same
Sub Total	105,000	105,000
Operating		
Juveniles [a/]	80,000	200,000
Feed [b/]	420,000	420,000
Labor [c/]	540,000	540,000
Depreciation	24,000	24,000
Sub Total	1,064,000	1,118,000
Revenue		
400 kg x Rp. 3,000/kg	1,200,000	1,200,000
Tax (5% of revenue)	60,000	60,000
Income	76,000	44,000

a/ Juveniles stocked at 10/m^2 with 50% survival, average harvest weight of 80 grams/shrimp.

b/ Feed costs Rp. 350/kilo, conversion ratio of 3:1.

c/ Labor represents opportunity cost.

	Rp. 8/Juv.	Rp.20/Juv.
Benefit/cost: a) with opportunity cost of labor	.07	.05
b) without opportunity cost of labor	1.2	1.0

TABLE 62: Annual Costs and Earnings for Small Scale Freshwater Prawn Hatchery with Production of 4.8 Million Juveniles Per Year a/

Costs		
Fixed b/		(Rp.)
Land		10,000,000
Building		5,000,000
Equipment		10,000,000
Vehicle		12,000,000
	Sub Total	37,000,000
Operating		
Labor		
Manager		6,000,000
Labor		4,320,000
Artemia		16,250,000
Utilities		3,600,000
Depreciation		4,254,000
	Sub Total	34,424,000
Revenue		
@ Rp. 8/juvenile		38,400,000
@ Rp. 20/juvenile		96,000,000
Income		
@ Rp. 8/juvenile		3,976,000
@ Rp. 20/juvenile		61,576,000

a/ Production would be sufficient to stock 24 ha with two crops per year.

b/ Land and building depreciated over 7 year project period; equipment and vehicles over 5 years.

Benefit/cost	@ Rp. 8	.12
	@ Rp. 20	1.79

6.2.5 Small Scale Penaeid Shrimp Hatchery Development and Tambak Intensification Program

Tambak culture of penaeid shrimp, and especially of *Penaeus monodon*, is receiving increasing attention from both the government and private sectors. The potential for increasing production of this valuable export commodity has been previously noted.

The most serious constraint on tambak intensification is the inadequate supply of fry. There are currently two sources, natural catch and hatchery production. The natural fry catch in 1983 was estimated at 309 million, but this was sufficient to fulfill only 16% of the demand (as shown in Table 63) at the lowest stocking density considered. Supplies from nature are very dependent on proper environmental conditions and tend to fluctuate widely. As such, a consistent fry supply will have to come from private hatcheries.

Existing private hatcheries have an installed capacity of about 580 million fry per year, but are producing only about 10% of this amount. A number of these hatcheries can be expected to fail within the next two years.

The number of hatcheries required to supply the fry market adequately depends on the size of installations. A small scale hatchery of the type contemplated for recommendation as a project element would produce about 12 million fry per year. If this were taken as an average, 110 fully operational hatcheries would be required to fulfill demand at the lowest level of stocking density and four times that many at the most intense level.

The benefits that can accrue from higher stocking rates and improved management in tambaks can be appreciated by comparing Tables 64 and 65. In the former table, costs and earnings are given for sample tambaks in Sulawesi and Jawa Timur at present stocking rates.

In contrast, using improved management techniques and increasing stocking rates for shrimp, there is a 6.5 fold increase in wages to labor and a 7 to 9 fold increase inincome to management. However, achieving these production and income levels depends on the availability of inputs to the farmer and adequate water supply to the tambak.

The Asian Development Bank has funded a tambak improvement project including five hatcheries with a total planned production of 200 million fry per year by 1989. This would only be an additional 13% of total demand at the lowest stocking rate and 3% of demand at the highest rate. Government hatcheries, of which there are six, are making an insignificant contribution at the present time.

TABLE 63: Potential Fry Demand, by Region, for Various Stocking Rates and Cropping Systems. Fry Demand in Millions.

Stocking rate (fry/ha)	1 crop/yr	2 crops/yr
	Aceh	
10,000	280	560
15,000	410	820
20,000	550	1,000
	Java	
10,000	1,000	2,000
15,000	1,600	3,200
20,000	3,800	5,600
	Sulawesi Selatan	
10,000	1,900	2,600
15,000	2,800	3,800
20,000	3,800	5,600
	TOTAL	
10,000	1,900	2,600
15,000	2,800	5,600
20,000	3,800	7,600

TABLE 64: Costs and Earnings for an Average Tambak in Sulawesi Selatan and Jawa Timur, per Hectare, Per Crop.

	Sulawesi Selatan	Java Timur
		Rp.
Costs		
Fry		
Milkfish a/	83,000	22,500
Shrimp b/	150,000	150,000
Fertilizer	30,000	30,000
Pesticide	-26,000	26,000
Sub Total	289,000	228,500
Revenue		
Milkfish + Trashfish c/	365,000	343,000
Shrimp (Tiger + white) d/	645,000	400,000
Sub Total	1,010,000	743,000
Labor	289,000	120,000
Harvest Cost		
Labor	70,000	70,000
Commission	8,000	4,000
TOTAL COSTS	656,000	422,500
Income	354,000	320,500

a/ Milkfish fingerlings purchased at Rp. 50/ea, stocked at 1,660/ha.

b/ Shrimp fry purchased a Rp. 30/ea for PL30 stocked at 5,000 per ha.

c/ Average price at Rp. 900/kg for milkfish.

d/ Top price of Rp. 7,000/kg for tiger prawns.

Benefit/Cost: Sulawesi Selatan, .35; Java Timur, .76.

TABLE 65: Cost and Earnings for an Improved Tambak, Per Ha, Per Crop. Two Crops Per Year are Possible Where Water Supply is Good

		Rp.
Costs		
Fry		
Milkfish		23,000
Shrimp, PL30		600,000
Fertilizer		30,000
Pesticide		26,000
Rice bran		30,000
	Sub Total	709,000
Revenue		
Milkfish (400 kg x Rp. 1,000/kg)		400,000
Shrimp (500 kg x Rp. 7,000/kg)		3,500,000
	Sub Total	3,900,000
Labor		
20% of revenue		780,000
Harvest Cost		
Labor		140,000
Miscellaneous (food, etc.)		500,000
Commission (Rp. 100/kg of shrimp)		50,000
	Sub Total	690,000
Gross Income		1,721,000
Tax (10% of income)		172,000
Income		1,549,000

Benefit/Cost - .66
Increase in income over traditional methods--approximately 438%.
Increase in return to labor--approximately 270%.

6.2.5.1 Tambak Shrimp Demand and Marketing in Indonesia

Indonesia's exports of shrimp products have declined slightly since the partial trawl ban was put into effect in 1980. However, as can be seen in Table 66, overall value rebounded sharply in 1982 due to an increase in the international price for shrimp.

TABLE 66: Indonesian Shrimp Exports

Year	Quantity (000 mt)	Value (Million US$)
1977	31.4	139.2
1978	32.6	162.0
1979	34.7	200.5
1980	31.9	180.9
1981	25.0	162.8
1982	25.4	181.2

Shrimp exports in 1982 accounted for over 70% of the value of Indonesian fishery exports. Exports to Japan accounted for 86% of Indonesian shrimp exports, with the U.S. accounting for only 1%, Singapore 4%, Hong Kong 7%, and Western Europe 1%. Japanese consumption of shrimp increased by nearly 11% annually from 1970-1980, and this increase was completely supplied by imports, which increased from 57,000 mt in 1970 to 167,000 mt in 1981. India supplied 25% of those imports and Indonesia 15%.

World economic conditions in recent years have produced a slowdown in the growth of shrimp consumption in many developed countries (although not in the U.S.). Also, various economic factors (including continuing high interest rates, fluctuating exchange rates, inflation) are expected to dampen the growth of shrimp markets in the next decade. A recent FAO study on international shrimp markets projects that Japan, the U.S., and Western Europe will, however, provide for an additional demand of 55,000 tons of shrimp in 1990 as compared to 1981, and that Japan will account for about 15,000 tons. In addition, several other countries, particularly Hong Kong and Singapore, have shown strong additional demand potential. The FAO study concludes that overall global demand for shrimp by 1990 will require an increase in worldwide shrimp production of over 150,000 mt.

This increased production seems unlikely to come from marine fisheries, as many of the key shrimp grounds in the world are considered to be fully exploited. In fact, world catch of shrimp, despite wide variations in national landings, has remained relatively constant since 1977. Indonesia, with its large expanse of tambaks, is in a position to exploit this developing world demand through brackishwater aquaculture. In particular, with the imposition of the partial trawl ban in 1980, Indonesia is unlikely to increase its marine shrimp production and will have to rely on aquaculture for increased shrimp production and hence shrimp exports. In sum, then, international demand for shrimp seems likely to run ahead of international supply during the next decade and thereby provide an opportunity for increased Indonesian shrimp exports.

At present, there are currently estimated to be some 69,025 households in Indonesia practicing brackishwater aquaculture, with over 117,000 fish farmers (primary tambak farmers), as shown in Table 67. In addition, there are usually two to three workers per hectare of tambak, which suggests that somewhere on the order of 400,000 people are employed in brackishwater fish farming. As seen in Table 68, 43% of all tambaks are under 2 hectares; 79% are under 5 hectares and 93% are under 10 ha. It has been said that as tambak shrimp production has developed, large groups are buying up tambaks and consolidating their holdings, thereby forcing out the small producers. This was not evident in our interviews, but land holding patterns might well be investigated to determine the extent to which this is taking place.

The average annual gross income (before input costs are taken out) per primary tambak farmer is about Rp. 1,118,000/yr, based on the overall value of production. It is also interesting to note that while fish account for about 76% of the volume of tambak harvest (and shrimp 24%), fish account for only 52% of the value of the harvest (see Table 69). It is no wonder, then, that these relatively poor tambak farmers are turning, or trying to turn, to high valued shrimp species. This, in conjunction with a strong international market for shrimp and the decline in marine shrimp production (as described below), explains the increasing interest in all sectors for producing shrimp.

As shown in Table 70, shrimp production in Indonesia grew from 61,000 mt in 1973 to about 155,000 mt in 1979 and then fell to 130,892 mt in 1982. This decrease has come completely from marine shrimp production (due to the trawl ban), where production fell from 130,917 mt in 1979 to 100,490 mt in 1982. At the same time, brackishwater shrimp production increased from 23,856 mt in 1979 to 30,602 mt in 1982. Indonesia shrimp exports peaked in 1979 at 34,700 mt, valued at about US $200 million and fell to about 25,400 mt in 1982 with total value of US $181 million, as shown in Table 66.

TABLE 67: Brackishwater Fish Ponds

Province	# of Households	# of Fish Farmers	Ha in Production	Rp. Value of All Products
Sumatera	10,584	18,945	27,125	12,146,215
Java	37,537	62,509	110,503	67,239,064
Bali-Nusa Tenggara Timur	3,206	5,493	3,160	2,593,665
Kalimantan	412	701	1,598	408,940
Maluku-Irian Jaya	8	14	11	3,980
TOTAL	69,025	117,034	208,695	130,934,447

Average Gross
Income Per Farmer: Rp. 1,118,811/yr

SOURCE: 1982 Statistical Year Book
Directorate General of Fisheries
Ministry of Agriculture

TABLE 68: Number of Brackishwater Pond Culture Households by Size of Fisheries Management and Province, 1982

Satuan: Buah
Unit : No

Province	Total	Size of Fisheries Management			
		2 Ha	2 - 5 Ha	5 - 10 Ha	10 Ha
Total	69,025	30,863	25,312	10,352	2,508
SUMATERA	10,584	6,248	3,076	2,093	167
D.I. Aceh	9,922	4,848	2,865	2,055	159
Sumatera Utara	422	177	196	36	13
Sumatera Barat	1	1	-	-	-
Riau	29	20	7	2	-
Lampung	210	202	8	-	-
Jawa	37,537	14,789	16,147	5,502	1,099
DKI Jakarta	218	10	94	84	30
Jawa Barat	8,029	2,204	3,547	1,482	796
Jawa Tengah	14,729	9,377	4,618	634	100
Jawa Timur	14,561	3,198	7,888	3,302	173

TABLE 68: Number of Brackishwater Pond Culture Households by Size of Fisheries Management and Province, 1982 (Continued)

Satuan: Buah
Unit : No

Province	Total	Size of Fisheries Management			
		2 Ha	2 - 5 Ha	5 - 10 Ha	10 Ha
Bali-Nusa-Tenggara-Timor	3,206	2,722	405	57	22
Bali	103	18	75	8	2
Nusatenggara Barat	3,008	2,654	312	40	2
Nusatenggara Timur	95	50	18	9	18
Kalimantan	412	143	144	51	74
Kalimantan Selatan	110	-	69	31	10
Kalimantan Timur	302	143	75	20	64
Sulawesi	17,278	7,944	5,539	2,649	1,146
Sulawesi Utara	103	49	48	6	-
Sulawesi Tengah	140	30	73	28	9
Sulawesi Selatan	16,515	7,688	5,190	2,573	1,064
Sulawesi Tenggara	520	177	228	42	23
Maluku-Unan Jaya	8	7	1	-	-
Irian Jaya	8	7	1	-	-

TABLE 69: Value of Brackishwater Fish Pond Production by Species Type, 1982

Province	Fish		Shrimp	
	Value (mt)	Value (Rp.1,000)	Value (mt)	Value (Rp.1,000)
Sumatera	11,115	8,431,441	2,195	3,707,939
Java	59,754	41,608,301	19,581	25,630,763
Bali-Nusa Tenggara-Timor	1,479	1,240,400	363	1,353,265
Kalimantan	441	223,575	123	185,365
Sulawesi	25,385	17,084,085	8,820	31,458,498
Maluku-Irian Jaya	23	3,920	-	60
TOTAL	98,197	68,591,722	31,082	62,336,725

Table 71 shows the distribution of brackishwater shrimp production in the key regions on Aceh, Java and South Sulawesi. While production has increased in Indonesia as a whole, it has done so slowly, increasing only 3% from 1979-1982. Over 80% of all brackishwater shrimp comes from the key areas of East Java and South Sulawesi. With increasing international demand for shrimp and decreasing catch of marine shrimp, it is clear why the Government of Indonesia has made the increased production of brackishwater shrimp such a high priority during Repelita IV.

This governmental commitment to increased shrimp production from tambaks rests on the assumption that the world market will continue to be strong in the years ahead, and this seems likely. However, several key caveats should be made. First, if one takes a much longer view (to the year 2,000 and beyond), it is impossible to project what the world shrimp market will be. If it decreases suddenly, then Indonesia will be left with an industry developed in large part at the expense of the long-term use of mangrove and possibly other coastal resources. Essentially, any program which encourages shrimp production must also focus on the long-term viability of coastal resources and this simply means intensifying the use of current tambaks rather than building new tambaks.

TABLE 70: Production of Shrimp in Indonesia (1973 - 1982) (mt)

	1973	1974	1975	1976	1977	1978	1979	1982
Marine								
Tiger Shrimp	11,732	10,583	12,244	9,252	7,716	9,275	9,027	10,068
Banana Shrimp	25,434	25,849	27,534	18,974	24,346	31,927	31,620	30,693
Total tiger and banana shrimp	37,166	36,332	39,778	28,226	32,062	41,232	40,646	40,761
Other Shrimp	16,211	13,324	18,687	78,451	95,520	87,294	90,270	59,729
Total Marine Shrimp	53,377	49,656	58,465	106,677	127,582	128,526	130,917	100,490
Brackishwater								
Tiger Shrimp	1,561	1,788	3,803	5,099	4,079	4,600	6,965	8,783
Other Shrimp	5,590	6,591	5,800	8,960	17,093	17,018	16,891	11,819
Total Brackishwater Shrimp	7,151	8,379	9,603	14,059	21,172	21,618	23,856	30,602
Marine and Brackishwater								
Tiger and Marine Banana	38,727	38,120	43,581	33,325	36,141	45,832	47,612	49,544
Other	21,801	19,915	24,487	87,411	112,613	104,312	107,161	81,348
Total	60,528	69,571	69,068	120,736	148,754	150,144	154,773	130,892

TABLE 71: Tambak Production of Shrimp in Selected Provinces (mt)

	1978			1979			1982		
	Tiger	Other	Total	Tiger	Other	Total	Tiger	Other	Total
West Java	386	5,844	6,230	121	5,784	5,905	593	8,830	9,423
Central Java	237	3,434	3,671	300	3,297	3,597	459	5,282	5,741
East Java	194	2,779	2,973	1,837	2,475	4,312	1,876	2,233	4,109
South Sulawesi	2,969	2,229	5,198	3,920	2,936	6,856	5,289	3,348	8,637
Aceh	771	2,026	2,797	730	2,005	2,735	497	1,638	2,135

SOURCE: Directorate General of Fisheries

Second, Indonesian tambak farmers will need to become more efficient in order to compete effectively with shrimp farmers in South and Latin America as well as in other parts of Asia, for the growing U.S. market.

Third, Indonesia has a serious problem with quality control of shrimp and shrimp products, starting from the point at which irrigation water is contaminated, through handling and processing from farmer to processor. Again, any commitment to increased shrimp production must take account of the quality control problem (primarily Salmonella) and attempt to deal with it. If, as some people have suggested, it is impossible to "sanitize" shrimp grown in tambaks and make them safe for human consumption, then government policy in this area should be carefully reviewed.

6.2.5.2 Market Channels

There are four key steps in the marketing of shrimp from tambak to export: harvest, market channels, handling, and processing plants.

Farmers harvest their tambaks according to species of shrimp and the region. In general, tiger prawns are harvested in March and April and in November and December. Farmers generally harvest shrimp at a time when their size reaches 20 tails/kilo, and due to varied growth rates, harvesting may cover several weeks. Once the shrimp are harvested, they move through marketing channels to cold storage/processors. At the current time, processors are operating at such a low percentage of their total capacity (on the order of 10-20%) that there is strong competition for tambak produced shrimp. A system of marketing channels for shrimp has developed in Indonesia to include middlemen, and agents and/or auctioneers who act between the producer and the processor. At present, the system seems to work fairly well and processors are bearing the majority of the marketing costs.

During our interviews, several marketing channels were "discovered." These are shown in Table 72.

TABLE 72: Tambak Shrimp Marketing Channels

(1)	(2)	(3)	(4)
Producer	Producer	Producer	Producer
	Producer Group	Collector	Producer Group
	Marketing Agent		Marketing Agent
Cold Storage			
Processor	Cold Storage	Cold Storage	Collector
	Processor	Processor	
			Cold Storage
			Processor

These four channels are based on the distance from producer to processor, size of land holdings, the extent of tambak dispersion, and whether or not a kelompok tani or KUD has formed, with a member of the group designated as responsible for marketing. The following are generic examples of various marketing channels and mark-ups which we encountered.

The Dinas Perikanan in South Sulawesi provided a description of the third type of distribution system (column (3) in Table 71), seen below:

Farmer Price:	Rp. 6,000/kilo	36 tails/kilo or more
	Rp. 7,000/kilo	35 tails/kilo or less

of which

Collector	Rp. 100-250/kilo
Commission:	

Shrimp prices are theoretically set by a group of five shrimp processors in Ujung Pandang, in conjunction with government officials, every three months depending on the export price of shrimp. This system of price setting, however, did not seem to hold in reality, while the market channel described certainly exists.

Another market channel which was found was the second channel (Producer-Producer Group Agent-Processor), as shown below:

Price to Farmer:	Rp. 7,500/kilo	Under 21 tails/kilo
	Rp. 7,000/kilo	21-25 tails/kilo
	Rp. 6,500/kilo	over 26 tails/kilo

of which

Agent

Commission: Rp. 100/kilo

This "agent" owns and operates his own tambak of about 6 hectares and acts as one of three agents for a group of 10 farmers covering about 50 hectares. In his role as agent, he takes a commission of Rp. 100/kilo (1.3-1.5%). For this, he goes to Ujung Pandang to discuss prices with the processors and is free to negotiate for the best price possible. In this way, it seems that the farmer receives a very competitive price. In addition, at present, the processors send their trucks and ice holding boxes to the tambak and pay for all transport costs between tambak and the cold storage facility.

Another tambak farmer, holding 100 hectares of tambaks and primarily producing milkfish, followed the fourth market channel: selling shrimp to collectors who delivered it to processors, as shown below:

Farmer Price: Rp. 5,000-7,000/kilo (no size differential)

of which Commission: Rp. 150-250/kilo.

In the Surabaya area, shrimp prices are somewhat higher, although the marketing mechanisms are largely the same. One particular KUD, which acts as a marketing agent for the members, established the following market channel:

Farmer Price:	Rp. 7,500-8,000/kilo	Under 17 tails/kilo
	Rp. 6,500/kilo	17-over tails/kilo
KUD Commission: (2.5%)	Rp. 160-200/kilo	

Transport and cold storage costs during transport are paid by processors. At present, there are 16 processors in Surabaya and they are all operating far below capacity. In addition, the KUD does not have any agreements with the processors and markets the shrimp on a competitive basis.

In general, prices and commissions paid to fish farmers are based on a competitive market system, although some farmers are worried about eventual "price fixing" among processors. While this is a possible danger, at present, there is such a shortage of raw material that competition among processors is likely to remain strong. In addition, competition among collectors is also strong--whether they are financed by (and hence tied to) a specific processing plant or are self-financed. This further assures good farmer prices. Finally, and perhaps the best situation for the tambak farmers, when the collection agent is replaced by a farmers' association which appoints a key farmer to market their product, competition among the processors is further assured. This system allows farmers to avoid "agents" and "collectors" and helps ensure that the farmers end up with a better price.

In sum, the market channels for shrimp from tambak are in place and are very competitive due to the severe shortage of raw material for processing plants. At present, farmers do not seem to receive lower prices due to an absence of competition; however, as processors begin to integrate vertically (i.e., as they begin to build their own hatcheries and tambaks), these marketing channels could become less competitive and more subject to non-competitive pricing.

6.2.5.3 Affiliated Market Channels: Shrimp Fry

The market channels for shrimp fry follow several paths from hatchery to farmer, depending primarily on location and whether or not a farmers' group exists or an agent has been employed to distribute the fry (see Table 73).

TABLE 73: Shrimp Fry Market Channels

Hatchery	Hatchery	Hatchery	Hatchery
↓	↓	↓	↓
Farmer	Distribution Center	Agent or Group Repr.	Distribution Center or Nursery
	↓	↓	↓
	Farmer	Farmer	Agent or Group Representative
			↓
			Farmer

If the farmer is near the hatchery, he can buy directly, usually at a price corresponding to the shrimp's post larvae stage (PL 10, for example, means ten-day old post larvae): PL15 - Rp. 15, PL20 - Rp. 20, PL30 - Rp. 30. If the hatchery must transport fry to a distribution center in another province (say Surabaya in East Java to South Sulawesi), transport costs including mortality may be as much as Rp. 3/fry. This increases the price to the farmer by about Rp. 5/fry due to transportation costs and mark-up. For instance, one private hatchery on Bali sells fry F.O.B. Denpasar airport (the buyer assumes all transport responsibility from Denpasar to the farmer) for Rp. 15, 20 or 30/fry, depending on the stage of post larvae. These fry are sold in South Sulawesi for Rp. 20, 25 and 35 apiece for PL15, PL20 and PL30s, respectively. In South Sulawesi, which "imported 40 million fry during 1983" (according to Dinas Perikanan officials), PL30 fry were selling for up to Rp. 45/fry. These prices vary, of course, during the season and during periods of relative abundance or shortage of wild fry.

The market for fry is large but does face several key constraints. First, demand in South Sulawesi and East Java for shrimp fry peaks during February to May, and September to November when farmers traditionally "plant." During the other months, shrimp fry demand may be quite low, although the planting season in Aceh may be different. This presents some difficulties to hatcheries, which should operate year round. However, this problem may well be self-correcting in that as hatchery fry become available year round, farmers will likely adapt their planting and grow-out scheme. From our interviews, this process is already underway and it seems likely that a year round market for fry will develop.

Second, if transportation of fry to market (i.e., the farmers) is required, there is generally a 24-hour time period during which the post larvae can be shipped. Beyond 24 hours, mortality rates become intolerable. As such, where transport is necessary, distribution systems through agents or KUDs will have to be developed. Again, this is already starting to occur. Third, some farmers believe that wild fry are better/stronger than hatchery fry. This may, from the farmer's standpoint, be true because hatchery-produced fry may have to be introduced slowly into the grow-out ponds (through nursery and transition ponds) to minimize fry mortality. This is a matter for some education and training in fry handling, but seems unlikely to hinder demand. Finally, and perhaps most important, is a lack of farmers' operating capital. Even if fry are available, small-scale fish farmers may not have the money to buy them, as well as other inputs.

Artemia is another important affiliated market and is addressed in another part of this report. Here, it is only important to note that as hatchery development proceeds, the demand for artemia will increase. The current import price for good quality U.S. artemia is about US $70/lb (compared to $22/lb in the U.S.). Artemia production is likely a very economically sound venture in Indonesia, given its extremely high price and the likelihood of increasing hatchery development.

6.2.5.4 Biotechnology

In the last decade, refinements have been made in shrimp larvae production that can yield consistent survival rates of 50 to 70% from egg to PL10. Much of this work was done at Galveston, Texas by the National Marine Fisheries Service and by Aquacop of Tahiti.

A survey of Indonesian hatcheries revealed that most of them were suffering from one or more of several technical problems in the following areas:

- poor site selection,
- inadequate facility design,
- poor algae cultures,
- improper feeding regimes, and/or
- inefficient brood stock management.

Some of the hatcheries that were sited where there was access to high quality sea water on a year round basis seemed to be doing moderately well. Government hatcheries tended to be the worst, especially in facility design and management. The problem with hatchery development is that poor models were introduced either by private companies or through existing public facilities and these models have spread. At the same time, there is a shortage of properly trained hatchery operators and designers to counteract the trend.

6.2.5.5 Costs and Earnings

The model penaeid shrimp hatchery would have an annual production capacity of about 14 million PL20s. During the first year of operation, production is estimated at 25% of capacity, rising to 50% the second year, and reaching full capacity the third year. The costs, revenues, cash flow, and IRR for this facility are displayed in Tables 74 and 75. Utility costs were based on operation of a 15 KVA diesel generator.

6.2.5.6 Development Constraints

Institutional factors bear heavily on small scale hatchery development and include the following:

1. Although an appropriate vehicle for hatchery development that would maximize benefits would be KUDs or kelompok tani, these organizations are often very weak in both structure and financing. Frequently, they do not adequately serve or respond to members.

2. There is a critical shortage of trained hatchery workers and small business managers.

3. The financial resources of hatchery customers, i.e., the tambak farmers, are limited and their access to appropriate credit is restricted.

4. Hatchery sites are limited and often far from tambak areas; thus, an organizational link must be established across districts or provinces.

6.2.6 Artemia Culture

Artemia are primitive crustaceans inhabiting highly saline waters. Their value to the aquaculturist stems from the high nutritional quality of the newly hatched larvae, called nauplii. The nauplii are encysted under specific salinity conditions and the cysts can be stored for years. They are essential for shrimp larvae culture, as no substitute has been found.

Although world supplies of artemia are more than adequate to meet any demand from existing hatcheries, the cysts are subject to high duty and what at first glance appears to be exhorbitant retail mark-up. Many hatcheries cannot afford adequate supplies and this is one of the causes of low hatchery productivity.

An artemia production project is viewed as complementary to a penaeid shrimp hatchery development program because it has been estimated that 20-25 tons of cyst are needed annually to adequately supply existing hatcheries and those planned under the ADB program. While artemia occur naturally in arid regions where saline lakes form, it is possible to propagate both cysts and adults during the dry season in monsoonal climates, and in fact, they are now being produced for hatchery consumption in Thailand and the Philippines.

Experience in the Philippines has indicated that one hectare can produce from 25 to 55 kg of cysts during a 5-month dry season. So about 1,000 ha of salt pans in production would be required to satisfy national short term demand.

It is difficult to estimate the extent of area required to reach this target because several methods of salt crystalization are used and would affect the degree to which artemia can be integrated into small scale salt production. Observations on Madura suggest that about 25% of the average salt pan systems could be used. If that estimate is correct, a total salt pan area of about 2,000 to 4,000 ha would be required. Excluding those salt pans operated by the state salt enterprise, there are 4,300 ha on Madura plus about 50,000 ha of tambaks on Java which are used to produce salt during the dry season.

TABLE 74: Cost and Earnings for a Model Hatchery for Production of 14 Million PL20s Per Year

Costs		
Fixed		Rp.
	Land	20,000,000
	Building	13,650,000
	Equipment	15,000,000
	Vehicle	15,000,000
	Sub-Total	63,650,000
Operating		
	Artemia	6,960,000
	Brood Stock	43,200,000
Labor		
	Manager	6,000,000
	Technicians	10,800,000
	Laborers	7,200,000
Utilities		6,000,000
Fuel		1,200,000
	Sub-Total	38,160,000
Revenue		280,000,000

NOTES:

1. Selling price of PL20 is Rp. 20/each.
2. One hectare of beach front is required.

TABLE 75: Cash Flow and IRR for Model Penaeid Hatchery Producing 14 Million PL20s Per Year for Seven Year Project Period, in Million Rupiahs

	YEAR						
Costs	1	2	3	4	5	6	7
Fixed							
Land	20,000						
Building	13,650						
Equipment	15,000						
Vehicles					15,000		
Sub-Total	63,650				15,000		
Operating							
Artemia	3,000	6,000	6,000	6,000	6,000	6,000	6,000
Brood Stock	21,600	43,200	43,200	43,200	43,200	43,200	43,200
Labor							
Manager	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Technican	10,800	10,800	10,800	10,800	10,800	10,800	10,800
Laborers	7,200	7,200	7,200	7,200	7,200	7,200	7,200
Utilities	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Fuel	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Sub-Total	55,800	80,400	80,400	80,400	80,400	80,400	80,400
Revenue	70,000	140,000	280,000	280,000	280,000	280,000	280,000
Income	49,450	59,600	199,600	199,600	184,600	199,600	199,600
Cumulative	49,450	10,150	209,750	409,350	593,950	793,550	993,150

IRR = 210%

6.2.6.1 Biotechnology

Since artemia cannot survive in tambaks or salt pans during the rainy season, they must be innoculated at the onset of the dry season when salinity has reached an appropriate level to exclude predators. The artemia are hatched and reared to adult size in normal strength seawater or they can be innoculated into salt pans as nauplii.

Successful culture depends upon proper preparation of the pond, water management and fertilization. Techniques have been developed in the Philippines which should be readily transferable to Indonesia.

6.2.6.2 Cost/Benefit Analysis

The investment required to incorporate artemia propagation into salt production systems is quite small. Assuming 10% of a 2 ha salt farm can be used, the results would be as shown in Table 76.

6.2.6.3 Marketing

Artemia production by small scale producers would result in a new product for which there are no existing domestic market channels. A major project component would be to develop the most direct path possible between producer and consumer (the private hatcheries).

6.2.6.4 Development Constraint

Salt farmers must be convinced that artemia will not interfere with salt yield and in fact, will increase it. Direct technical assistance at the village level is needed, but the demonstration must use the traditional salt production system prevalent in the project area. Correct processing methods must be introduced to maintain product quality.

6.2.6.5 Financial Constraints

Although the capital inputs for artemia are small, salt farmers have very low incomes. Thus, credit assistance would have to be available to them at low cost and properly timed, with a minimum of bureaucratic obstacles.

6.3 Suggested Project Design and Implementation

The following recommendations elaborate on the projects identified earlier. In general, they represent an intensification of existing activity in aquaculture, build on previous projects, or attempt to transfer success in one technical area to a closely related one.

TABLE 76: Cost and Earnings for Small Scale Artemia Production Integrated with Salt Farming

Fixed Costs	
Hatching Tank	20,000
Aerator	80,000
Processing Equipment	50,000
Sub-Total	150,000
Operating Expenses	
Artemia Cysts	60,000
Fertilizers	90,000
Rice Bran	5,000
Electricity	12,600
Depreciation on equipment	30,000
Sub-Total	197,600
Revenue	
8 kg x Rp.77,000/kg	616,000
Income	418,400

Benefit/costs = 2.1

NOTES:

1. Dike repairs would be needed to increase water depth to 40 cms. Labor would be supplied by salt farmer.

2. A producer price of Rp. 77,000 per kg is assumed on the basis of the lowest price for imported cysts. High quality cysts from San Francisco Bay currently sell for Rp. 120,000/kg.

3. Salt production from a 2 ha pond system totals 90 tons and at a producer price of Rp. 30,000 per ton, yields gross revenues of Rp. 2,700,000 per year. In the village we sampled, salt-derived income amounted to Rp. 143 per person per day.

4. There would be an excellent market for the adult artemia as food for brood stock and post larvae. However, we have no data on which to base an estimate for earnings from this source.

The successful implementation of the proposed projects rests not only on the soundness of the project components but also on the institutional mechanism by which they are carried out. In most instances, these mechanisms are fairly clear and are based on four key assumptions. (1) The government's role is in training, demonstration and transfer of technology and management techniques to the private sector. (2) The best way to get people to adopt new technologies and use them is to not only to transfer the "technology" but also to ensure that it provides substantial benefits. In simple terms, if a technology allows a fish farmer to increase his income (if it is profitable), then he will be more likely to continue using it. (3) Any project in this area must look at the "end-to-end" system that must be dealt with. To work at one part of the production, marketing and consumption system while the rest is faltering will not lead to a successful project. (4) It will take a substantial time commitment to ensure success. It is on the basis of these four ideas that the suggested projects were designed.

6.3.1 Sumateran Freshwater Aquaculture Development

The components of a freshwater aquaculture program should be diverse enough to take advantage of the major freshwater resources of the island so that benefits can have the widest possible geographical distribution. Advantage should also be taken of past and present aquaculture assistance programs in the region.

The Sumateran Freshwater Aquaculture Development Project has several objectives:

- increase income to small-holder rice farmers and river dwellers,
- increase productivity of private hatcheries,
- improve the effectiveness of provincial fisheries services to act as an effective agent in technology transfer,
- stimulate and assist the development of private sector catfish (Pangasius) hatcheries, and
- estimate the capacity of Lake Toba for restocking carp, possibly leading to increased effort and hence increasing local catches and indirectly building institutional research ability.

Project elements would be located in North Sumatera, Riau, Jambi and South Sumatera. Rice-cum-fish culture utilizes the vast freshwater resource entrapped in sawah, while an assessment of the restocking capacity of Lake Toba will enable a more rational utilization of Sumatera's largest standing body of fresh water. Catfish cage culture in the other provinces will utilize the extensive river systems found there.

The goal of the proposed project is to successfully expand private sector activities in rice-cum-fish and cage culture. With regard to rice-cum-fish culture, private sector activity already exists and activities in this area focus on continued expansion. This requires working directly with private farmers. At the same time, efforts to develop a government capability in extension and training facilities for hatchery technicians and farmers must continue. Essentially then, we see a two-tier approach: (1) building up government capability for transferring rice-cum-fish technology to the private sector and (2) direct extension work with private farmers.

Because Pangasius cage culture is such a new activity, most early activities would be undertaken by the Dinas Perikanan and "key" local farmers (for demonstration). However, over the course of the project, it would acquire the same two-tier approach as outlined above. It is important to note as well that the issue of credit and improved credit facilities is important to not only these, but all projects involving small scale fish farmers. It may well be that for the purposes of this project, the implementation of a low-level credit scheme should be considered. This would go a long way to ensure project success.

Finally, the Lake Toba restocking program would be primarily a government activity due to the apparently limited commercial fishing potential of the lake. If cage culture becomes viable, however, we would envision the project working with local fish farmers in order to establish private sector activities in the area.

6.3.1.1 Rice-Cum-Fish Culture

This project component consists of the following elements, the first five of which are directed toward upgrading the fish culture center at Kerasan:

1. Fund the acquisition of quality brood stock and the distribution of their offspring to private hatcheries.

2. Improve the site's water supply to provide sediment-free water.

3. Set up and replicate in Simalungun, mina padi and palawija demonstration centers adapted to the government's rice planting system (pola tertib tanam).

4. Develop least-cost diet formulations for mina padi with the objective of increasing fry survival.

5. Fund expanded short term training courses with field visit follow-ups and evaluations.

6. Provide technical assistance directly to private hatcheries, concentrating on proper handling

of brood stock and nursery pond management.

7. Support a credit program to mina padi and palawija fish farmers through the local development bank (Bank Pembangunan Daerah) or BRI, whichever can best design and operate an appropriate credit program.

8. Support in-country university level training for at least two additional professional staff.

9. Support overseas short term work-study programs for existing staff, particularly to ASEAN countries where rice-cum-fish culture is well developed.

The Fisheries Service Fish Fry Production Center at Kerasaan would be the local counterpart agency (Dinas Perikanan, UPBAT/BBI Sentral, Kerasan) for all technical assistance activities and the location for technical advisors.

A model credit program for small scale fish farmers should be designed, at least partially funded, and administered through the most appropriate bank, which could be Bank Pembangunan Daerah. An in-kind credit approach might be taken. The credit program should be flexible enough to fund both individuals and producer groups (kelompok tani, KUD, etc.).

A technical advisor specializing in rice-cum-fish culture would be assigned to the center during the project period. If available, an expert in carp hatchery management should be assigned to the project, but this individual should have extensive practical experience.

A second advisor (perhaps short-term) specializing in disease and nutrition of freshwater fish would carry on activities at the center, but would also be attached to the catfish cage culture project in Jambi or Palembang.

It should be stressed that the advisors attached to <u>any</u> project should have sufficient funds allocated to carry out their assignments effectively. Many DGF facilities are seriously under-funded and although counterpart funds may be technically available, their administration is cumbersome.

In-country higher education for additional staff could be accomplished through a scholarship program and would take candidates from the region. IPB would be the institution of choice.

6.3.1.2 Lake Toba Limnological Program

A restocking program through increasing the production of fingerlings at the Ambariter Fish Seed Center is currently underway. However, there have been no limnological studies of the lake to determine its capacity to absorb increased stocks. A limnological study would have several objectives. First, the lake's primary and secondary productivity could be estimated and hence its theoretical capacity for restocking carp or other desirable species. Second, it would develop aquatic research capability at both the university and public research institutional levels. Third, invaluable baseline data would be generated by which to monitor the lake's water quality. There must also be a mark recapture program to determine the natural and fishing mortality of released fish. The component would consist of the following elements:

1. <u>Mark-Recapture Program</u>
   Fingerlings released from the Ambarita hatchery would be marked by fin-clipping or appropriate tagging and a reward system set up. At the same time, a similar program would be initiated to estimate the tilapia population in the lake.

2. <u>Limnological Study</u>
   The study would have the specific objective of measuring primary and secondary productivity to obtain a theoretical estimate of restocking capacity.

To provide a local focus for research, AARD would have to enter into a joint agreement with the Dinas Perikanan in Prapat.

An appropriate boat and equipment for limnological studies would have to be provided. A lab at the Ambarita station would need to be set up and equipped. The boat could be locally built and would be about 25 feet. A reward fund for the return of marked fish should be also be implemented.

A resident expert would reside at Lake Toba to direct and assist the program. One counterpart limnologist and two biological technicians should also supplied, preferably by AARD. The advisor should be provided with adequate funding to carry on field activities. The program would run for three years.

6.3.1.3 Cage Culture Development

This project would consist of the following components:

1. Two model hatcheries would be constructed, one in Jambi and the other in Palembang. These hatcheries would produce Pangasius fry for the development of cage culture in rivers.

2. Training programs would be given to private hatchery operators and would include the biotechnology of Pangasius fry production and small business management practices.

3. At least three demonstration sites for cage culture would be established in the Riau, Jambi and South Sumatera provinces.

4. Extension agents would be trained at the hatchery and demonstration sites. A minimum target would be six per year during the project's life.

5. Project personnel should encourage the formation of small producer groups centered around a model hatchery. A credit program should be established. The group would receive marketing assistance as well as production inputs.

6. Lab facilities at the Dinas Perikanan station at Palembang should be improved in order to enable more effective monitoring of Musi River water quality. The most immediate requirement is the establishment of a hook up with the PLN electrical line, a few kilometers away.

7. Technicians at the station would be trained through an on-the-job training program.

8. The nutrition expert mentioned above would develop least-cost rations for fry and fingerlings of Pangasius and appropriate means of fabricating feeds.

Model hatchery construction would be phased in over a four year period, simultaneously with cage culture demonstration sites, which would be tied to production coming on line from the first model hatcheries.

If response to the demonstration effort was favorable, the development of small producer groups could be initiated. The development of succeeding demonstration sites would be coordinated with the output of extension workers from the first model hatchery demonstration complex.

The organizational structure for the model hatcheries should be carefully considered. It would be set up as a DGF facility, a cooperative service center, or a private non-profit foundation. If established as a co-op service center, the facility would have to be in a financial position to provide a variety of services beyond fry production. Alternatively, the first hatchery might be built as a DGF facility, with subsequent installations organized in the alternative ways. In the case of a private foundation, the facility would be turned over to a producers' group once they were strong enough to support it.

One expert in Pangasius breeding and cage culture would be permanently assigned to the project. This expert could come from one of the ASEAN countries where Pangasius culture is well developed. A fish nutrition expert would work alternately between North Sumatera and the cage culture areas. The period of assignment would be three years, starting from the initiation of the first demonstration site activities. Both experts would maintain close contact with private producers, providing direct technical assistance.

A domestic or foreign organization with expertise in the organization of coops or other producer groups should assist if the project were to become involved in supporting such groups. Participants in these groups would be trained at the demonstration sites and model hatchery. Courses would be broad enough to include aspects of business management beyond the biotechnology components of cage culture and hatchery operation.

It is recommended that the Sumatera Freshwater Fisheries Development Project be carried out by the the provincial Dinas Perikanan in the Provinces of North and South Sumatera. Clearly, these projects will also have to be coordinated with the DGF in Jakarta.

While the key agency would be the local Dinas Perikanan, work must also be directed at private sector fishermen and marketing agents. In particular, efforts must be made to improve credit facilities for fish farmers. This will require work with local kelompok tani (farmers groups), local KUDs (if they exist), and perhaps the BRI. Table 77 shows the various elements of the proposed Sumatera Freshwater Fisheries Project and the institutional relationships envisioned.

6.3.2 Freshwater Prawn Pond Culture and Marketing Development

Because of the successful transfer of an efficient technology (hatchery methods) to the DGF, a firm basis, namely adequate fry supply, has now been established in Indonesia for the expansion of freshwater prawn farming. The objectives of a freshwater prawn project will be to:

1. increase the income of small fish pond operators and their associations; and

2. by augmenting the financial resources available to these associations, strengthening their ability to provide a broader range of services to their members.

The project would require the services of a fisheries marketing expert on an intermittent basis following an initial one year period of intense market promotion effort.

An expert on freshwater prawn culture would set up demonstration ponds and develop cost-efficient feeding practices. Short training courses of one or two weeks would be offered to local farmers with practical work at the pond site. Particular emphasis would be placed on post-harvest handling. An efficient transport system will also be needed to ensure adequate delivery of juveniles from Priggi to pond demonstration sites. This will require the provision of a refrigerated truck.

TABLE 77: Sumatera Freshwater Fisheries Project: Institutional Relationships

I.	**Upgrading/Expanding Rice-Cum-Fish Culture**	
A.	Improve Government Facilities	D.P.
B.	Demonstration Ponds	D.P., Farmers
C.	Improve Credit Facilities	DGF, Dept. of Cooperatives, BRI, BPD
D.	Nutritional Research	AARD
E.	Technical Assistance to Private Hatcheries	D.P. Hatcheries
II.	**Lake Toba Restocking Program**	
A.	Mark-Recapture Program	AARD
B.	Lake Toba Productivity Study	AARD
III.	**Pengasius Cage Culture Development**	
A.	Hatchery Development	D.P. Kelompok Tani - KUD
B.	Demonstration Cages	D.P. - KUD Farmers
C.	Training	D.P. Kelompok Tani

D.P. = Dinas Perikanan

It is recommended that the proposed macrobrachium development project be institutionally centered at the Dinas Perikanan in Yogyakarta. While the geographic focus of the project will include Central Java (the Priggi Hatchery) and Sumatera (eventual marketing of macrobrachium and pond development), the key elements to support the project are already in place in Yogyakarta.

The program of the D.P. in Yogyakarta includes continued support of macrobrachium hatcheries and the building of a new hatchery at Samas, a unique extension program to encourage farmers to undertake fish and macrobrachium culture, and a market program by which the State Fish Enterprise guarantees to buy all macrobrachium harvested. Of particular interest is the extension program which is focused around key respected (model) farmers and village groups. This program is unique in its efforts to work with village groups (youth, religious, and women's groups) to promote pond development. In addition, the staff of the D.P. has formed its own cooperative which is serving as a model and practical training site for young extension agents as well as for local farmers and farmer groups. This particular D.P., by establishing a base program in each of the areas of the proposed project, provides a strong institutional base from which to run the proposed project.

This project, as with the other projects, has as its ultimate goal the development of government capability to transfer technology to the private sector and the implementation of that technology by the private sector. In this project, three major elements are identified. First, hatchery development will be limited initially to low level assistance to the government. Second, if and when macrobrachium become commercially viable, then efforts at developing small scale private hatcheries should start. Third, pond and marketing development can be undertaken in conjuction with the D.P., but must be focused on private entrepreneurs.

The risks involved in this project revolve around three key things: 1) market development, 2) credit, and 3) personnel changes. Without market development, the project will fail. We believe that there is strong demand in Sumatera and strong latent demand in Java (domestic and for export). However, marketing channels and marketing arrangements will have to be developed. Credit will be needed to assist farmers in getting started on macrobrachium and also for "marketing agents" or collectors to establish themselves as market channels unless those channels are provided by cold storage facilities. The local D.P. is already providing "in-kind" credit by providing free fry to farmers. Some further credit will likely be necessary. Finally, the personnel of the local D.P. seem committed and energetic. However, personnel transfers could strongly affect this.

6.3.3 Small Scale Penaeid Shrimp Hatchery and Tambak Intensification Assistance

This project would aim to assist shrimp aquaculture in the following ways:

- Raise productivity of small tambak farmers by increasing fry supply.

- o Help DGF to become an effective disseminator of efficient shrimp hatchery technology.
- o Strengthen small scale producers' associations.
- o Provide opportunities for the development of new types of small business.
- o Improve product quality through better tambak water management and post-harvest handling.

To accomplish these objectives, the following activities will be developed:

1. Upgrade two DGF hatcheries, one in South Sulawesi and one in East Java.
   - o Complete renovation will establish them as model penaeid shrimp hatcheries.
   - o Upon completion of renovation, DGF personnel will undergo training.
   - o Training courses will be offered to private hatchery operators at regular intervals.
2. Establish pioneer companies or operate small scale hatcheries through a Cooperative Service Center. A pioneer company might be organized (as a "Perusahaan Nasional Pribumi") around a group of young university graduates from both business and biology faculties. The company would be assisted by a respected local business leader on a volunteer basis. In the case of a cooperative service center, the hatchery would be owned by the member KUDs or kelompok tani, but technical staff would be hired from outside the member groups. The hatchery would provide a nucleus around which the organization would be strengthened and its range of services to member groups expanded.
3. Upgrade DGF tambak demonstration centers in Central Java and South Sulawesi and finance short term courses.
4. Provide direct technical assistance to tambak farmers through the lead farmer system. This assistance will emphasize quality control through the introduction of best post-harvest handling possible. Processors should be encouraged to provide incentives to tambak farmers if they provide higher quality shrimp.
5. Establish a model in-kind credit program to provide fry, fertilizer, milk fish fry, feeds and pumps to groups of small scale tambak farmers. The mechanism,

i.e., type of bank, would depend on the borrower--whether kelompok tani, KUD, or "pioneer" company.

6. Encourage the production of artemia cysts by small scale salt producers on Madura through the reactivation of appropriate demonstration plots at the village level. Project personnel would provide direct, on-site assistance to salt producers in production, processing and marketing of the cysts. Direct market channels would be established between producers and hatcheries. Expatriot personnel could most likely be provided from one of the ASEAN countries, either Thailand or the Philippines, where artemia cysts are currently being produced for use by the aquaculture industry. Previous studies of artemia potential have suggested overseas short term training in complex biochemical analysis of cyst quality and development of cyst production through the national salt company. We believe that the former is of little use because of lack of equipment in Indonesia, while the latter is not required since the national salt enterprise should have sufficient funds available to undertake such a project. The small scale salt producer is a much more appropriate target group.

This proposed project maintains the two part institutional focus described earlier: developing government capability for transferring technology to the private sector and working directly with the private sector in technology implementation.

Suggested institutional relationships for the project are shown in Table 78. Two elements of this project, upgrading DGF hatcheries and tambak demonstration sites, will be undertaken directly with provincial D.P.s. The location for this project cannot yet be recommended, but East Java and South Sulawesi are likely sites. While current DGF hatcheries are in very bad shape, the team believes that they developed poorly due to poor training and bad technology. Our reasons for recommending a DGF hatchery program are based in part on the development of DGF macrobrachium hatcheries. Here, where technical assistance was provided and appropriate technology and training were introduced, the DGF hatcheries are working well and the technology is spreading. It shows, hopefully, that with appropriate technology, training and technical assistance, the DGF can successfully operate shrimp hatchery facilities.

The institutional focus for a program in tambak management and handling/quality control will be direct technical assistance to small-scale tambak farmers. Because of the need to work with farmers' groups and the need to develop (or provide) better credit facilities and management, this project will likely have to be coordinated with local KUDs (and perhaps the Department of Cooperatives) and the BIMAS/INTAM program. It is important that the institutional arrangements developed should be focused on providing direct assistance to small scale farmers.

TABLE 78: Small Scale Penaeid Shrimp Hatchery Development: Institutional Developments

1.	Hatchery renovation and training	DGF
2.	Hatchery development through cooperative service centers	DG of Coops.
3.	Development of pioneer companies	DG of Small Industry
4.	Tambak demonstration center improvement	DGF
5.	Direct technical assistance to tambak farmers	BIMAS
6.	Model credit program	BIMAS, BRI, regional development banks
7.	Artemia propagation	DGF, BIMAS

The team believes that the best way to develop artemia production is not through government demplots, but through DGF extension and demplot development at the village level. Because of the need to develop village level (as opposed to government) extension work and demonstration plots, direct assistance should be provided to local villages. In addition, it is likely that credit will be required and that KUDs or klompok tanis may be formed. As such, coordination with the Department of Cooperatives and Credit Institutions will be required.

Finally, and perhaps the most difficult institutional problem to deal with, is the development of small scale private hatcheries. The insititutional problem is quite simple: the team believes that direct technical assistance should not be provided to private sector hatcheries that are backed with enough capital resources to buy whatever technical assistance they need. However, the team also believes that there is a strong need for developing small scale hatcheries which directly benefit small scale farmers and their KUDs or kelompok tani. The question then becomes: "How can the development of private small scale hatcheries that are not backed by powerful financial interest groups be aided?" The team has discussed this issue widely and offers three institutional possibilities: a cooperative service approach, a "pioneer" company, and a non-profit foundation.

During the team's field work, interviews were held with CLUSA representatives in South Sulawesi and Central Java regarding their program activities. Of particular interest was the Puspeta project. As described to the team, Puspeta is an autonomous, independent and secondary cooperative working with primary KUDs and farmers' groups. Its goal is to encourage the development of cooperatives from the bottom up by working independently of governmental structures within which KUDs operate as "branch-offices" of government provincial cooperative programs. By instituting this type of structure, Puspeta is theoretically able to help generate KUD participation through the use of a "cooperative foundation." This foundation provides management, and financial and technical support to the individual cooperatives and encourages them to develop small scale industry. It also allows the individual cooperatives to take advantage of potential economies of scale and comparative advantage by working within the framework of a group of cooperatives.

The team believes that this may be a mechanism that could be used to provide assistance to small scale tambak farmers. If a "shrimp cooperative service center" were established to provide assistance to cooperatives involved in shrimp farming activities and to form a "foundation" for such cooperatives, this might well provide an institutional focus for an integrated small scale hatchery and tambak management program. For example, this cooperative service center could fund the development of a small scale hatchery which would actually be owned and operated by the service center. As the hatchery became self-sufficient, its management and operations could be taken over by the service center or transferred to an appropriate member co-op. In the same way, experimental artemia production could be developed by the service center in a different member co-op. Finally, a "marketing" co-op could be developed which would be responsible for improved handling and quality control. The advantage of this approach is that each member cooperative would have its "market" within the service center <u>and</u> that the service center, run by the member cooperatives as a whole, would serve to ensure smooth relationships among members. It also has the advantage of providing hatchery and other technical assistance directly to farmer groups who should be the target group.

The disadvantage to this approach is that time and care will have to be taken to form the "foundation." In fact, it may require a year or more to establish the institutional mechanism by which to introduce training and assistance. And, there is no guarantee that such an institutional framework would be successful.

An alternative to this would be to establish an arrangement with a private, non-profit foundation to provide model hatchery development and training. The current Central Java Enterprise Development Project is pursuing such a strategy through its work on shrimp hatcheries with Dian Desa. Such a foundation would then be called upon to be the technology transfer agent to small scale farmers. This approach has the advantage of working with an already established and (hopefully) respected institution with experts specializing in rural development. However, it has the disadvantages that such an organization may be difficult to find and that the assistance is not provided directly to the target group. CJEDP activities in this area should be monitored closely to see if such an approach is effective in providing assistance/aid to small scale fish farmers.

A third approach would be to work with the appropriate GOI agency to establish small scale privately run hatcheries. In this approach, candidates (preferably graduates of fisheries schools) would be identified for training in hatchery technology and business management techniques. A group of these candidates (say three to five) would be trained and then assisted in the start up of small scale private hatcheries. Grants and loans from Indonesian credit programs might be combined to fund this activity. These small scale hatcheries would then be provided technical assistance for a period of several years until they could run independently. This approach could, in fact, be combined with the service center concept.

This approach has the disadvantage of not necessarily providing direct assistance to farmer groups. Some means of ensuring increased fry availability to small scale farmers might have to be introduced. In addition, efforts to get sufficient credit resources for building the hatcheries could be difficult.

6.3.3.1 Implementation Issues

Target Groups

It is clear that most of Indonesia's private sector hatcheries are funded by people and groups who have enough capital and backing to buy whatever technical assistance they require. However, we are also aware that successful hatcheries and increased supplies of fry are essential to the increased income of fish farmers. It is for this reason, in fact, that the Government of Indonesia has specifically asked for assistance in this area. And it is for that reason (increasing the standard of living of tambak farmers) that we recommend that the government obtain donor agency assistance.

The role of the GOI in this regard should be to properly train hatchery specialists and to provide first rate facilities which stand as models for hatchery development. In both of these roles, the GOI is severely lacking. At present, GOI penaeid shrimp hatcheries are not serving a useful purpose - they are generally faulty in design and underfunded, sometimes operating only one or two months per year. In addition, key government training facilities are promoting and transferring technology which is inappropriate for Indonesia and which is years out of date. This study team believes that assistance should be requested in the area of shrimp hatcheries to rectify this situation.

Another question which has arisen is whether or not tambak owners and operators are an appropriate target group for assistance because some shrimp processors are integrating "backward" into hatcheries and tambaks. It is therefore suggested that large scale investors are "buying" up large areas of tambaks from small scale farmers. Land ownership patterns in Indonesia are extremely complex, including a mixture of formal legal ownership and traditional ownership patterns. Developing a clear understanding of ownership patterns was beyond the scope of this project; however, some general observations can be made.

According to data in Table 65, almost 80% of all households involved in tambak aquaculture have holdings of less than 5 ha. This accounts for an estimated 55% of all ha of current tambak. In other words, farms of less than 5 ha comprise well over 50% of total tambak hectarage. If one looks instead at tambaks of 10 ha or less, these figures increase to 96% of brackishwater households employed in aquaculture and over 85% of total tambak area. These estimates are developed in Table 79.

TABLE 79: Hectares in Tambaks by Size of Tambak

Average Estimated Holding Size	Number of Households	Area (Estimated) Hectare	% of Total Area
1 ha	30853	30,000	15
3 ha	25312	75,000	38
6 ha	10352	60,000	31
15 ha	2508	30,000	15
TOTAL	9025	195,000	99%

In lieu of more complete information on land ownership patterns, which we feel may be difficult or impossible to obtain, it seems clear that there are a substantial number of independent "small holder" tambak operators in Indonesia. Another question that arises is whether or not these tambak farmers are a good target group, from an income perspective, for assistance.

Income to tambak farmers varies, of course, by type of farming, site of farm, and on whether one is looking at the owner or his workers. The best small scale tambak operators were reported to make a gross income of about Rp. 1,800,000 per year per hectare. However, it should be noted that many of the tambak workers make on the order of 10-20% of this amount per year.

The 1980 Tambak Irrigation Project report written by Amythas Experts and Associates found that in West Java, net return ranged from Rp. 63/ha to Rp. 253/ha. For a small farmer (1-2 ha), this does not allow much room for savings, investment or even living expenses (1980 data). Based on Table 66, one can generate an estimate of average gross income per hectare to tambak farmers, as seen in Table 81. These figures are only "ballpark" estimates of income before subtracting costs.

Without taking into account economies of scale that come with large land holdings, and looking at the average tambak farmer rather than the best farmers, it seems relatively clear that small scale tambak farmers, at such a low income, are an excellent target group.

It is also important to note that while there are up to 500,000 people involved with brackishwater aquaculture, this is a small percentage of the total workers in the fisheries sector.

Other Donor Agencies

The Asian Development Bank, through its Brackishwater Aquaculture Development Project, is providing for the rehabilitation of about 280 km of primary and secondary canals servicing about 19,780 ha of tambaks; five shrimp hatcheries, each producing about 40,000,000 fry per year; training of extension workers to work in the project areas as well as the use of these people in the field; training of hatchery personnel; on-farm development; and the introduction of pumping schemes for about 2000 ha of ponds.

This project, at a cost of over US $50,000,000, would seem to swamp any contribution that another donor agency might make. However, this study team believes that this is not true for a variety of reasons. First, while it has been surprisingly difficult to obtain information on the status of the ADB project, we feel that their hatcheries may not effectively serve small scale tambak farmers. Second, the ADB project targets only a small portion of Indonesia's tambaks and does so without taking into account a greater, overall coastal resources management context.

TABLE 80: Tambak Yields in the Project Area

	West Java	Central Java	East Java	South Sulawesi	Aceh
Milkfish a/	205	326	320	380	384
Tiger Shrimp b/	14	13	40 e/	75	40
White Shrimp c/	50 e/	50 e/	70	60	128
Trash Fish d/	265	125	135	90	95

<u>1977-1979 average for</u>:

a/ *Chanos chanos*,

b/ *Penaeus monodon*

c/ *Penaeus merguiensis*, *Metapenaeus endevouri* and (in Aceh) *Penaeus indicus*

d/ Tilapia, gobies, mullet, small crustacea, etc.

e/ FAO estimates

Price Estimates:

Milkfish	-	Rp. 1,000/kilo
Fry Fresh Fish	-	Rp. 250/kilo
Tiger Prawn	-	Rp. 7,000/kilo
Banana Prawn	-	Rp. 2,000/kilo
Other	-	Rp. 250/kilo

TABLE 81: Gross Income Estimates Per Ha (Rps) Per Crop

	West Java	Central Java	East Java	South Sulawesi	Aceh
Milkfish	205,000	126,000	320,000	380,000	384,000
Trash Fish	66,250	31,250	33,750	22,500	23,750
Tiger Shrimp	98,000	91,000	280,000	525,000	280,000
White Shrimp	100,000	100,000	140,000	120,000	256,000
TOTAL	418,000	466,700	693,750	952,500	847,750

The study team would like to see tambak development in connection with management of mangroves and upland watersheds. Third, while the ADB and the GOI plan to determine the final disposition of the hatcheries (either to the private sector or KUDs), this will not occur until 1988 or 1989 and it seems unlikely that small scale farmers or KUDs will be able to afford "leasing" or effectively compete for such a hatchery. Fourth, fry and extension services will only be provided to farmers in the project area. Finally, the ADB project does not seem to address handling and quality control issues.

While the strengths and weaknesses of this ADB project should be carefully considered, this study team believes that there is room for other donor agencies' involvement in this key sub-sector of the overall fisheries sector in Indonesia. In short, the target group of such assistance should be the small scale shrimp farmers because it is not clear that the ADB project addresses their needs.

Export Commodity Development

The Government of Indonesia has identified fisheries (and particularly shrimp) as a major area for development in Repelita IV. Its goals include: attainment of higher income levels and quality of life for fishermen and fish farmers, increased production and increased exports.

There is little question that increased shrimp production in tambaks will increase the income of shrimp exporters. However, one must retain the broader perspective and look to the over 400,000 tambak farmers (and the over 60,000 households) who will also benefit. One must look to increased income and earnings to fish farmers and weigh that against the slightly decreased production of food fish (e.g., milkfish; in general there seems little argument, however, that major increases in fish production for domestic consumption will likely have to come from unexploited marine stocks, not tambaks). One must also look at this sub-sector within the context of other fisheries activities. The other projects recommended here for the aquaculture sub-sector are directed at domestic production and consumption, and it must be determined if they can balance between the varied objectives of providing for increased food production, income and employment generation, export earnings and conservation.

Quality Control

The problems with quality control of shrimp must be addressed, including the handling of shrimp from harvest to export. The health problems created by polluted water in tambaks are now being dealt with by "washing" the shrimp in a chlorinated solution. Consideration should be given as to whether this is an acceptable practice. However, it should also be kept in mind that almost US $200 million in shrimp was successfully exported from Indonesia in 1983. Clearly, the export market is strong in spite of these problems. Rather than back away from such an industry-wide problem, it might be more useful to assist in quality control from tambak to the processor.

6.3.3.2 Risks

This project has several risks which are summarized here:

- o environment--siltation of irrigation channels may cause serious problems in water supply;

- o environment--water pollution causes problems in quality control;

- o credit -- mechanisms are required to provide improved credit facilities to small scale fish farmers;

- o target group - care must be taken to ensure that assistance reaches the appropriate target group; and

- o DGF commitment -- assurances must be given that if DGF facilities are upgraded, they will be properly supported after the project. In light of this, project design should include some work directly with the small scale farmers to ensure that project goals are met.

6.4 Training Needs and Institutions in the Aquaculture Sector

We see the most pressing need for training among people directly involved in production. At present, aqualculturists get training at a variety of institutions or through traditional means. Some available facilities are:

- o DGF demonstration centers,

- o universities,

- o specialized secondary schools such as Tegal and agricultural secondary schools, and

- o the Fishery Industry Academy in Jakarta.

In all project components, we have advocated strengthening DGF facilities at the Dinas level because these facilities are widespread and are currently offering training in fish and shrimp farming. Although some of these centers provide effective training, most are underfunded and require facility improvement. In addition, there are staff shortages and existing staffs need upgrading. Some centers also use outdated, inefficient technology. Strengthening these centers will pay off in more effective interaction with the aquaculture industry.

If it proved feasible to establish model hatcheries through cooperative service centers, excellent "hands on" training opportunities would be made available to the private sector. A non-profit aquaculture foundation might have training as one of its main objectives. However, the existing Dinas system probably offers the quickest way to extend technology to fish and shrimp farmers.

At present, no university has adaquate facilities for training brackishwater scientists. Hopefully, the AARD center at Maros, South Sulawesi, will establish strong links with Hasanuddin University to enable university faculty and students to conduct appropriate research. Such a relationship would also strenghthen AARD's research effort. The same holds true of the research center now under construction at Gondol.

6.5 Government Programs and Policies Affecting Aquaculture Development

The Government of Indonesia's policy has identified aquaculture as an area for considerable growth during Repelita IV. In particular, the government has placed the development of brackishwater shrimp production very high on its list of development priorities. However, there are some policies and programs which will have an effect on the future of aquaculture development in Indonesia.

6.5.1 Credit

One of the key problems facing small-scale fish farmer and aquaculture development is the availability and viability of credit from institutional sources. Much credit provided to fish farmers is "in kind" credit (loans of fry and fertilizer) which is repaid at harvest time. This credit is, however, prone to create ties between the lender and borrower which are subject to some abuse. Institutional credit programs are marked by high defaults, a lack of farmer understanding of loan terms, and little or no project evaluation and/or supervision.

The credit programs available for fisheries and aquaculture financing are reviewed in a number of documents and need not be reiterated here (see 1983 ADB Fisheries Sector Survey, for example). Several of these loan programs are unsuitable for small scale fish farmers (KIK and KMKP require land holdings of over 3 ha), while others are difficult to get because they require land certificates and up to 100% collateral. The BIMAS Fishery Credit Program is, in theory, suited to small scale brackishwater shrimp farmers because it provides soft credit terms and no collateral. However, the maximum amount of the loan is Rp. 5 million, which is not enough in most cases to provide for the investment and operational needs of the fish farmers. The purpose of the brackishwater aquaculture intensification program (INTAM) is to increase total production and productivity of brackishwater aquaculture by focusing on the following six areas:

1) pond construction
2) water supply and management

3) pond preparation
4) increased stocking rates
5) processing and marketing
6) management.

It is hoped that in FY 84/85, the project will address these problems in 11,300 ha of tambak in Aceh, Java and South Sulawesi. Polyculture (shrimp and milkfish) will acount for 10,300 ha and 1,000 ha will be monocultured shrimp.

The INTAM program will provide "credit packets" for needed inputs such as fry, fertilizer and pesticides. The credit scheme will, in general, be funded by KIK and KMKP. It will serve farmers with holdings of less than 2 ha, and will provide up to Rp. 8,320/ha for monoculture and Rp. 3,331/ha for polyculture.

During the course of this study, several key problems with credit have become clear. These are:

1. Insufficient funding levels — credit available to carry out pond rehabilitation and upgrading of dikes is not nearly commensurate with the cost of such activities. For instance, one estimate is that it cost Rp. 3,000,000/ha for inputs and operating costs for brackishwater fish/shrimp culture. The BRI will only loan up to 50% of this amount.

2. One reason for low funding levels is a lack of land ownership certificates for fish farmers. Banks want to loan against collateral, i.e., land, and the farmers have only historical claims. Obtaining land certificates can be a long and costly process.

3. Because farmers harvest intermittently, they require credit not only for rehabilitation of ponds, for inputs, and for operating costs, but also for everyday living expenses instead of for "production" purposes.

4. Actual interest rates are high; typically on the order of 20%. Even with lower rates, when one adds in fixed costs and opportunity costs of obtaining credit, the actual cost of money is much higher.

5. Often credit will only be approved post-harvest, and then only up to 50% of the harvest (maximum). However, the farmer needs credit to provide inputs to the ponds and to support workers and families prior to the harvest. It's not much different from the old complaint that "you can't borrow money unless you prove you don't need it."

6. Perhaps the most difficult problem is the sheer complexity of the credit system, which simply overwhelms many small fish farmers.

These problems will be difficult to overcome. One mechanism for doing so is clearly the KUD movement which can serve as an intermediary between individual farmers and loan programs and which can, by itself, serve as a savings and loan organization. The KUD movement must be further developed to be fully effective and it must:

(1) be an organization created by farmers and not by the government;

(2) establish trust among its members; and

(3) be able to obtain and provide managerial talent to help with credit, marketing and supply services. From the observations of this study team, the KUD movement is developing, albeit slowly.

This study does not provide an adequate analysis of credit and credit facilities or of the KUD movement. It is clear that any project which addresses the needs of small scale fish farmers will have to look more closely at these things.

6.5.2 Environmental Concerns

There are no direct detrimental environmental effects of the proposed Sumatera Freshwater Fisheries Project, of the Small-Scale Penaeid Shrimp Hatchery and Tambak Intensification Project, or the Macrobrachium or Giant Freshwater Shrimp Development Project. However, there are several environmental risks to the long term success of these projects, particularly water pollution and siltation.

Many freshwater streams are becoming increasingly polluted throughout Indonesia and the continuation of this pollution could, in the long run, have serious detrimental effects on the overall health of the entire inland fisheries industry (including open water fishing and fish culture). While these environmental concerns/risks must be dealt with on a broad scale, the study team believes that the Sumatera Freshwater Fisheries Project should go ahead, due to the fact that it will, of itself, cause no environmental harm.

Siltation presents a much more serious and immediate problem to projects in some areas dealing with tambak intensification and water supply (irrigation canals). While the study team believes that efforts should be made now to increase the effectiveness of existing tambaks through intensification and better management, it is fully aware that unless efforts to manage forestry and upland resources are made, siltation problems will undermine the irrigation systems which are vital to brackishwater fish/shrimp culture. This problem must be dealt with in conjunction with tambak improvement efforts. A prime example of the need for this is the on-going ADB Brackishwater Fisheries Development Project which is rennovating canals that feed some 20,000 ha of existing tambaks. It is not clear to this study team what is or will be done to keep those canals from gradually re-silting relatively soon after they are rehabilitated.

6.6 List of Persons Contacted

1.	Mr. Abdu Rachman	Director General of Fisheries
2.	Mr. Burhanuddin Lubis	Director for Production Development
3.	Mr. Slamet Prayitno	Director of Extension
4.	Mr. Soleh Samsi	Head of Subdirectorate of Aquaculture
5.	Mr. Abdullah Ben Peuken	Head of Subdirectorate for Extension
6.	Mr. Dikdik Sodikin	Subdirectorate of Resources Development
7.	Mr. Sumarno	Subdirectorate of Resources Development
8.	Ms. Sutopo	Head of Foreign Corporation Subdirectorate
9.	Mr. Mudjitaba	Staff of Business and Enterprise
10.	Mr. Muchtar	Staff of Infrastructure Development
11.	Mr. Hartoyo	Head of Subdirectorate of Hatchery Production
12.	Mr. Damanhuri	Director of Planning
13.	Mr. Robinson Sihite	Head of Subdirectorate of Planning
14.	Mr. Djoko Sugiarto	Head of Finance and Budget Directorate of Planning
15.	Dr. Susanto Hardjolukito	Staff of Business and Infrastrucutre
16.	Mr. Ichtiadi	Staff of Directorate of Production Development
17.	Mr. Hutagalung	Staff of Foreign Cooperation
18.	Mr. Haji Achmad	Fish Farmer
19.	Dr. Ir. Gunawan Satari	Director, AARD
20.	Mr. Sofyan Ilyas	Head, Central Fisheries Research Institute
21.	Mr. Alie Poernomo	Head, Coastal Aquaculture Reserch Institute

22. Mr. Atmadja	Director, Inland Fisheries Research Institute
23. Dr. Purwito	Director, Marine Fisheries Research Institute
24. Sr. Sampurno	Head, Sub-station of Fish Technology
25. Mr. Tatang Sudjastani	Staff, Marine Fisheries Research Institute
26. Mr. Dwiponggo	Chief, Directorate of Planning, AARD
27. Mr. Zulkifli Zangkarau	Staff, Inland Fisheries Research Institute
28. Dr. Kee Chai Chong	Consultant, Socio-economics, ICLARM
29. Mr. Abdurrachman	Staff, CRIF
30. Mr. Yusuf Hardjadipura	CRIF
31. Mrs. Hartati	CRIF
32. Mr. Rosmadji	Staff, Contractor Widjaya Karya
33. Mr. Lim	Staff, Mina Seraya Perdana Peneus
34. Mr. Kusno Rahardjo	Chief of Fisheries, North Sumatera
35. Mr. Sembiring	Head, Extension Services, North Sumatera
36. Mr. R.B. Sihombing	Head, Fisheries Marketing, North Sumatera
37. Mr. Z.P. Syahbandi	Head, Fisheries Planning, North Sumatera
38. Mr. Martondang	Head, Fisheries Production, North Sumatera
39. Mr. Pardede	Chief, Parapat Fisheries Station
40. Mr. James Lucas	USAID Consultant at Lake Toba
41. Dr. Catalino de la Cruz	USAID Consultant, Pematang Siantar
42. Mr. Damanik	Ambarita Hatchery Manager
43. Mr. Siswanto	Karasaan Hatchery Manager
44. Mr. Sihombing	Private Hatchery Owner, Pematang Siantar
45. Mr. Sartin	Traditional Nila Tambak Owner
46. Mr. Aminuddin	Ketua II KUD Mina Makmur Belawan
47. Mr. Sinaga	Chief, Fishery Simalungun District
48. Mr. Frederick Chandra	Director, P.T. Juta Jelita
49. Mr. Edy Mulyono	Director, P.T. Juta Jelita

50. Mr. Hutagalung	Chief, Fishery Service, Medan
51. Mr. Marjono Atimoredjo	P.T. Summa International, Consultant for Bank Indonesia
52. Ms. Sri Sulasmi	Staff, Karasaan Carp Hatchery
53. Ir. Mochtar Abdullah	Chief, Fishery and Animal Husbandry Division, BIMAS
54. Ir. Dundung Abdul Adjid	Secretary, Bimas
55. Ir. Rifai Husen	Chief, Planning Division, BIMAS
56. Ir. Umar	Chief, Production Development, Sumatera Selatan
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58. Mr. Suprapto	Manager, P.T. Pioneer, Palembang
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61. Mr. Titi Sari	Staff, Fishery Service, Dinas Perikanan, Sumatera Selatan.
62. Mr. Muchlis	Staff, Dinas Perikanan, Sumatera Selatan
63. Dr. Hardjoeno	Deputy Rector, Hasanuddin University
64. Prof. Amiruddin	Governor, South Sulawesi Province
65. Dr. Mas'ud Sikong	Hasanuddin University
66. Mr. Kismowarih	Staff, Dinas Perikanan, South Sulawesi
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68. Ir. Husni	Head, Program and Planning Division, Dinas Perikanan, South Sulawesi
69. Dr. Andi Singke	Chief, Fishery District, Maros
70. Mr. Abdurrachman	Staff, CRIF
71. Hadji Badang	Tambak Farmer, Maros
72. Mr. Andi Bur	Chief, Fishery District, Barru

73. Mr. Suharto	Penaeus Monodon Hatchery, P.T. Perru Desa Takalasi, Barru
74. Ir. Andrias Giling	Staff, P.T. Perru
75. Mr. Nurisak	Balai Benih Udang, Barru
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78. Mr. Maksimus	Staff, Balai Benih Udang, Barru
79. Mr. Nurdin	Milkfish Fry Collector, South Sulawesi
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81. Ir. Ary Dwiyanto	Staff, P.T. Bina Upaya Benur, South Sulawesi
82. Dr. A. Badarudin	Chief, Fishery Service, Wajo District
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86. Mr. Aspari	Staff, P.T. Nursale Galesong, South Sulawesi
87. Mr. Slamet Subardjo	Staff, P.T. Nursale Galesong, South Sulawesi
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93. Mr. P. Mari Marna	Subject Matter Specialist, Dinas Perikanan Maluku Province
94. Mr. Sangaji	Chief for Extension Development, Fishery Service, Maluku Province
95. Dr. Ir. J.L. Nanere	Vice Rector, Pattiumra University

96.	Mr. Umarella	Chief for Administration Development, Fishery Service, Maluku Province
97.	Mr. Djuhari	Chief of P.P.A., Fishery Service, Maluku Province
98.	Mr. Nyoman Tjahyadi	Chief, Trade Serve, Maluku Province
99.	Mr. Engko	Vice Governor of Maluku Province
100.	Ir. A.G.G. Harmony	Chief, Fishery Service, Bali
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102.	Mr. Dewa Gede	Staff, Macrobrachium Hatchery, BBUG, Bali
103.	Mr. Merangi	Staff, Macrobrachium Hatchery, BBUG, Bali
104.	Mr. Ida Bagus Putra	Staff, Macrobrachium Hatchery, BBUG, Bali
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107.	Mr. Tadjudin Dauly	Acting Manager, Gondol AARD Facility
108.	Ir. Ibnu Hajar Zain	Chief, Fishery Service, East Java Province
109.	Mr. Eddy	Staff, Fishery Service, East Java Province
110.	Mr. Mohamad Soleh	Chief, Fishery District, Bangkalan
111.	Mr. Imam	Chief, Fishery District, Sampang
112.	Mr. Chou I Lung	Consultant, Republic of Korea
113.	Mr. Nurhadi	Chairman, KUD Bangil, Koperasi Tani Tambak
114.	Mr. Affandi	Chairman, KUD Bangil, Koperasi Tani Tambak
116.	Mr. Nursedjati Ma'ruf	Manager, Prigi Machrobrachium Hatchery
117.	Mr. Subianto	Staff, Prigi Machrobrachium Hatchery
118.	Mr. Soehoed Rahoetomo	Balai Induk Udang Galah, Pandaan

119. Ir. Mulyono	Deputy Director, Brackishwater Pond Development Program, Surabaya
120. Mr. Mudjiman	Manager, BBU, Pasir Putih
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137. Mr. Budiarno	Starr, Fishery Service, Yogyakarta

138. Mr. Basirun	Fish Farmer, Bantul District, Yogyakarta
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