East-West Environment and Policy Institute

Research Report No. 3

A Strategic Goal Analysis of Options for Tuna Longline Joint Ventures in Southeast Asia: Indonesia–Japan Case Study

by Gerald Marten
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East-West Center
Honolulu, Hawaii

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FOREWORD

Changing national perceptions of the ocean are resulting in the unilateral extension of national claims to ownership of resources in the seabed and the watercolumn up to 200 nautical miles from national baselines. Nevertheless, many marine resources such as fish, oil, and environmental quality are transnational in distribution; the ocean, a continuous fluid system, transmits environmental pollutants and their impacts; and maritime activities such as scientific research, fishing, oil and gas exploration, and transportation often transcend the new national marine jurisdictional boundaries. Management policies for these national zones of extended jurisdiction may be developed and implemented with insufficient scientific and technical understanding of the transnational character of the ocean environment. Such policies may thus produce an increase in international tensions, misunderstandings, and conflicts concerning marine activities, resources, and environmental quality.

These issues form the conceptual framework for the EAPI project, "Marine Environment and Extended Maritime Jurisdictions: Transnational Environment and Resource Management in Southeast Asian Seas." The goals of the project are to provide an independent, informal forum for the specific identification and exchange of views on evolving Asia-Pacific ocean management issues, and to undertake subsequent research designed to provide a knowledge base to aid in the international understanding of these issues.

With the near-universal promulgation of 200-nautical-mile fishing zones, access of distant-water fishing fleets to stocks within many of these zones is undergoing an abrupt or phased reduction, or an alteration of operational terms. As a result, distant-water fishing efforts are becoming concentrated in jurisdictional zones of nations permitting favorable concessionary access. Such a concentration of highly efficient effort endangers maintenance of optimum sustainable yield of stocks, especially if their distribution and population dynamics are poorly understood. For species which migrate between national zones, intensified distant-water and/or coastal state efforts within a particular national zone could have implications for other nations which have interests in and/or claims upon these migratory stocks.

The objectives of this part of the Project are to compare the advantages and disadvantages—for the resource owner, resource exploiter, *and* the resource—of various cooperative arrangements for distant-water fishing for tuna. This inquiry has received the focused effort of a multidisciplinary, multinational research team led by Gerald Marten, (Ecologist, U.S.) Research Associate, EAPI; and Yoshiaki Matsuda, (Economist, Japan) Research Associate, EAPI; and consisting of John Bardach, (Marine Biologist, U.S.) Research Associate, RSI: Salvatore Comitini, (Economist, U.S.) Adjunct Research Associate and Associate Professor of Agricultural Economics and Economics, University of Hawaii; Surna Djajadiningrat (Economist, Indonesia) Research Intern, EAPI; Sutanto Hardjolukito (Economist, Indonesia) Grantee, EAPI; Kazuomi Ouchi (Law Professor, Japan), EAPI Fellow; and Virginia Aprieto (Fisheries Biologist, the Philippines), EAPI Fellow. Both the substantive focus and the team composition and interaction are representative of the East-West Center style. This EAPI Research Report is the first of several on this subject.

Dr. Mark J. Valencia
Project Coordinator

A Strategic Goal Analysis of Options for Tuna Longline Joint Ventures in Southeast Asia: Indonesia – Japan Case Study

by
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ABSTRACT

With the advent of extended maritime jurisdictions, new arrangements will be sought between fisheries resource owners and distant-water fishing fleets that may want to share use of fishery resources. Each party has motives for wanting to exploit the fishery, and each has strengths and weaknesses in doing so. The purpose of this study was to develop a logical process to identify arrangements that are fair and profitable for both parties. As a case study, we examined conflicts and agreements of interest between Indonesia and Japan with respect to arrangements they might have for exploiting Indonesia's tuna fishery. Forty-eight possible arrangements between the two countries were evaluated by a multinational, multidisciplinary team employing goal analysis, an optimization technique for dealing with multiple objectives. The arrangements differed in the following respects: type of fishing operation (all of them longline, but differing with respect to vessel size and other characteristics); kind of processing (cold store, freezing and canning, canning, or freezer-carrier operations); ownership (Indonesian, joint-venture, or Japanese); base of operation (Indonesia or Japan); participating Japanese sector (small-scale tuna fishermen, medium-scale tuna fishermen, or traders and large-scale fishery companies); and marketing alternatives (fresh fish, frozen fish, or canned goods markets). Tradeoffs were examined among eleven goals that might be pursued in negotiating an arrangement: employment, foreign exchange earnings, fishermen's income, profits, technology transfer, and cost minimization for Indonesia; tuna supply, use to full capacity of existing fleet, employment, fishermen's profits, and traders' profits for Japan. The role of constraints on capital that Indonesia might put into an arrangement was also examined. This study found many points of agreement of interests between the two countries, to the extent that they can share in efficient and profitable fishing, processing, and marketing operations, where both parties can enjoy the benefits. In particular, freezer-carrier operations combined with Indonesian-based fishing offers many advantages over the recent fee-fishing

arrangement. Genuine conflicts of interests also were found in tradeoffs between employment and profits and in how the ownership and profits of the operations are shared between the two countries. Although results are preliminary and require further refinement and validation before they can assist with real fishery negotiations, this approach to exploring new options for bilateral fishery arrangements has great potential and should be pursued to the point where it can be utilized in practice.

INTRODUCTION

Background

With the advent of extended maritime jurisdictions questions arise about future relationships between fisheries resource owners and distant-water fishing fleets that may want to share the use of fishery resources. Each has its own motives for wanting to exploit the fishery, each has valid reasons to justify its position, and each has its own strengths and weaknesses in its ability to implement its desires.[1]

Despite the efforts of some nations to distinguish highly migratory species such as tuna from other species shared by neighboring coastal states, many developing nations regard tuna as their own property and have initiated negotiations with distant-water fishing fleets concerning the exploitation of tuna within their jurisdictions.[2] As a consequence, distant-water fishing fleets are being increasingly shut off from free access to fish stocks they enjoyed until recently. It seems that a major portion of world fisheries will fall under national jurisdictions as a result of the authority that many countries are in the process of asserting over their maritime resources. Ninety percent of the known world fishing grounds are located within 200 nmi of one country or another.[3] Distant-water fishing fleets are therefore faced with problems of overcapitalization and unemployment unless they can retain access to fish stocks they formerly exploited without restriction.

If the resource owner is a developing country, it likely has a well-developed artisanal fishery that already exploits the numerous species of its inshore areas, but it may be limited in the technical experience, financial resources, and facilities it can bring to bear on fully exploiting its offshore fisheries. This is particularly so for the highly competitive tuna industry, which has developed a sophisticated international network for catching, processing, and marketing the fish, where developing countries stand to gain if they are involved in the entire process, including marketing of final products.

Because distant-water fleets have a surplus of trained manpower and equipment that a fisheries resource owner may lack, it seems logical for resource owners, particularly if they are developing countries, to collaborate with distant-water fleets to obtain full benefits from their fisheries. In fact, such cooperative arrangements existed long before extended maritime jurisdictions entered the scene, but they have not always been satisfactory. The resource-owning nation often feels itself to be in an economically disadvantageous bargaining position from which it is not getting a fair share of the benefits. Furthermore, its real participation is often marginal and does not lead to acquiring skills and equipment that would allow it to grow beyond its dependence on foreign participation.[4]

On the other hand, the foreign fishing fleet often feels insecure about the relationship because of legal advantages the resource owner may have and the difficulties of depending on an inexperienced partner in a highly competitive industry. As a consequence, many such joint ventures have failed. Others have been a commercial success but have continued with inequities leaving one or the other partner dissatisfied with the arrangement that sooner or later have to be resolved.[5]

Numerous extended maritime jurisdiction tuna fishing arrangements are currently under negotiation, and even more will arise in the near future. Therefore, there is a need for a logical process to identify arrangements that are fair and profitable for both parties to encourage an atmosphere of mutual trust for fisheries development.

Research Strategy

The East-West Center is a forum for scientific interchange, providing an opportunity for scientists of the United States, Asia, and the Pacific to examine international policy questions with an openness and flexibility not normally possible during formal negotiations. In this spirit, a small group of fisheries biologists, economists, and lawyers from the United States, Japan, the Philippines, and Indonesia assembled in 1979 under the auspices of the East-West Environment and Policy Institute Project on Marine Environment and Extended Maritime Jurisdictions. The objectives were to bring together information on the exploitation of tuna in Southeast Asia, to examine the implications of the information for transnational relations and fisheries resource management, and to determine the political and economic implications of possible cooperative arrangements for tuna exploitation.

Although each member of the group had his or her own research problem, they decided to undertake a joint exercise aimed at evaluating a broad range of possible cooperative arrangements between fisheries resource owners and distant-water fleets from the point of view of conflicts and agreements of interest between the two parties. Indonesia was chosen

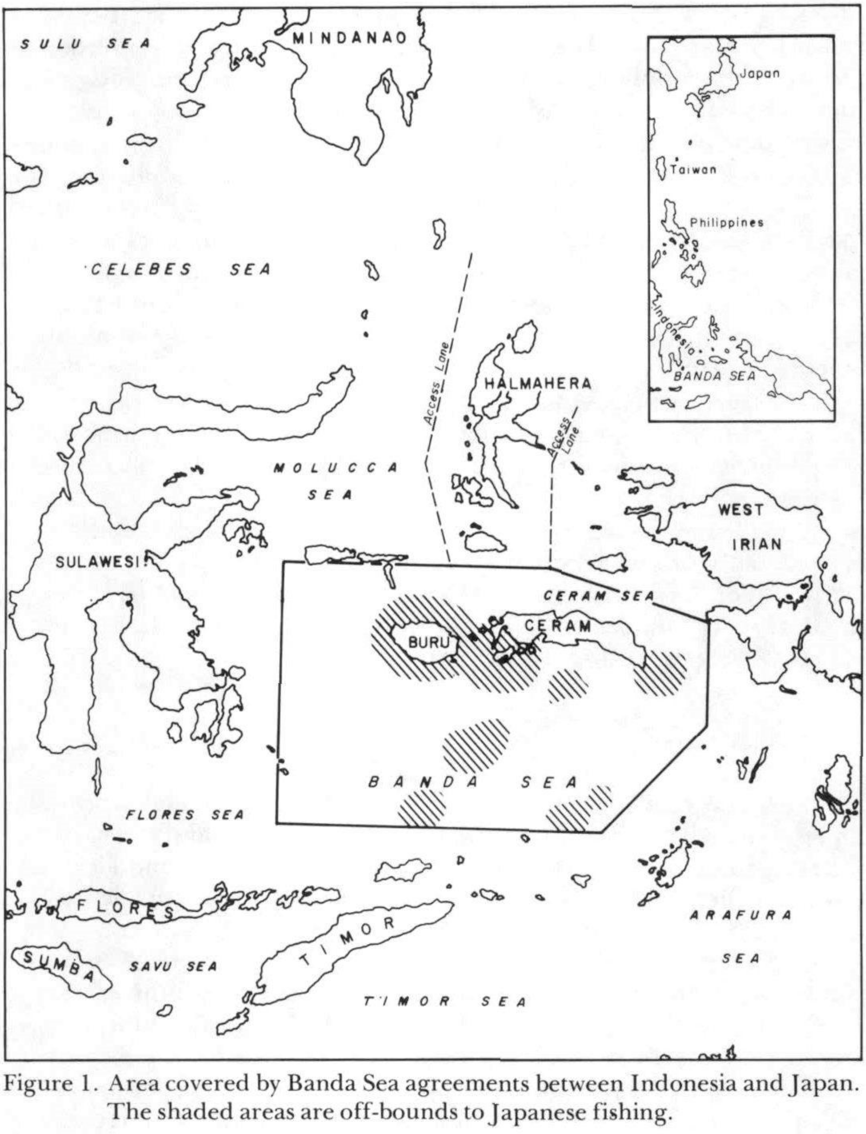

Figure 1. Area covered by Banda Sea agreements between Indonesia and Japan. The shaded areas are off-bounds to Japanese fishing.

as the resource owner and Japan as the distant-water fleet. These two countries have for a number of years had a tuna fee fishing arrangement for the Banda Sea, an area in Indonesia's archipelagic waters (Figure 1).

The investigation was restricted to longline fishing of the large tunas, because this has been a major fishing activity in Indonesia under bilateral agreement with Japan and because suitable data were readily available.

This is not to suggest that tuna longline fisheries are deemed more important than other fisheries (such as purse seining); skipjack tuna, for example, could be particularly important in terms of development potential and significance for future bilateral agreements. The purpose of this report is to use tuna longline fisheries to illustrate an analytic approach that could have useful applications in other fisheries.

Although the project started with this very specific context, the exercise took on a more general character as it evolved, becoming an approach that could apply in many respects to Southeast Asian countries other than Indonesia and to distant-water fleets besides Japan (eg, Korea and Taiwan). The exercise took five months from inception to completion of the first draft of this report. Goal analysis, employing multiple objective optimization in the form of goal programming, was chosen to explore the interests of both partners (Indonesia and Japan) and how each might benefit from a joint fishery.

The group passed through the following steps, each of which is elaborated in a chapter of this report:

1. *Enumerating goals.* Lists of goals were made for Indonesia and Japan. The lists accounted for the fact that different interest groups in the same country might have different goals. It was also recognized that even a single interest group might have goals that conflict with one another. The most difficult part of this step was assigning operational definitions to the goals.
2. *Listing alternative fishery arrangements.* The different possible arrangements between Indonesia and Japan were the decision variables of the optimization problem. To simplify the exercise, the arrangements considered were restricted to longline operations for large tunas, which have a well-developed international market. The most important decisions in listing arrangements concerned classification. Various arrangements were classified according to who participates in the fishing (Indonesia, Japan, or both), who participates in the processing, the type of fishing operation, and the type of processing. Had we been dealing with fish that could be considered seriously for Indonesian domestic consumption, we also would have had to classify the arrangement with respect to marketing and whether the fish are consumed locally or exported. However, because the Indonesian members of the group were of the opinion there is no significant demand for the large tunas in Indonesia, we considered only arrangements leading to export and assumed that marketing considerations after the tuna reached other countries were beyond the scope of our study.

3. *Tabulating the value of each arrangement with respect to each goal.* In this step, data were tabulated to be used to evaluate alternative bilateral arrangements. An example of a goal value is the number of Indonesian fishermen employed under a fee fishing arrangement. Another example would be the amount of Japanese or Indonesian profit in a particular arrangement. A two-way table was prepared, with goals one way and arrangements the other way. This was the most difficult and laborious step in the exercise because it required a concrete description of fishing, processing, and marketing operations to estimate the cost, income, employment, and other results to be expected under each arrangement. It was also necessary to be explicit about joint-venture responsibilities to calculate capital, employment, profit, and so on, that would accrue to each partner.
4. *Evaluating the arrangements.* Evaluation involved identification of (a) arrangements that performed best with respect to the different goals, (b) tradeoffs between the goals, and (c) conflicts and agreement of interest between Indonesia and Japan. We did this in two ways: first by visual examination of the goal values, then by goal programming. Goal programming is an extension of linear programming that operates with the same kinds of linear functions and constraints. It differs from linear programming in that it can have more than one objective function. This allows the user of goal programming to change the priorities placed on different objectives, thereby exploring the tradeoffs between them.
5. *Evaluating the approach.* This analysis involved numerous subjective judgments, and members of the team found themselves in disagreement about these judgments on many occasions. In some cases, the team did not have sufficient information to complete each step of the analysis to its satisfaction; while in others there were more fundamental disagreements. The main results of the exercise to date have been to get a feeling for what we could do with goal analysis, to identify key substantive issues in bilateral tuna negotiations, and to outline a basis for further development of the approach.

HISTORY OF TUNA FISHING RELATIONS BETWEEN INDONESIA AND JAPAN

In Indonesia, skipjack pole-and-line fishing has been operated by state enterprises in Aer Tembaga (North Sulawesi), Ambon, Sorong (West Irian), and one joint-venture company with Japan in Ternate (North Molucca). Tuna longliners, used for large tuna fishing, also have been operated by a state enterprise located in Benoa (Bali) and Sabang (a small island north of Sumatra Island), which possesses 18 modern 90-GT tuna longliners and a cold storage capacity of 1800 MT. This enterprise was established in 1972 with Japanese support and its full operation began in 1975. Its operation has not been particularly successful, however, due mainly to uncertain tuna migrations, limitations in fishing duration because of vessel size, unexpected species composition of the catch, and freezer deficiencies where temperature must be maintained at −48°C to meet standards for sashimi, the highest-priced tuna product on the Japanese market.

Before World War II, Japanese tuna vessels occasionally fished the Banda Sea, Flores Sea, Timor Islands area, and the Indian Ocean south of the Sunda Islands. Research and training vessels also explored coastal areas of Sumatra and the Nicobar Islands.[6] Although these fishing activities ceased by 1945 (the year of the Japanese surrender), they were resumed by 1952 and were extended to the Indian Ocean and the South Pacific Ocean.[7]

In 1957, Indonesia unilaterally declared the archipelagic principle as the basis for the claim over its territorial waters. Indonesia's determination to enforce this principle led to friction between Indonesia and Japanese fishing interests, especially in the Banda Sea. The Japanese protested to Indonesia in 1957 and again in 1960 claiming traditional fishing rights, but Indonesia held its position. A number of Japanese fishing vessels were detained by Indonesian authorities and charged with violation of Indonesian law.

Efforts by the two countries to resolve the matter finally resulted in an interim agreement between the government of the Republic of Indonesia and representatives of the National Federation of Fisheries Cooperatives of Japan and the Federation of Japanese Tuna Fisheries Cooperative Associations in 1968. As the arrangement was valid for only one year, it had to be renewed annually, and negotiations often bogged down during renewal. Because the Indonesians were not satisfied with revenues realized from the agreement, they insisted on modifications that the Japanese accepted not only because of the importance of the Banda Sea fishery for the livelihoods of a significant number of people in the Japanese fishing industry, but also because of the importance of Indonesia to Japanese economic activities.

The arrangement was renewed five times between 1968 and 1975 and brought about US$10 million to the Indonesian government during those years: $147,640 from license fees, $1,929,186 from grants, and $7,856,285 in the form of credit project aid.[8] During the same period, Japanese fishermen caught about 40,000 MT of tuna from the Banda Sea (Japan Fishery Agency, 1970–79), valued at US$20 million (assuming an average price of $500 per MT).

The agreement was revised in 1975 to include pledges of economic assistance and a profit-sharing system. According to this agreement, Indonesia received 40 percent of the profit from Banda Sea fishing. The profit declared by the Japanese, however, was only 2.5 percent of the gross value of the catch so Indonesia received only 1 percent of gross value, not enough to cover administrative costs. Although a quota was set at 8000 MT per year, the average annual catch was only 3048 MT during 1976 and 1978.[9] While up to 100 vessels were permitted to operate under the contract, there were only 23 reporting in 1975–1976, 35 in 1976–1977, and 77 applying between September 1977 and June 1978. Between September 1977 and April 1978, only 35 vessels reported for verification and checking at Ambon. During the three-year period of the revised agreement, besides profit sharing, the Indonesians obtained grants in the form of one training vessel and its equipment valued at US$1.8 million, and a repair shop valued at US$200,000. The Japanese also trained Indonesian fishermen.

The last Banda Sea agreement, based on a catch fee of 3.75 percent of the standard landed value at Japanese ports, was established in 1979. Besides a fixed catch quota of 7000 MT per year, restrictions on boat size and number of trips, exclusive fishing rights for Japan, and obligations for in-country training, it required reporting of catches and inspection of boats at Ambon. Although the last Banda Sea agreement was an improvement from the Indonesian point of view, the fishing activity was economically marginal for Japan, though politically important. The agreement was not renewed in 1980.

GOAL FORMULATIONS

Japanese Perspective

The economic impacts of 200-nmi limits on Japanese tuna and skipjack fisheries are substantial because 48 percent of the tuna and 41 percent of the skipjack catches by the Japanese fishing fleet in 1977 came from within 200 nmi of the coasts of 54 foreign nations.[10] With 200-nmi limits, the conditions imposed on Japanese fishing by coastal nations are ever increasing. These include entry fees, registration fees, fishing fees, quotas, excess catch fees, less favorable joint-venture arrangements, requests for expansion of export agricultural products to Japan, and development cooperation.

Japanese goals for distant-water tuna fisheries correspond to four distinct interest groups: (1) consumers, (2) small- to medium-scale tuna fishermen (called Japanese fishermen in this report), (3) large-scale fishing and trading companies, processors, and other related industries (called Japanese traders in this report), and (4) the Japanese government. Each has different goals and constraints.[11]

Consumers

Japanese consumers want a reliable supply of high quality tuna at reasonable prices. In the face of many factors leading to higher tuna prices, the best way to maintain reasonable tuna prices is to ensure an adequate supply.

Albacore, yellowfin, bluefin, bigeye, and skipjack are regarded as the primary tuna species on the international market, but their markets vary in different countries. Japanese prefer large tuna raw and spiced, although canned tuna usage is increasing. In Japan, bigeye and bluefin are the preferred species for the sashimi market and command the highest prices; yellowfin are next in preference. Skipjack, consumed primarily as katsuo-bushi (a smoke-dried product) but also as sashimi, are generally considered separate from tuna in the Japanese market.

Japanese Fishermen

Members of tuna fishing cooperatives, individuals, and small- or medium-sized companies supply more than 96 percent of the total Japanese tuna catch. As their livelihood depends on tuna fisheries, they have had difficulties adjusting to the proliferation of restrictions placed on their fishing by 200-nmi limits. The tuna longline fishery experienced a comfortable growth during the 1960s, during which the industry established an extensive infrastructure all over the world. A fishing enterprise owns 1 or 2 vessels on the average, and the vessel size has often increased from 20 GT to 50 – 100 GT or 200 – 500 GT as the company has grown.

By the 1970s, Japanese fishermen were confronted with low catches per unit effort and consequent overcapitalization. General inflationary trends, rising labor costs, increasing fuel prices, increasing competition with tuna fleets from Taiwan and Korea, a depressed domestic economy due to oil crises and environmental concerns, and the advent of the 200-nmi limits have combined to weaken these small- or medium-sized enterprises. Since they cannot accumulate enough capital for the joint fishing ventures with coastal states that would help those countries to develop their own fisheries, there are not many choices for Japanese fishermen but to continue fishing for their survival. In recent years, the Japanese tuna longline fishery has been confronted with a series of oil crises involving not only higher fuel prices, but problems of access to fuel such that the survival of the present energy-intensive style of fishing has been questioned. Although Japanese tuna fishermen have integrated horizontally by forming fishing cooperatives, there is also pressure for vertical integration (including processing and marketing) to minimize transaction costs which make up a substantial portion of the marketing margin.

Japanese Traders

Japanese traders are the most prominent tuna joint-venture partners. They are not only able to handle joint ventures financially, but they actually prefer joint-venture arrangements to fee fishing because their marketing role in joint ventures presents the most attractive investment opportunity. Most of these trading companies are new to tuna fishing, but are assuming an expanding role. Although much of their capital is borrowed, their resources are relatively mobile. They are attracted to ventures providing higher rates of return on capital investment than other available prospects. The profit, however, need not always be direct or immediate. It may be satisfactory to the trading company if profits come from byproducts of the joint venture or if profits develop once the venture has grown to maturity.

The Japanese Government

The Japanese government has been responsible for two important areas of national concern: first, facilitating a smooth transition through gradual economic dislocations caused by 200-nmi limits; second, promoting international cooperation. Tuna fisheries in Japan represent a unique distant-water fishing system that has grown out of the traditional subsistence fishery with the encouragement of government licensing schemes. The Japanese fishery has developed a sophisticated statistical reporting system on which current tuna resource assessments depend.

The success of the Japanese tuna fishing fleet has been threatened by new constraints imposed by 200-nmi limits and the limited flexibility of the industry to respond to those constraints due to overcapitalization, cost inflation, and difficulties in relocating displaced fishermen or transferring them to fishing other species. Current trends in Japanese tuna fisheries are not encouraging and may lead to drastic cutbacks. At the same time, the demand for Japanese fishing technology is increasing as coastal states try to develop their own fisheries. Satisfying this demand is a question of transferring Japanese technology to developing countries while gradually reducing the scale of Japanese fishing in those areas.

Indonesian Perspective

Since the government of Indonesia is owner of all fishery resources within jurisdictional limits of the country, the goals of development and management of those resources are necessarily (and rightly so) national, or social goals. In contrast to Japan, Indonesian participation in the fishery is through state enterprise. It is not appropriate for Indonesia to have private goals (eg, profit maximization) interspersed with the social goals since the social goals always have higher priority. Economic considerations, however, such as profit are significant as constraints since the state cannot be expected to take on an enterprise which will lose money. The goals of Indonesia in developing the tuna fishery under its jurisdiction are as follows.

Foreign Exchange

Indonesia needs foreign exchange to meet the needs of its development program. The more the country can produce and sell abroad, the greater its capacity as a nation to earn critical foreign exchange and the less will be its dependence on borrowed foreign capital. The large tunas represent important sources of foreign exchange through sales in markets in Japan, the United States, and Western Europe.

Income and Employment

One of the important development goals of Indonesia is to raise citizen's levels of income and employment, especially those disadvantaged by being far from production centers and markets in heavily populated areas of the country. Eastern Indonesia is one such area with substantial resources of underexploited tuna. Development of a tuna fishery can assist in promoting income and employment in two ways: (1) by transferring small scale fishermen from the relatively low-earning fisheries of the coastal areas to the higher-earning fishery for tuna; and (2) by developing fish processing and distribution facilities which can absorb underemployed labor from lesser-earning activities.

Nutrition

Another national goal of the government of Indonesia is to raise the per capita level of fish consumption in the country from the present level of around 10 kg per capita per year to a more adequate nutritional level of around 30 kg per capita per year. This, however, cannot be done through direct development of tuna resources because the large tunas do not have a market in Indonesia. It can only be done indirectly by developing highly trained fishermen in modern methods of fish harvesting techniques that can be used as a demonstration effect to develop other fisheries for domestic consumption.

Technology Transfer

The government also wishes to foster technology transfer from prospective foreign users of Indonesia's resources to improve and advance the technical skills of Indonesian nationals. Development of tuna resources within the jurisdiction of Indonesia, in cooperation with foreign enterprise, can provide a mechanism for training and improving the skills of Indonesian managers of fishing enterprises and of fishermen.

Regional Development

Due to unbalanced levels of economic development among different regions of the country, the government wants to promote regional development in more remote areas of the country, for example in eastern Indonesia (especially the Moluccas, Irian Jaya, Nusa Tenggarra). By developing tuna resources in these areas, two impacts will assist regional development: (1) a multiplier effect through increased investment and employment in the fishing venture itself; and (2) forward and backward linkages with the processing and servicing sectors which will further promote the development process in the region.

Goal Formulation Results

Table 1 shows the goals and constraints identified by the group. Data tables were prepared for goals marked with asterisks. Goals not marked with an asterisk were not developed because of lack of data or difficulties in deciding on an operational definition. Those marked with two asterisks were viewed as the highest priority goals during final analysis. Operational definitions of the goals used in this study are in Table 2.

Table 1. Tuna Fishing Goals and Constraints for Indonesia and Japan

Indonesia	Japan
Goals	Short-term goals
1. Food (nutrition)	1. Economic efficiency
2. Employment**	2. Optimum tuna supply**
3. Foreign exchange**	3. Full capacity of existing fleet*
4. Regional development	4. Smooth transition
5. Increase in Gross Domestic Product	5. Employment**
6. Fishermen's income*	6. Fishermen's profit**
7. Total profit**	7. Traders' profit**
	8. Total profit*
Subgoals	Long-term goals
1. Technology transfer**	1. Development of coastal fisheries
2. Stability of catch	2. Development of high sea fisheries
3. Conservation of resources	3. Development of underutilized species use
4. Minimization of cost*	4. Dietary change from tuna to other animal products
Constraints	5. Resource enhancement
1. Infrastructure	6. Transfer of technology**
2. Capital**	7. Development of regional integration
3. Training	8. Gradual economic dislocation*
4. Socio-political aspects	Constraints
5. Fish resources	1. Regulation and agreements
6. Surveillance and enforcement	2. Fish Resources
	3. Minimum rate of return
	4. Bait availability
	5. Maximum rate of fee
	6. Labor
	7. Fuel price
	8. Illegal conduct
	9. Incoherent bilateral arrangements
	10. Nationalization by coastal states

Table 2. Tuna Fishery Goals and Operational Definitions Used in This Study

Goal	Item	Operational definition
Minimum	Capital investment (I)[a]	Indonesian investment requirement (US $/MT[b])
Maximum	Employment (I)	Indonesian employment (man-years/MT[b]) × wage (US $/MT[b])
Minimum	Total cost (I)	Total cost to Indonesia, including interest on investment (US $/MT[b])
Maximum	Fishermen's income (I)	Gross value to Indonesian fishermen (US $/MT[b])
Maximum	Foreign exchange (I)	Gross value to Indonesia including fee or ½ export tax for joint-venture (US $/MT[b])
Maximum	Profits (I)	Gross value to Indonesia minus total cost to Indonesia including interest (US $/MT[b])
Minimum	Capital investment (J)	Japanese investment requirement (US $/MT[b])
Maximum	Fleet utilization (J)	Employment of Japanese fishing vessels (vessel-years/MT[b]) × respective fixed cost (US $/MT[b])
Maximum	Employment (J)	Employment of Japanese fishermen (man-year/MT[b]) × wages (US $/MT[b])
Minimum	Economic dislocation (J)	Adjusted capital investment by Indonesia and Japanese traders in fishery (US $/MT[b])
Maximum	Tuna supply to Japan (J)	Tuna supply to Japan (MT/MT[b]) × Yaizu prices (US $/MT[b])
Maximum	Total profits (J)	Gross value minus total cost including export tax, fee, and interest (US $/MT[b])
Maximum	Fishermen's profits (J)	Gross value minus total cost including export tax, fee, and interest (US $/MT[b])
Maximum	Traders' profits (J)	Gross value minus total cost including export tax, fee, and interest (US $/MT[b])
Maximum	Technology transfer (I)	Number of trainees × training periods × weight (points/MT[b]) × $10,000 (US $/MT[b])

[a] I represents Indonesia; J represents Japan; and units are originally based on 7000 tons of tuna catch.

[b] One metric ton of fish production. (In case of processing, figure is based on the initial metric ton of fish caught.)

FISHERY ARRANGEMENTS

Each arrangement (see Table 3) consists of four distinct dimensions: fishing mode, fishing ownership, processing operation, and processing ownership.

Fishing Mode

Type A

Twenty-GT tuna longline vessels were the main coastal tuna boats in Japan before 1965 and are still used extensively among Japanese coastal fishermen who fish tuna in the Pacific Ocean north of 20° North latitude, south of 40° North latitude, and west of 145° East longitude. This size boat is large enough to fish at sea for at least 20 days and usually returns to its home port about once a month. The catch consists primarily of yellowfin, albacore, and bigeye. This type of fishing operation lends itself to the involvement of Japanese fishermen in joint-venture development of small-scale tuna fisheries in Indonesia.

Type B

Thirty-GT tuna longline vessels are not a popular size in Japan, but this size of skipjack pole-and-line vessel is popular in Indonesia. We were able to apply existing information on these vessels to Indonesian conditions of tuna longlining. The main feature of this fishing mode is that it was assumed it would not include Japanese fishermen, even in a joint venture. Japanese traders would be the partners in joint ventures in this type of fishing.

Type C

Eighty-GT tuna longline vessels are one of the most popular sizes in the Japanese tuna longline fishery and were the common size used by Japan under the Banda Sea Agreement. Due to a lack of immediately available Indonesian information on this size of vessel, activities with this size were assumed to be limited to arrangements including Japanese participation.

Table 3. Fishing and Processing Operations Examined in This Study

Fishing						Processing				
Type	Size of boat (tons)	Ownership[a]	Base	Japanese participants[a]	Reference	Operation	Ownership[a]	Japanese participants[a]	Markets[b]	Prices[b] (US$ /MT)
						No processing (transportation)	?	None	United States or Europe	2769[c]
						No processing (transportation)	J	Fishermen[d] or traders	Japan	2427
A	20	J-V	Indonesia	SSTF	New type	Cold storage	I	None	Export	1050
A	20	J-V	Indonesia	SSTF and traders	New type	Cold storage	J-V	Traders	Export	1155
						Cold storage	J-V	SSTF and traders	Export	1155
B	30	I	Indonesia	None	New type	Cold storage	J-V	Fishermen and traders	Export	1155
B	30	J-V	Indonesia	Traders	New type	Cold storage	J	traders	Export	1155
						Freezing and canning	I	None	Export	1050 2769[c]
						Freezing and canning	J-V	Traders	Japan United States[c]	1155 3212[c]
C	80	J	Japan	Fishermen	Current type[d]	Freezing and canning	J-V	SSTF and traders	Japan United States[c]	1155 3212[c]
C	80	J	Indonesia	Fishermen	New type	Freezing and canning	J-V	Fishermen and traders	Japan United States[c]	1155 3212[c]

C	80	J-V	Indonesia	Fishermen	New type	Freezing and canning	J	Traders	Japan United States[c]	1155 3212[c]
C	80	J-V	Indonesia	Fishermen and traders	New type	Canning	I	None	United States[c] Europe[c]	2769[c]
						Canning	J-V	Traders	United States[c]	3035[c]
						Canning	J-V	SSTF and traders	United States[c]	3035[c]
						Canning	J-V	Fishermen and traders	United States[c]	3035[c]
						Canning	J	Traders	United States[c]	3035[c]
						Freezer-carrier (600 tons)	I	None	Transshipment point	1050
						Freezer-carrier (1200 tons)	J-V	Traders	Japan	2427
						Freezer-carrier (1200 tons)	J-V	SSTF and traders	Japan	2427
						Freezer-carrier (1200 tons)	J-V	Fishermen and traders	Japan	2427
						Freezer-carrier (1200 tons)	J	Traders	Japan	2427

[a] I is Indonesian ownership; J-V is joint ownership by Indonesian and Japanese partners; J is Japanese ownership; SSTF is small-scale tuna fishermen.
[b] Frozen tuna, unless specified.
[c] Canned goods.
[d] Current fee fishing.

Processing Operation

Five basic processing alternatives were considered: no processing, cold storage, freezing and canning, canning, and freezer-carrier. No processing refers to the kind of longline tuna fee fishing recently employed in the Banda Sea where fish are frozen and transported to market in the same vessel that catches them.

Nine marketing formats were considered (see Appendix Table 8). These included two fresh fish markets in Indonesia, four frozen fish outlets in Indonesia and Japan, and three world markets for canned goods. It was assumed that Japanese or joint-venture ownership would have a marketing advantage over Indonesian ownership because of the aid of existing Japanese marketing networks.

Indonesian-based fishing activities were assumed to lead to sales from Indonesia's fresh fish market to international traders or processors. A higher value was added when fishing activities were combined with processing. Three-percent shrinkage rates were assumed during cold storage or freezing due to product loss. Freezing and canning operations in the Banda Sea were assumed to be able to produce only 5160 MT of frozen tuna and 840 MT of canned goods. Only one-half of yellowfin tuna was processed into cans and the rest was frozen. The conversion ratio from fresh fish to canned goods was assumed to be 50 percent. Canning combinations were assumed to produce canned goods for sale in non-Japanese markets.

Freezer-carrier operations involve the transfer of fish from the fishing vessel to a mother ship that freezes the fish and carries them to a foreign market. A freezer-carrier is therefore a floating base in contrast with the onshore bases in other processing operations. It was assumed that Indonesian freezer-carriers (600 GT) could travel only between the Banda Sea and transshipment ports in Southeast Asia, while joint-venture or Japanese owned freezer-carriers (1200 GT) could travel between the Banda Sea and Japan.

Ownership

Three ownership modes (Indonesian, joint-venture, and Japanese) were possible for fishing or for processing. Indonesian ownership refers to an enterprise with 100 percent Indonesian capital, which may include borrowed capital from organizations such as the World Bank or the Asian Development Bank, but not from Japanese fishermen or traders. Not all combinations of Indonesian ownership with fishing modes and processing operations were considered. The following limitations were assumed:

1. Exclusively Indonesian fishing was permitted only in type B vessels;
2. Direct marketing by Indonesia in Japan was not allowed;
3. Ex-vessel prices and frozen tuna free on board (FOB) prices were 10 percent cheaper for Indonesian ownership than for joint-venture or Japanese ownership; and
4. The export market for canned goods was limited to Europe (for pricing purposes).

Joint-venture ownership in this report refers to an enterprise with 50/50 capital sharing between Indonesian and Japanese partners. Profit is shared the same way. In joint ventures based on type A and type C fishing (arrangements 5–12 and 44–47 in Appendix Table 13), the sharing of capital and profits between Indonesia, Japanese fishermen, and Japanese traders was assumed to be 50, 25, and 25 percent, respectively. We placed the following restrictions on joint-venture enterprises:

1. Joint ventures based on type B fishing were restricted to Indonesian fishermen and Japanese traders; no Japanese fishermen were involved in this type of joint venture;
2. Aside from canned goods, all fish went to Japanese markets in the form of frozen fish; and
3. Japanese fishermen could be involved in processing along with Japanese traders and vice versa when the joint venture applied to both type A or C fishing and processing.

Japanese ownership refers to an enterprise with 100 percent Japanese capital which may include capital borrowed from the Japanese government. Within this framework, two different interest groups (Japanese fishermen and Japanese traders) were identified. Under Japanese ownership it was assumed:

1. Japanese traders were not involved in fishing;
2. Only Japanese fishermen could fish, with fishing fee paid to the Indonesian government;
3. Only type C fishing was allowed, and Japanese fishermen using type C vessels to catch fish were allowed to use freezer-carriers to transport fish to Japan; and
4. Aside from canned goods, all fish went to Japanese markets in the form of frozen fish.

GOAL VALUES OF FISHERY ARRANGEMENTS

A goal value is the unit cost or benefit of any arrangement with respect to a particular goal. An example is the amount of Indonesian employment generated by producing one metric ton of fish with joint-venture type C fishing and Japanese canning.

Goal values were calculated in three steps. First, physical and economic information was tabulated on catching, processing, and marketing 7000 MT of tuna from Indonesia's Banda Sea (an area known to most members of the group) to facilitate concrete and realistic thinking about the equipment, facilities, and marketing conditions involved in a fishery of this scale (see Appendix Tables 1 – 10). Second, the physical and economic information was used to calculate goal values with respect to the 15 goals for which we were able to quantify values. Third, figures were divided by 7000 to place the goal values on a per metric ton basis. The result was a table of values for the 48 fishery arrangements considered with respect to the 15 goals (see Appendix Table 13).

Although values for most goals could be expressed in US dollars, some (such as employment and technology transfer) were first defined in non-monetary units. In addition to formulating values for those goals in non-monetary units, a tentative conversion factor was specified to dollar value for each of them (see Appendix Table 10). For example, three wages were assumed: US$1500/person/year for Indonesian labor; US$10,000/person/year for Japanese fishermen using type A vessels; and US$20,000/person/year for Japanese fishermen using type C vessels.

Five examples are discussed below to illustrate how goal values were derived. They are capital investment, foreign exchange, costs, profits, and technology transfer.

Capital Investment

Appendix Table 1 (Estimates of Physical Information Per Unit) shows the number of units of fishing and processing operations required to handle 7000 MT of tuna per year. Unit investment costs of skipjack pole-and-line, refrigerated carrier, and storage facilities in Indonesia (see Appendix Table 2) based on existing skipjack pole-and-line fishing in Indonesia were adjusted to apply to a tuna longline fishery in Indonesia, including investment costs for tuna longline vessels (30 GT), freezer-carriers (600 GT), cold storage complexes (600 GT), canneries, and cold storage and canning complexes (see Appendix Table 3). Similar unit investment costs in Japan were estimated and adopted for 20-GT tuna longliners, 80-GT tuna longliners, and 1200-GT freezer-carriers (see Appendix Table 6). All the above data were then integrated into the summary of investment costs in Appendix Table 7. Based on this summary, capital investment requirements for each of the three interest groups (Indonesia, Japanese fishermen, and Japanese traders) to handle 7000 MT of tuna a year were estimated with respect to the 48 fishery arrangements. Finally, the capital investment requirements were divided by 7000 to determine the per metric ton values in Appendix Table 13.

Indonesian Foreign Exchange

First, the species composition of the catch was tabulated and alternative processing products noted (see Appendix Table 10). The tonnage of product could be less than the tonnage of fish catch due to losses during processing. Second, tuna prices were tabulated according to different marketing options (see Appendix Table 8). Gross income was then calculated by multiplying product tonnage by product price and assigning income to Indonesia in proportion to its share of the capital investment. Except for arrangements 13, 39, and 48, all fish are exported. With those exceptions, Indonesian foreign exchange earnings were the same as Indonesian gross value including an export tax (1.5 percent of FOB price) and fishing fee (3.75 percent of landing value at Yaizu, Japan). The total foreign exchange earnings were divided by 7000 to arrive at the per ton value in Appendix Table 13.

Costs

Fixed costs and operating costs were estimated on the basis of the total investment for tuna longline vessels (30 GT), freezer-carriers (600 GT), cold storage complexes (600 GT), canneries, and cold storage canning in Indonesia (see Appendix Table 3). The results are shown in Appendix Tables 4 and 5. Costs were also estimated for 20-GT tuna longliners, 30-GT tuna longliners, and 1200-GT freezer-carriers in Japan (see Appendix Table 6) and integrated into Appendix Table 7. These costs exclude tax, fee, and interest. Then, the export tax, fishing fee, and interest on capital investment for each of the three interest groups (Indonesia, Japanese fishermen, and Japanese traders) were determined for each of the fishery arrangements and added to fixed and operating costs to estimate total costs. Finally, total costs were divided by 7000 to estimate cost per metric ton (see Appendix Table 13).

Profits

Two different definitions of profit were used: Profits I (net return to the enterprise before corporation tax was withheld), and Profits II (net return to the enterprise before corporation tax and interest were withheld). Profits were calculated by subtracting costs from gross value. Profits I (called profits in this report) were divided by 7000 to put them on a per ton basis in Appendix Table 13. Profits II were used to calculate the rate of return on capital investment. Corporation tax was assumed exempt due to government policies promoting this industry.

Technology Transfer

Technology transfer effects were assumed to be a three-way interaction of the number of trainees, the training period (years), and a weighting factor. Technology transfer effects per fishing unit were estimated for each operation using a point system (see Appendix Table 9) to estimate technology transfer values for 7000 MT of tuna. A single conversion factor of US$10,000 per point was based on the average total cost for one year of training per foreign student in Japan in 1977. The final values for technology transfer were divided by 7000 to obtain the per ton value for each arrangement (see Appendix Table 13).

EVALUATION OF ARRANGEMENTS

Methods of Analysis

The analytic techniques most commonly used to assess alternatives for decision makers are cost-effectiveness analysis, benefit-cost analysis, risk-benefit analysis, optimization models, and multiple criteria assessment.[18] Among single criterion approaches, cost-effectiveness chooses the least-cost way of achieving a given objective, whereas benefit-cost and risk-benefit analyses deal with a single measure of economic benefit such as gross national product or national income. These approaches do not deal, however, with distributional considerations, monetizing benefits, or costs associated with nonmarket values. Optimization techniques, including linear and nonlinear programming, dynamic programming, and integer programming, make analysis possible for complex problems conditioned by constraints and/or having a large number of decision variables.

Multiple-criteria assessment approaches are useful for problems of resource allocation and development involving both economic and noneconomic considerations, particularly if the impacts have a variety of effects on diverse groups. We decided to use goal programming[13] wherever simple visual inspection of tables was not sufficient. Goal programming is basically an extension of linear programming that performs the same functions as cost-effectiveness, benefit-cost, and risk-benefit analyses. It has the same computational power as linear programming for dealing with complex problems, but is unique in the ease with which it handles multiple objectives.

Whereas linear programming has a single objective function, goal programming can have any number of objective functions g_j:

$$g_j = \sum_i c_{ij} x_i$$

where c_{ij} is the unit value of the ith decision variable with respect to the jth goal (that is, its goal value); and x_i is the value of the ith decision variable, which must be zero or positive. In our problem the decision variables are fishery arrangements, and x_i is the number of tons of fish exploited under the ith arrangement.

Goal programming can have equality and inequality constraints as are found in linear programming:

$$\sum_i a_{ik} x_i \leqslant b_k$$

where b_k is the level of the kth constraint. This is the maximum sustainable yield of the tuna resource, the ceiling on available capital, and so on; and a_{ik} is the unit value of the ith decision variable with respect to the kth constraint.

The optimal solution is the values of the decision variables, x_i, which minimize the difference between actual goals, g_j, and desired goal values, G_j:

$$\text{Min} \left\{ \sum_j w_j \mid G_j - g_j \mid \right\}$$

where w_j is the weighting coefficient for the jth goal. Goals can be assigned any nonnegative value, G_j, such as the desired level of production of fresh fish, canned products, employment, or foreign exchange. If the goal is to minimize, the desired goal value can be assigned as zero. If the goal is to maximize, it can be assigned an unattainably high value.

Goal programming provides two ways of attaching different importances to different goals. The first is the weighting coefficient, w_j. Second, goals may be ordered according to priorities. (More than one goal may be assigned the same priority if desired.) Solution of the problem starts by considering only first priority goals. If a unique solution is found, then all lower priority goals are ignored. If there is not a unique solution, then a solution is sought including second priority goals, but only within the decision domain that is best for first priority goals. If a unique solution is found, the computation stops. If not, lower priority goals are incorporated until the solution is found.

The special strength of goal programming is that it can deal with numerous objectives simultaneously. In this way, it is possible to change the weightings and priorities placed on different goals to observe tradeoffs among them.

Similar to linear programming, goal programming can handle problems with many constraints and decision variables. For example, if there are 100 decision variables, then there are approximately 10^{33} possible cases (subsets of the decision variables with positive values) that might be considered in searching for the optimal solution. This is a large number when one considers that there are only 10^{16} seconds in one billion years. The goal programming algorithm can usually find a solution for a hundred decision variables with less than a hundred iterations. (A computer program to implement goal programming is available from the senior author on request.)

It is not the role of scientists to assign priorities to goals; this is the province of policymakers involved in fishery negotiations. Therefore, in the illustrative goal programming results that follow we maintained all goals at one priority and assigned weights according to estimated dollar values. For some goals, such as technology transfer, our dollar value assignment was necessarily subjective, but we feel that the results presented hold up over the range of dollar values that might reasonably be assigned. In contrast, selection of the best fishery arrangements for real negotiating decisions would depend very much upon priorities, as is clear here.

Key Characteristics of Fishing and Processing Operations

It is first useful to survey the effectiveness of the different fishing and processing operations that might go into an arrangement, postponing for the moment the question of how costs and benefits might be distributed between Indonesia and Japan. Remembering that foreign exchange, employment, rate of return on investment, and technology transfer are goals of primary concern for Indonesia and that capital is a key constraint, one can see that Tables 4 and 5 (as well as Appendix Tables 11 – 13) summarize the principal costs and benefits of different fishing and processing operations at the scale of the Banda Sea tuna fishery.

Tables 4 and 5 show that fishing and processing operations span about the same range of capital investment requirements, but there is considerable variation among different fishing operations and among different processing operations as to the amount of capital required. In the case of fishing, type C fishing requires twice or more the capital investment of the other types. In the case of processing, canneries require the most capital and freezer-carriers the least capital, particularly if Japan is involved in operating the freezer-carriers.

Employment generated by fishing is substantially greater than by processing and is more or less independent of the type of fishing. The employment generated by processing varies considerably with the kind of processing, being greatest for canning and least for cold storage.

Gross value is important as potential foreign exchange for Indonesia, and when used to generate employment, as the source of income for fishing and processing workers. Except for Japanese fee fishing, the gross value from fishing alone is not very great. It is increased immensely, however, by transporting the fish to Japan or by some other form of processing that adds value to the fish by putting them in a form suitable for the international market. Although there is a slight progression in value as one passes from cold storage to freezing-canning to pure canning, the greatest gross value can be realized by carrying the fish by freezer-carrier to Japan.

None of the fishing operations shows a net profit, the worst case being type C, Indonesia-based fishing. All of the processing operations show a net profit, in the range of 40 to 60 percent for cold storage, freezing-canning, and canning, and as high as 600 percent for freezer-carrier operations.

Technology transfer effects in fishing are generally higher than those in processing even though some processing such as canning has relatively higher employment. This is mainly because in processing joint ventures most jobs for Indonesians would not be the kind of managerial jobs that give the highest credits for technology transfer. In contrast, technology transfer effects for type C (80 GT) tuna joint-venture fishing are high because of the greater ease of Indonesian participation at all levels.

Except for profits and rates of return on investment, none of the goals in Tables 4 and 5 appear to rate high or low in concert with other goals, with one significant exception: the negative relationship between employment and profits. Both employment and profits compete for the gross value that is obtained, and in general, an operation that generates a high

Table 4. Key Characteristics of Fishing Operations (Based on Appendix Table 11)

Type	Boat size (GT)	Ownership[a]	Capital investment	Employment Japan	Employment Indonesia	Gross value	Profits	Return on investment	Technology transfer	Food for Japan
A	20	J-V	Medium low	Very high	Medium	Low	Negative	Negative	Medium	0
B	30	I or J-V	Medium low	0	High	Low	Negative	Negative	Medium	0
C	80	J	Very high	Very high	Very low	Very high	Negative	Negative	Low	Very high
C	80	J-V	High	Medium	Medium	Low	Very negative	Very negative	Very high	0

[a]J is Japan; I is Indonesia; and J-V is a joint venture.

Table 5. Key Characteristics of Processing Operations (Based on Appendix Table 11)

Operation	Ownership[a]	Capital investment	Employment Japan	Employment Indonesia	Gross value	Profits	Return on investment	Technology transfer	Food for Japan
Cold Storage	I	Medium	0	Very Low	Medium	Medium	Medium	Medium	0
	J-V or J	Medium	Very low	Very Low	Medium	Medium	Medium	Low	Very high
Freezing-canning	I	Medium	0	Low	Medium	Medium	Medium	Medium	?
	J-V or J	Medium	Very low	Low	Medium	Medium	Medium	Low	High
Canning	I	High	0	Medium	Medium	Medium	Medium	Medium	0
	J-V or J	High	Very low	Medium	Medium high	Medium	Medium	Low	0
Freezer-carrier	I	Low	0	Low	Medium	Low	Low	Medium	0
	J-V or J	Very low	Low	Medium low	Very high	Very high	Very high	Low	Very high

[a]J is Japan; I is Indonesia; and J-V is a joint venture.

level of employment has higher operating costs and less profits. The higher employment generated by fishing significantly limits the profits in the fishery sector.

Performance of Fishery Arrangements

We will now evaluate the 48 arrangements based on operations in Table 3 in view of the costs and benefits experienced by Indonesia and Japan, that is, the goal values in Appendix 13. An important feature of Appendix Tables 11 – 12 is that although cold storage, freezing-canning, and canning operations show a high rate of return when considered alone, they need a supply of fish to function. Consequently, when cold storage or canning (which is profitable by itself) is combined with tuna longline fishing in the Banda Sea (which may be unprofitable), the rate of return from the total operation may be marginal or negative. Table 6 gives a summary of the arrangements that perform best with respect to each goal. There is no single solution which is best for all goals.

If we consider first the Indonesian perspective and focus on Indonesian goals of high employment, foreign exchange, and technology transfer while keeping in mind the need for moderate demands on capital and an acceptable rate of return on investment (assumed to be 20 percent), only 19 of 48 arrangements satisfy these conditions (Table 7). Indonesian type B fishing with Indonesian canning generates the most employment, while both this arrangement and Indonesian type B fishing with joint-venture freezer-carrier processing generate the highest foreign exchange earnings. In contrast, the best technology transfer comes from joint-venture type C fishing combined with joint-venture processing of any kind. The lowest demands for Indonesian capital come from Japanese fishing (Table 6).

The rates of return on investment for Indonesia are at best moderate (23 percent) for Indonesian sole ownership and, except for combinations with joint-venture freezer-carrier processing, the same holds true for Indonesian or joint-venture processing combined with joint-venture type A or B fishing (24 to 30 percent). Moreover, the return is even negative in the case of type C joint-venture fishing (see Appendix Table 11).

If all of the above goals are considered jointly, by adding their estimated dollar values, the best overall arrangement for Indonesia is Indonesian type B fishing with joint-venture freezer-carrier processing (see Appendix Table 14).

Turning to Japanese interests, which include food supply, fishermen's employment, and profits, 26 arrangements provide an acceptable rate of

Table 6. Best Arrangements for Each Goal[a]

Goal items	Goal	Ranges	Best arrangement (US$/MT)	2nd best arrangement (US$/MT)	3rd best arrangement (US$/MT)
Capital investment (I)	Mininum	0–2049	*Fee fishing*: 0	Fishing (B:J-V)—processing (J): 367	Fishing (A:J-V)—processing (J): 404
Employment (I)	Maximum	0–43	Fishing (B:I)—canning (I): 43	Fishing (B:I)—canning (J-V): 43	Fishing (B:I)—canning (J): 42
Total cost (I)	Minimum	0–1258	Fee fishing: 0	Fishing (B:J-V)—processing (J): 311	Fishing (A:J-V)—processing (J): 345
Fishermen's income (I)	Maximum	0–1019	Fishing (B:I)—freezer-carrier (I): 1019	Fishing (C:J-V)—freezer-carrier (I): 769	Fishing (A or B:I)—freezer-carrier (I): 762
Foreign exchange (I)	Maximum	0–1465	Fishing (B:I)—freezer-carrier (J-V): 1465	Fishing (B:I)—canning (I): 1385	Fishing (A, B, or C:J-V)—freezer-carrier (J-V): 1232
Profits (I)	Maximum	−340–639	Fishing (B:J-V)—freezer-carrier (J-V): 639	Fishing (A:J-V)—freezer-carrier (J-V): 605	Fishing (B:I)—freezer-carrier (J-V): 565
Capital investment (J)	Minimum	0–2059	Fishing (B:I)—processing (I): 0	Fishing (B:I)—freezer-carrier (J-V): 113	Fishing (B:I)—freezer-carrier (J): 227
Fleet utilization (J)	Maximum	0–276	Fishing (C:J)—no processing: 276	Fishing (C:J-V or J)—any processing plants: 184	Fishing (A:J-V)—any processing plants: 91
Employment (J)	Maximum	0–1200	Fishing (C:J)—no processing: 1200	Fishing (C:J)—freezer-carrier (J): 971	Fishing (A or C:J-V)—any processing plants: 171
Economic dislocation (J)	Minimum	0–1001	Fishing (C:J)—no processing: 0	Fishing (A:J-V)—canning (J): 277	Fishing (A:J-V)—freezing and canning (J): 364
Tuna supply to Japan (J)	Maximum	0–2427	Any fishing—cold storage (J-V or J) or freezer-carrier (J-V or J): 2427	Any fishing—freezing and canning (J-V or J): 1944	Others: 0

Total profits (J)	Maximum	−499–1462	Fishing (B:I)—freezer-carrier (J): 1462	Fishing (B:J-V)—freezer-carrier (J): 1361	Fishing (A:J-V)—freezer-carrier (J): 1327
Fishermen's profits (J)	Maximum	−499–663	Fishing (A:J-V)—freezer-carrier (J): 663	Fishing (C:J)—freezer-carrier (J): 342	Fishing (A:J-V)—freezer-carrier (J-V): 302
Traders' profits (J)	Maximum	−145–1462	Fishing (B:I)—freezer-carrier (J): 1462	Fishing (B:J-V)—freezer-carrier (J): 1361	Fishing (B:I)—freezer-carrier (J-V): 713
Technology transfer effects	Maximum	43–485	Fishing (C:J-V)—on shore processing (J-V): 485	Fishing (C:J-V)—freezer-carrier (J-V): 473	Fishing (A:J-V)—on shore processing (I): 147
Rate of return on capital (I)[b]	Maximum	−16–143	Fishing (B:J-V)—freezer-carrier (J-V): 143	Fishing (A:J-V)—freezer-carrier (J-V): 127	Fishing (B:I)—freezer-carrier (J-V): 77
Rate of return on capital to fishermen (J)[b]	Maximum	−63–220	Fishing (A:J-V)—freezer-carrier (J-V): 220	Fishing (A:J-V)—freezer-carrier (J-V): 127	Fishing (C:J-V)—freezer-carrier (J-V): 35
Rate of return on capital to traders (J)[b]	Maximum	−16–654	Fishing (B:I)—freezer-carrier (J): 654	Fishing (B:I)—freezer-carrier (J-V): 638	Fishing (C:J-V)—freezer-carrier (J): 239
Rate of return on capital to total[b]	Maximum	−32–146	Fishing (B:I)—freezer-carrier (J): 146	Fishing (B:J-V)—freezer-carrier (J): 146	Fishing (A:I)—freezer-carrier (J) or fishing (B:J-V)—freezer-carrier (J-V): 143

[a]Fishing A, B, and C are based on 20-GT, 30-GT, and 80-GT vessel operations; I, J-V, and J represent Indonesian, joint-venture, and Japanese ownerships or goals, respectively.
[b]Unit in percent.

Table 7. Arrangements with Acceptable Rates of Return on Capital Investment for Indonesia[a] (Based on Appendix Table 13)

Arrangement[b]		Investment (US$/MT)	Employment (US$/MT)	Fishermen's income (US$/MT)	Foreign exchange earnings (US$/MT)	Profits (US$/MT)	Rate of return on capital investment (%)	Technology transfer effects (US$/MT)
Fishing: (A:J-V)	Cold storage (I)	1281	23	257	762	218	27	147
	Freezing and canning (I)	1368	26	257	849	226	26	147
	Canning (I)	1719	37	257	1128	276	26	147
Fishing (A:J-V)	Cold storage (J-V)	842	22	257	569	117	24	128
	Freezing and canning (J-V)	886	26	257	628	135	25	128
	Canning (J-V)	1061	37	257	770	161	25	128
	Freezer-carrier (J-V)	517	25	257	1232	605	127	116
Fishing (B:I)	Cold storage (I)	1610	29	467	1019	202	23	130
	Freezing and canning (I)	1698	32	467	1106	210	23	130
	Canning (I)	2049	43	467	1385	260	23	130
	Freezer-carrier (J-V)	847	31	467	1465	565	77	99
Fishing (B:J-V)	Cold storage (I)	1244	22	257	762	252	30	130
	Freezing and canning (I)	1331	25	257	849	260	30	130
	Canning (I)	1682	36	257	1128	310	28	130
Fishing (B:J-V)	Cold storage (J-V)	805	22	257	569	151	29	111
	Freezing and canning (J-V)	849	25	257	628	176	30	111
	Canning (J-V)	1024	36	257	770	196	29	111
	Freezer-carrier (J-V)	480	24	257	1232	639	143	99
Fishing (C:J-V)	Freezer-carrier (J-V)	800	20	249	1232	198	35	473

[a]Over 20 percent on capital investment.
[b]Fishing A, B, and C are based on 20-GT, 30-GT, and 80-GT vessel operations; I and J-V represent Indonesian and joint-venture ownerships, respectively.

return assumed to be 15 percent or more. Table 8 indicates that the greatest food supply for Japan is assured by any kind of fishing combined with cold storage or freezer-carrier processing in which Japan has a part. The greatest employment for Japanese fishermen is of course generated by exclusively Japanese fee fishing, but next to that, the greatest Japanese employment is found in joint-venture type A or C fishing. Joint-venture type A or C fishing, combined with joint-venture freezer-carriers also gives the best rate of return on Japanese fishermen's capital. In contrast, the highest rate of return on Japanese traders' capital comes from Indonesian type B fishing with joint-venture or Japanese freezer-carriers (which involves the lowest capital investment for Japan). (Joint-venture type B fishing combined with Japanese freezer-carriers also gives high profits for Japanese traders.)

If all Japanese goals are considered simultaneously in terms of dollar value, the best overall arrangement for Japan is Indonesian type B fishing with Japanese freezer-carrier processing (see Appendix Table 15).

Of the 48 arrangements, 10 provide an acceptable return on investment for both Indonesia and Japan, while only 4 perform satisfactorily with respect to most goals of both countries (Table 9). Joint-venture freezer-carrier processing combined with joint-venture type A or B fishing or Indonesian type B fishing are the three best solutions among these according to rates of return on capital.

If all high priority goals of Indonesia and Japan are considered jointly in terms of dollar value, the best overall arrangement for both Indonesia and Japan is Indonesian type B fishing with joint-venture freezer-carrier processing (see Appendix Table 16). Thus, as long as there are no constraints, Indonesian type B fishing (30-GT vessels) appears to be the best overall option for both nations. Freezer-carrier processing also appears the best option for both nations, although it is better for Japan to operate alone and better for Indonesia in a joint venture. There is, however, one major defect in these best arrangements: Indonesian type B fishing would not employ Japanese fishermen who have been fishing the Banda Sea under recent fee fishing agreements.

Limited Indonesian Capital

Because Indonesia has many development programs placing demands on its limited capital, it is realistic to consider the implications of limited capital. Because the best solution might be a mix of two or more arrangements, it was not feasible to identify the best solution by simple visual examination of goal values or combined dollar values. We therefore used

Table 8. Arrangements with Acceptable Rates of Return on Capital Investment for Japan[a] (Based on Appendix Table 13)

Arrangement[b]		Investment (US$/MT)	Tuna supply (US$/MT)	Fishermen's employment (US$/MT)	Profits to fishermen (US$/MT)	Profits to traders (US$/MT)	Total profits to Japan (US$/MT)	Rate of return on capital investment (%)
Fishing (A:J-V)	Cold storage (J-V)	842	2427	171	59	59	117	24
	Freezing and canning (J-V)	886	1944	171	67	67	135	25
	Canning (J-V)	1061	0	171	81	81	161	25
	Freezer-carrier (J-V)	517	2427	171	302	302	605	127
Fishing (A:J-V)	Cold storage (J)	1281	2427	171	166	166	331	36
	Freezing and canning (J)	1368	1944	171	184	184	369	37
	Canning (J)	1719	0	171	213	213	426	35
	Freezer-carrier (J)	631	2427	171	663	663	1327	220
Fishing (B:I)	Cold storage (J-V)	438	2427	0	0	225	225	61
	Freezing and canning (J-V)	482	1944	0	0	243	243	60
	Canning (J-V)	658	0	0	0	269	264	51
	Freezer-carrier (J-V)	113	2427	0	0	713	713	638
Fishing (B:I)	Cold storage (J)	877	2427	0	0	467	467	63
	Freezing and canning (J)	965	1944	0	0	504	504	62
	Canning (J)	1315	0	0	0	561	561	53
	Freezer-carrier (J)	227	2427	0	0	1462	1462	654
Fishing (B:J-V)	Cold storage (J-V)	805	2427	0	0	151	151	29
	Freezing and canning (J-V)	849	1944	0	0	169	169	30
	Canning (J-V)	1024	0	0	0	196	196	29
	Freezer-carrier (J-V)	480	2427	0	0	639	639	143
Fishing (B:J-V)	Cold storage (J)	1244	2427	0	0	366	366	39
	Freezing and canning (J)	1331	1944	0	0	403	403	40
	Canning (J)	1682	0	0	0	460	460	37
	Freezer-carrier (J)	594	2427	0	0	1361	1361	239
Fishing (C:J-V)	Freezer-carrier (J-V)	800	2427	171	99	99	198	35
Fishing (C:J)	Freezer-carrier (J)	1600	2427	971	342	0	342	31

[a]Over 15 percent on capital investment.

[b]Fishing A, B, and C are based on 20-GT, 30-GT, and 80-GT vessel operations; I, J-V, and J represent Indonesian, joint-venture, and Japanese ownerships, respectively.

Table 9. Arrangements with Acceptable Rates of Return (US $/MT) on Investment for Both Indonesia and Japan (Based on Appendix Table 13)

Arrangement[a]				Indonesia				Japan		
Fishing owner	Fishing type	Processing owner	Processing type	Return on investment (%)	Employment	Foreign exchange	Technology transfer	Return on investment (%)	Food for Japan	Employment of fishermen
I[b]	B	I	Cold storage	23	27	1018	130	—	0	0
I[b]	B	I	Freezing-canning	23	29	1106	130	—	0	0
I[b]	B	I	Canning	23	32	1385	130	—	0	0
I[c]	B	J-V	Freezer-carrier	77	31	1465	99	638	2427	0
J-V[d]	A	J-V	Cold storage	24	22	569	128	24	2427	171
J-V[d]	A	J-V	Freezing-canning	25	26	628	128	25	1944	171
J-V	A	J-V	Canning	25	37	770	128	25	0	171
J-V[c and d]	A	J-V	Freezer-carrier	127	26	1232	116	127	2427	171
J-V	B	J-V	Cold storage	29	22	569	111	29	2427	0
J-V	B	J-V	Freezing-canning	30	25	628	111	30	1944	0
J-V	B	J-V	Canning	29	36	770	111	29	0	0
J-V[c]	B	J-V	Freezer-carrier	143	24	1232	99	143	2427	0
J-V[d]	C	J-V	Freezer-carrier	35	20	1232	473	35	2427	171
J[b]	C	J	Freezer-carrier	—	—	91	43	31	2427	971

[a] Fishing A, B, and C are based on 20-GT, 30-GT, and 80-GT vessel operations; J-V, I and J represent Indonesian joint-venture and Japanese ownership, respectively.

[b] Best solutions from sole ownerships (either Indonesian or Japanese).

[c] Three distinguished solutions based on rate of return on capital.

[d] Four best solutions from all interests when different interests of Japanese types A and C fishermen were neglected.

goal programming to identify the best mix of arrangements with limited Indonesian capital. Results are shown in Figure 2.

The results are simple in the case of processing. From the Indonesian (and mutual) point of view, processing should be joint-venture freezer-carrier to the extent that Indonesian capital allows, with the remainder being exclusively Japanese. From the Japanese point of view, Japanese freezer-carriers are best regardless of the availability of Indonesian capital.

The implications of Indonesian capital constraints for fishing operations are more complicated (see Figure 2 and Appendix Tables 14–16). With limited Indonesian capital, fee fishing should be displaced by joint-venture fishing to the extent that Indonesian capital allows. However, the best joint venture is type A for Japan and type B for Indonesia. While both types of fishing perform equally with respect to Indonesian employment and foreign exchange, joint-venture type B fishing not only requires less capital for Indonesia than type A but produces more profits. For Japan, joint-venture type A fishing improves Japanese employment, although established fishermen would be displaced by smaller scale tuna fishermen and Japanese fishermen would realize negative profits (see Table 3 and Appendix Table 17).

If the interests of both countries are considered simultaneously (Figure 2), as Indonesian capital increases, there is a replacement of fee fishing by type B, which in turn is replaced by type A with the availability of additional capital. Type A requires more Indonesian capital than type B, but it provides better technology transfer for Indonesia and fishermen employment for Japan, although at the expense of profits for the fishing sectors of both countries. Once fishing is combined with joint-venture freezer-carriers, however, the negative aspects of the fishing sector are substantially compensated for such that all interest groups enjoy reasonable profits (see Appendix Table 17).

For all interests, Indonesian type B fishing replaces joint-venture fishing as the best arrangement when Indonesian capital becomes great enough to no longer limit the choices (Figure 2). Although Indonesian type B fishing has a higher capital requirement for Indonesia, it also provides higher employment and foreign exchange earnings for Indonesia and higher traders' profits for Japan when combined with joint-venture freezer-carrier operations. This arrangement, however, falls short with respect to Indonesian total profits and technology transfer and it is deficient in providing benefits for Japanese fishermen (see Appendix Table 17).

Figure 2 shows optimal arrangements from the overall point of view of major Japanese and Indonesian goals; but the best arrangement can be

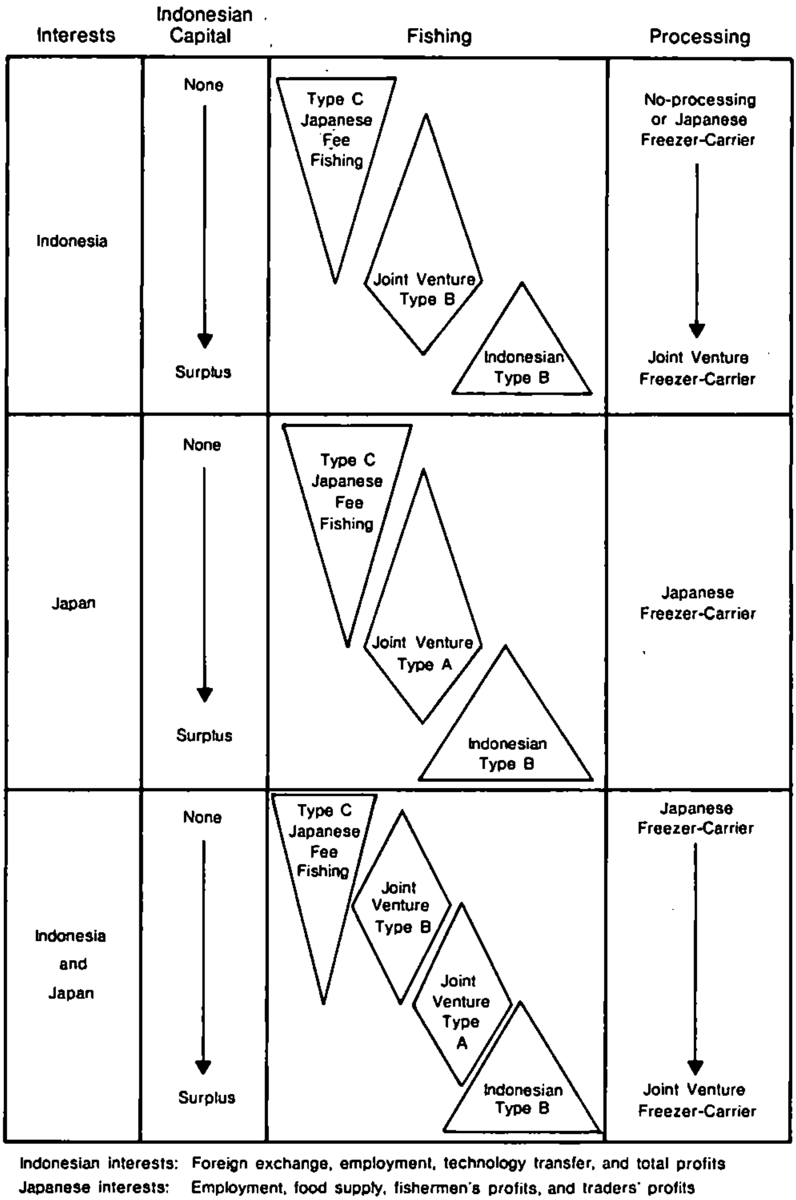

Figure 2. Optimal arrangements from goal programming, based on joint consideration of high priority goals (with dollar weighting), including Indonesian capital constraints using goal programming (based on Appendix Tables 14–16). (Polygon width indicates the portion of the fishing that is exploited under each arrangement.)

different if special emphasis is placed on certain of these goals (see Appendix Table 18). For example, type C fishing (80-GT vessels), which has not appeared among the best overall options in the preceding discussion, performs quite well when high profits are not a major consideration. Japanese type C fee fishing appears best when considering Japanese fleet utilization or tuna supply combined with Indonesian goals of employment, fishermen's income, technology transfer, and minimization of capital investment. Joint-venture type C fishing combined with joint-venture freezer-carrier (see Appendix Table 18) is best when considering Indonesia's foreign exchange and technology transfer goals. The same combination also appears best when combining Japanese goals of tuna supply or fleet utilization with the major Indonesian goals.

Conclusions

Although the type of fee fishing that has prevailed in the Banda Sea in recent years generates more employment for Japanese fishermen than any other arrangement examined, fee fishing is far from optimal for both Indonesia and Japan in other ways. It generates very little employment, foreign exchange, or technology transfer for Indonesia and is at best a marginal economic activity for Japan. If there is to be fee fishing, it would be economically more attractive to Japan if it were freezer-carrier fee fishing, which is prohibited under the recent agreements.

Of the four processing options examined, only canning and freezer-carrier appear favorable enough to warrant serious consideration (see Table 5). The earnings for Indonesian fishermen are greatest if Indonesia does all the fishing, but the rate of return on capital is negative. If Indonesia is operating the fishery alone, the best overall option is canning for European and North American markets. Canning provides the most local employment and adds the most value to the product, thereby generating higher foreign exchange earnings than other kinds of processing. Canning is, however, very undesirable if capital is limited or if supplying food to Japan is a high priority.

The other most attractive processing option for Indonesia, freezer-carrier processing, would give Indonesian fishermen employment by providing the opportunity to be involved in processing and expand their marketing frontiers, even though the rate of return on capital might be marginal if Indonesia does it alone. Furthermore, if Indonesia should want to enter joint-venture, freezer-carrier processing for the Japanese market, it would be financially much more secure for Indonesia (in the sense of return on investment) than canning or freezer-carrier processing on their own because the capital investment and operating costs of joint-venture freezer-carrier operations are substantially less. Freezer-carrier processing is also advantageous for Japan in providing an opportunity for profitable investments, employment for Japanese, and food for Japan in a form for which there is the most demand. It should be noted that these benefits to both Japan and Indonesia are gained at a cost to Indonesian employment, since freezer-carrier operations generate significantly less Indonesian employment than local canning. Although it might be best from a Japanese view for freezer-carrier operations to be run exclusively by Japan, a joint venture would be more equitable by allowing Indonesia to share in the profits that result from marketing the fish in Japan.

Although we were able to successfully evaluate how well different processing operations perform according to the goals involved, we did not encounter such a clear picture for fishing operations (types A, B, and C). In many instances, none of the fishing modes was clearly better than the others. As a result, a slight shift in goal priorities could change the best fishing mode from one type to the other.

Considering the ownership of fishing, there is a tradeoff between profit and employment. Whereas fish marketing can be highly profitable, fishing itself is an economically marginal activity, though a necessary one to supply fish for any processing and marketing operation. To the extent one country or the other does the fishing, it increases its employment but diminishes the rate of return on its investment. Whereas Indonesia would enjoy a higher return on its investment than Japan in a joint venture covering both fishing and freezer-carrier processing, the profits could shift to Japanese traders if Indonesia made the additional capital investment to do all the fishing (thereby increasing Indonesian employment and foreign exchange earnings by 20 to 30 percent). Any real arrangement might therefore require negotiation of fish prices outside of market values, in order to make the arrangement equitable.

EVALUATION OF THE APPROACH

We found the goal analysis exercise to be a highly effective way to make planning objectives explicit, thereby allowing people of different backgrounds and different points of view to interact on a common problem: bilateral tuna arrangements that will benefit both parties equitably. The exercise provided numerous insights for each of the participants. Even the framework for thinking about the problem emerged only in the course of the exercise. For example, the classification scheme for fishery arrangements that was finally chosen has a form that none of us envisioned at the beginning. Moreover, although each of us was aware of at least some of the goals when we started, other goals became apparent only when suggested by others on the team and took on meaning only as we worked with them.

Conclusions drawn concerning the best fishery arrangements are also ones not expected at the beginning of the exercise. Although we had expected to find arrangements more suitable than the recent fee fishing arrangements from at least some points of view, we were surprised that the fee fishing arrangements emerged as inferior alternatives from so many points of view. Arrangements that did emerge as best were not a complete surprise to us, because the results are reasonable, but we could not have predicted beforehand that these particular arrangements would emerge as they did.

Limitations

Although the team was able to decide on an analytical framework and draw logical conclusions from that framework, there was no complete agreement about every detail of the framework. Each individual retained his own point of view and therefore his own interpretation to be placed on the conclusions. Some of these differences could be resolved with the acquisition of additional information, that is, by clearing up matters of fact; other differences will never be resolved because they stem from the inherently multifaceted character of the problem.

Goal analysis necessarily requires simplification, but preferably without losing essential features of the problem. For practical reasons it was necessary to work with a limited number of goals, with those selected as most important a consequence of the judgment of the half-dozen experts on our team. We need much broader input from potential users of this anlaysis (ie, people associated with tuna negotiations) before we can say that the analysis is truly dealing with the most important goals. Our classification of fishery arrangements forced an enormous simplification over the infinitude of possible arrangements if we had considered every detail. These classifications need improvement, particularly with respect to fishing modes (types A, B, and C), with which the team was far from satisfied.

The fact that we worked only with data available in Honolulu placed serious limitations on the analysis. Although we were using the Banda Sea as the geographic reference, we did not have data specific to the Banda Sea for most of our needs. The tables we prepared are in fact composites derived from a variety of sources encompassing other areas in the Pacific and even fisheries other than large tuna longline, so some results may be misleading. Some arrangements of practical interest (such as large, modern Indonesian vessels that could remain at sea for long periods and ensure a high quality product) were not included at all because of insufficient data. Data limitations also forced us to set aside several goals that otherwise would have been included in the final analysis.

There also are many considerations in fishery negotiations that we were not able to include. Our analysis was static and focused; but real-world development of a fishery would be incremental over time and coupled with economic considerations stemming from sectors other than fisheries. In addition, so far no attention has been given to fishery stock management considerations that would be necessary to ensure a sustainable yield.

So, to what extent do our conclusions hold up despite the difficulties just described? The results presented here are preliminary and would need considerable verification and modification before they could be relied upon for actual negotiations. Nonetheless, they have provided useful insights and suggest that goal analysis would be a useful backup for negotiators to employ alongside subjective judgments, to assist in assessing tradeoffs. It can never be expected to generate a single optimal arrangement to be adopted mechanically, as the analysis depends on goal priorities, and only negotiators can decide priorities.

Because we feel this approach merits further development, we have identified several areas of work that will help carry it forward to actual use. Some of these areas represent a consolidation of results obtained so far; others represent an expansion.

In-Depth Examination of Critical Issues

The goal analysis so far can be considered to have finished an identification phase. Of the 48 arrangements examined, very few emerged as worthy of serious consideration. We can question whether the attractiveness of these arrangements is solely a consequence of the limited number of higher priority objectives taken into account, the limited data available for evaluating the arrangements, and/or the subjective judgments of a small team. The most promising arrangements should be examined further, particularly with respect to economic feasibility and viability in light of numerous practical considerations not yet included in the analysis.

We also need to explore the basis in fact for issues that appear critical in choosing between the more promising arrangements. The following are examples of issues that emerged:

1. A tradeoff Indonesia must make between employment and foreign exchange earnings on the one hand and returns to investment on the other.
2. A similar tradeoff Japan must make between profitability of operations and employment of its fishing fleets.
3. A tradeoff both partners in a joint venture must make between responsibility for fishing operations and profits to be expected.
4. Approaches for dealing with unavoidable tradeoffs.

More Comprehensive Analysis of the Indonesian Marine Fishery

So far we have considered only a longline fishery for large exportable tuna. The entire Indonesian fishery, however, is much more complex. Other fishing gear (particularly purse seines) should be examined, thereby bringing additional fisheries arrangements (distinguished on the basis of gear) into the picture. These arrangements might be based not only on existing techniques, but also on new and innovative approaches.

When national interests are to be taken into account, it is not sufficient to consider each fish stock in isolation. Comprehensive fisheries policy decisions require consideration of how the exploitations of different stocks compete jointly for capital and contribute jointly to employment, food needs, and foreign exchange. We would start by extending the analysis to skipjack tuna, adding Indonesian food supply as a priority goal. We then would expand the analysis to include the rest of the export fishery (eg, shrimp) and finally encompass the entire Indonesian fishery, including the multispecies artisanal fishery.

Expanding the exercise to the entire extended economic zone fishery will not increase the number of goals, but it will increase the number of arrangements by adding additional fish stocks to arrangements already dealt with. It will be helpful to capitalize on this goal analysis experience to streamline classification of arrangements to prevent the number of arrangements from becoming too cumbersome. Once we are dealing with all the stocks of the fishery, the number of tradeoffs will become so great that analysis will be impossible without support from the computational power of goal programming.

Implications for Resource Conservation and Management

So far we have considered two parties in a fisheries arrangement: the resource owner and a distant-water fishing fleet. There is a third party, so to speak—the fisheries resource—and all three must be in harmony for the arrangement to be sustained.

Once we have defined fishing arrangements that are economically viable and serve the needs of both partners, the implications of the arrangements for sustained stock management should be examined. This involves studying tradeoffs between goals such as income, employment, food, and other social and economic needs as they bear on fish stock conservation. An example of such a tradeoff is found in the efficient small-boat purse seining operations that have developed for tuna in the Philippines, operations that may crop tuna prematurely in nursery areas.[14]

Fisheries arrangements can have a bearing on stock management in a variety of ways. The most prominent are:

1. stock assessment and catch assessment information;
2. direct effects of fishing gear and fish catches on fish stocks; and
3. enforceability of regulations.

Although all of the above should be dealt with, we feel the most urgent need is information necessary to manage the fishery on a sustained basis. Present catch statistics and biological information are inadequate for deciding the impact of various fishing gear and practices on stocks and therefore for what regulations should be in effect. Obtaining reliable information about stocks and catches is far from a trivial matter, because it involves legal access to fishing logs and practical means for collecting and tabulating the information. Information useful for management has an economic value, and such information should be treated as a goal alongside the more customary socioeconomic goals that must be traded off in fisheries negotiations.

Dynamic and Regional Views

Our view so far has been static. But how a fisheries operation is established, or the transition from one arrangement to another, may be as important as the costs and benefits of an arrangement once it is firmly in place. For example, as beneficial as an exclusively Indonesian arrangement might be for Indonesia, it is not realistic for Indonesia to jump immediately from fee fishing to complete self-sufficiency. Fisheries management policies may only make sense in terms of a scheduled sequence of arrangements. An optimization approach to examining time-sequencing strategies might use dynamic programming.

Other fishery-resource-owning countries and other distant-water fleets should be examined to test the generality of the ideas. It should be possible to do this much more quickly than for this first case study covering Indonesia and Japan. The implications for multilateral (regional) arrangements can then be examined.

APPENDIX A

Procedures Used to Construct Goal Values

Appendix Table 1. Estimates of Physical Information Per Unit

Operation[a]	Number of employees	Number of trips per year	Actual carrying capacity/ trip or cold store (MT)	Average production (tons/fishing or working day)	Average fishing (working days/ year)	Production (MT/year)	Number of units to handle 7000MT tuna/year
Fishing							
20 GT (I)[b]	7	12	10	0.5	240	120	60
20 GT (I)[c]	7	12	10	0.5	240	120	60
30 GT (I)[b]	8	12	15	0.6	240	144	48
80 GT (I)[b]	14	6	40	1.5	240	360	20
80 GT (I)[c]	14	6	40	1.5	240	360	20
80 GT (J)[b]	14	4	40	1.5	160	240	30
80 GT (J)[c]	14	6	40	1.5	240	360	20
Processing							
Freezer-carrier (I: 600 GT)	23	12	300	—	240	3500	2
Freezer-carrier (J: 1200 GT)	30	6	600	—	240	3500	2
Cold store complex (600 MT)[b]	17	24[d]	300	30	288	6790	1
Cold store complex with cannery (3.8 MT/day)[b]	63	24[d]	—	—	288	Freezing: 5160 MT[e] Canning: 840 MT[e]	1
Cannery (12.15 MT/day)[b]	216	—	—	12.15	288	Canning: 3500 MT[e]	1

[a] I and J represent Indonesian based operation and Japanese based operation, respectively.
[b] Onshore based operation.
[c] Offshore based operation.
[d] Turnover rates.
[e] Finished canned goods.

Appendix Table 2. Estimates of 1977 Costs (in U.S. dollars) for the Skipjack Pole-and-Line Fishery in Indonesia

Item	Investment costs			Unit investment costs
	Hardware	Software	Total	
Skipjack pole-and-line (28 – 30 GT)	2,444,206[a]	472,557[b]	2,916,763	104,170
Refrigerated carrier (2 – 600 GT)	3,655,502[c]	706,664[d]	4,362,166	2,181,083
Cold storage complex (600 GT)	5,143,659[e]	994,460[f]	6,138,119	6,138,119

[a] Includes engine and fishing equipment, installation and construction of hull, and other equipment. Exchange rate of R 415/$1 is adopted throughout this study.

[b] 21.74 percent of total software investment costs which consist of housing facilities, miscellaneous items, consulting services, working capital, and contingency.

[c] Represents actual cost of refrigerated carrier.

[d] 32.51 percent of total software investment costs.

[e] Includes power generating units and spare parts, construction and insulation of materials, repair of workshop equipment, land, construction of building, wooden jetty and others, and slipway.

[f] 45.75 percent of total software investment costs.

SOURCE: Hardjolukito, Sutanto. Personal communication, September 1979.

Appendix Table 3. 1977 Adjusted Cost Estimates (in US dollars) for the Tuna Longline Fishery in Indonesia

		Unit costs			Total costs		
Item	Number of units	Investment	Fixed costs[f]	Operational costs[f]	Investment	Fixed costs[f]	Operating costs[f]
Tuna longline vessel (30 GT)	48	106,948[a]	26,532	52,357	5,133,504	1,273,530	2,513,156
Freezer carrier (600 GT)	2	2,181,083[b]	479,839	514,227	4,362,166	959,677	1,028,454
Cold storage complex (600 MT)	1	6,138,119[c]	584,975	108,037	6,138,119	584,975	108,037
Cold storage with cannery	1	6,751,931[d]	645,285	540,172	6,751,931	645,285	540,172
Cannery	1	9,207,179[e]	883,955	1,028,454	9,207,179	883,955	1,620,516

[a] 102.7 percent of skipjack pole-and-line vessel investment costs.
[b] 100 percent of refrigerated carrier investment costs for skipjack pole and line fishery.
[c] 100 percent of cold storage complex (600 GT) investment costs for skipjack pole and line fishery.
[d] 110 percent of cold storage complex (600 GT) investment costs.
[e] 150 percent of cold storage complex (600 GT) investment costs.
[f] See Appendix Table 4.

Appendix Table 4. Fixed Cost Estimates (in US dollars) for the 1977 Tuna Longline Fishery in Indonesia

Item	Vessel (30 GT)	Freezer-carrier (600 GT)	Cold store complex (600 MT)	Cold store with cannery	Cannery
Number of units	48	2	1	1	1
Total investment	5,133,504	4,362,166	6,138,119	6,751,931	9,207,179
Hardware[a]	4,106,803	3,489,733	4,910,495	5,401,545	7,365,743
Hardware life (years)	7	10	15	15	15
Depreciation (hardware)[b]	586,686	348,973	327,366	360,103	491,050
Insurance (hardware)[c]	513,350	436,217	245,525	270,077	368,287
Repair and maintenance (hardware)	173,494[d]	174,487[d]	12,084[d]	15,105[e]	24,618[f]
Tax[g]	49,282	41,877	58,926	64,819	88,389
Interest[h]	513,350	436,216	613,812	675,193	920,718
Total fixed cost	1,836,162	1,437,770	1,257,713	1,385,297	1,893,062
Total fixed cost[i]	1,273,530	959,677	584,975	645,285	883,955
Unit fixed cost	918,081	718,885	1,257,713	1,385,297	1,893,062
Unit fixed cost[i]	26,532	479,839	584,975	645,285	883,955

[a] 80 percent of total investment.
[b] Hardware investment divided by years of life.
[c] 10 percent and 25 percent of average values (50 percent of new hardware prices) for building and vessels, respectively.
[d] Hardjolukito, Sutanto. Personal communication, September 1979.
[e] 125 percent of maintenance cost of cold storage complex.
[f] 200 percent of maintenance cost of cold storage complex.
[g] Taxes were regarded as 1.2 percent of average values.
[h] Interest costs were computed as follows: interest costs = total investment × 0.10.
[i] Excluding tax and interest costs.

Appendix Table 5. Operating Cost Estimates (in US dollars) for the 1977 Tuna Longline Fishery in Indonesia

Item	Vessel (30 GT)	Freezer-carrier (600 GT)	Cold store complex (600 MT)	Cold store with cannery	Cannery
Number of units	48	2	1	1	1
Total regular operating costs (annual)	2,239,368[a]	933,070[b]	92,424[c]	462,120[d]	1,386,360[e]
Overhead[f]	49,851[f]	2,077[g]	6,371[f]	31,840[h]	95,520[h]
General overhead[i]	223,937	93,307	9,242	46,212	138,636
Total operating costs	2,513,156	1,028,454	108,037	540,172	1,620,516
Unit operating costs	52,357	514,227	108,037	540,172	1,620,516

[a]Operation cost/vessel (30 GT)/180 days was multiplied by the number of vessels. Hardjolukito, Sutanto. Personal communication, September 1979.
[b]Operating cost/vessel (30 GT)/180 days was multiplied by 10 and further multiplied by the number of vessels. Hardjolukito, Sutanto: Personal communication, September 1979.
[c]Hardjolukito, Sutanto, Personal communication, September 1979.
[d]500 percent of cold storage complex regular operating costs.
[e]1500 percent of cold storage complex regular operating costs.
[f]Excluding insurance and maintenance. Hardjolukito, Sutanto. Personal communication, September 1979.
[g]Per vessel total overhead was regarded as the same as 30-GT vessel.
[h]6.89 percent of total regular operating costs (annual).
[i]10 percent of total regular operating costs (annual).

Appendix Table 6. 1977 Unit Cost Estimates (in US dollars) in Japan[a]

Operation	Investment	Fixed costs	Operating costs	Total costs	Vessel
Average 10–30-GT class fishing operation (18.04 GT)	94,204[b]	10,562[c]	59,667[d]	70,229	20-GT tuna longliner
Average 50–100-GT fulltime tuna longliner (76.6 GT)	480,442	64,481[c]	443,076	507,557	80-GT tuna longliner
Average vessel operation of the largest 25 fishing companies (956.2 GT)	794,155[e]	194,680[f]	1,469,764[g]	1,664,444	1200-GT freezer-carrier

[a]Exchange rate: 266.9 yen/US $1 for 1977 (monthly average).
[b]Excludes fixed asset for nonfishing operation.
[c]Includes only depreciation.
[d]Labor costs are assumed to be one-half of the actual costs in Japan. Interest and taxes are also excluded.
[e]Average fixed asset—average investment.
[f]Includes only costs associated with depreciation, repairment, rent, insurance, and taxes for fishing operations.
[g]Average fishing costs—average fixed costs.

SOURCE: Nōrin Suisan Shō. 1979. Gyogyō Keizai Chosa Hōkoku (Kigyō tai no Bu). 1977:23, 51, and 146–148.

Appendix Table 7. Summary of Total Cost Estimates (in US dollars)[a]

Operation	Number of units	Number of employees	Investment	Fixed costs	Operating costs	Total costs
20-GT tuna longliner (J)[b]	60	420	5,652,240	633,720	3,580,020	4,213,740
30-GT tuna longliner (I)	48	384	5,133,504	1,273,530	2,513,156	3,786,686
80-GT tuna longliner (J)[b]	30	420	14,413,260	1,934,430	13,292,280	15,226,710
80-GT tuna longliner (J: based on Indonesia)[b]	20	280	9,608,840	1,289,620	8,221,740	9,511,360
Freezer-carrier (I:600 GT)	2	46	4,362,166	959,677	1,028,454	1,988,131
Freezer-carrier (J: 1200 GT)[b]	2	60	1,588,310	389,360	2,939,528	3,328,888
Cold store complex (600 MT)	1	17	6,138,119	584,975	108,037	693,012
Cold store complex with cannery	1	63	6,751,931	645,285	540,172	1,185,457
Cannery	1	216	9,207,179	883,955	1,620,516	2,504,471

[a] Excludes tax, fee, and interest. These figures represent respective costs to deal with 7000 MT of tuna catch.

[b] Nōrin Suisan Shō. 1979:23, 51 and 146–155 (see Appendix Table 6). Foreign exchange rate of yen 266.9/US $1 is adopted.

Appendix Table 8. 1977 Tuna Prices

Category	Prices (US $/MT)	Reference
Ex-vessel price in Indonesia (I)[a]	467	1/2.25 of FOB price[b]
Ex-vessel price in Indonesia (J-V or J)[a]	514	110 percent of ex-vessel price in Indonesia (I)[a]
Frozen tuna FOB price in Indonesia (I)[a]	1050	Harjolukito, Sutanto. Personal communication, Sept. 1979.
Frozen tuna FOB price in Indonesia (J-V or J)[a]	1155	110 percent of FOB price in Indonesia (I)[a]
Yaizu price in Japan		
Yellowfin[c]	2073	Frozen fish price
Bigeye[c]	2967	Frozen fish price
Export price (FOB) of canned goods[d]		
World Market	3035	1977 average export price from Japan
United States	3212	1977 average export price to the United States from Japan
Europe	2769	1977 average export price to Europe (Switzerland, England, Belgium, West Germany, and others) from Japan

[a] I, J-V, or J represent Indonesian, joint-venture, or Japanese operation, respectively.
[b] This conversion ratio is adopted from the Japanese salmon case in the North Pacific in 1966. Suisan Sha. 1968:112, 429.
[c] Norin Suisan Sho. 1979:66 (see Appendix Table 6).
[d] Japan External Trade Organization (JETRO), 1978:382.

Appendix Table 9. Estimates of Technology Transfer Effects[a]

Category II \ Category I		20-GT fishing vessel (I, J-V, J)				30-GT fishing vessel (I, J-V, J)				80-GT fishing vessel (I, J-V)			
		A	B	C	D	A	B	C	D	A	B	C	D
On board													
Captain	1st												
	2nd									1	2	3	6
	3rd												
	4th	1	1	1	1	1	1	1	1				
Engineer	1st												
	2nd									1	1	2	2
	3rd									1	1	2	2
Radio engineer													
Administrator													
Freezer and cold store engineer													
Crew										11	1	0.5	5.5
On land													
Manager													
Section chief													

Category II \ Category I		80-GT fishing vessel (J)				Indonesian freezer-carrier (600 GT)				J-V freezer-carrier (1200 GT)			
		A	B	C	D	A	B	C	D	A	B	C	D
On board													
Captain	1st					1	2	3	6				
	2nd					1	1	2	2				
	3rd									1	1	2	2
	4th												
Engineer	1st					1	1	2	2	1	1.5	2	3
	2nd					1	1.5	1.5	2.25				
	3rd												
Radio engineer						1	0.5	2	1				
Administrator						1	0.5	2	1	1	0.5	2	1
Freezer and cold store engineer						1	1	2	2	1	1	2	2
Crew		2	1	0.5	1	8	0.5	0.5	2	10	0.5	0.5	2.5
On land													
Manager													
Section chief													

Category II \ Category I		Cold store, or cannery complex (I)				Cold store, or cannery complex (J-V)				Cold store, or cannery complex (J)			
		A	B	C	D	A	B	C	D	A	B	C	D
On board													
Captain	1st												
	2nd												
	3rd												
	4th												
Engineer	1st												
	2nd												
	3rd												
Radio engineer													
Administrator													
Freezer and cold store engineer													
Crew													
On land													
Manager		3	3	3	27	1.5	3	3	13.5	0	3	3	0
Section chief		3	2	2	12	3	2	2	12	3	2	1	6

Labor							8 1 0.5 4	8 1 0.5 4	8 1 0.5 4
Technology transfer effects per unit	1	1	15.5	1	18.25	10.5	43	29.5	10
Total[b]	60	48	310	30	36.50	21.0	43	29.5	10

[a] I, J-V, and J represent Indonesian, joint-venture between Indonesia and Japan, and Japanese operations; and A, B, C, and D refer to number of trainees, training period (years), weight, and A × B × C.

[b] Based on 7000 tons of tuna production.

Appendix Table 10. Other Miscellaneous Assumptions

1. The fish catch was assumed to equal the quota of 7000 tons per year set by the Indonesian and Japanese governments in 1979.
2. Excluding arrangements 13, 39, and 48, all arrangements were for export.
3. Direct tuna supply to Japan was assumed to be in the form of frozen fish and only by Japanese or joint-venture arrangements with Japanese partners. Canned goods were not imported to Japan.
4. Composition of harvest was assumed to be 3360 MT of bigeye, 3360 MT of yellowfin, and 280 MT of others, of which 1680 tons of yellowfin were used for canning in the freezing and canning arrangement.
5. Two shrinkage rates were used: 3 percent loss during cold storage and 50 percent loss for canning.
6. Corporation tax was excluded throughout the analysis.
7. Two kinds of costs and profits were used primarily: one excluded interest, export tax, and fishing fee while another included these.
8. In case of joint-venture arrangements, two capital shares (correspondingly profit shares) were adopted: 50/50 between Indonesia and Japan and 50/25/25 among Indonesian, Japanese fishermen, and Japanese traders.
9. Export tax, fishing fee, and interest were assumed as 1.5 percent of FOB price in Indonesia, 3.75 percent of landing value at Yaizu, and 10 percent of capital investment, respectively.

APPENDIX B
Goal Value Results

Starting with the previous assumptions, it was necessary to convert from monetary units to dollars. The following conversion ratios were used: for fleet utilization, two annual fixed costs ($10,502 per 20-GT vessel and $64,481 per 80-GT vessel) were adopted; for tuna supply, two Yaizu prices ($2967/ton for frozen bigeye and $2073 for other frozen tuna to Japan) were used; and based on average total cost for one year training per foreign student in Japan in 1977, a single conversion factor of $10,000 per point was used for technology transfer effects. Further, adjusted capital investment by Indonesia and the Japanese traders in fishing was adopted for economic dislocation in Japan. The adjustment was made by subtracting one-half of Japanese fishermen's capital investment in processing from investment by Indonesia and the Japanese traders in fishing. Special attention was also made to convert physical information on employment to dollar terms. Based on average wages of the Indonesian tuna longline joint venture with Japan and Japanese fishermen of respective sizes in 1977, three wages were adopted ($1500/person/year for Indonesian labor, $10,000/person/year for Japanese fishermen using 20-GT vessels, and $20,000/person/year for Japanese fishermen using 80-GT vessels).

All data were initially compiled for total based on 7000 MT of fish production and then converted to unit cost figured by division by 7000.

Appendix Table 11. Characteristics of Fishing and Processing Operations[a]

Operation[b]	Number of units	Number of employees	Annual Investment: (US$)	Total cost excluding interest: B (US$)	Total cost: C (US$)	Gross value: D (US$)	Profits: D − C (US$)	Rate of return on capital: $\frac{(D-B)}{(A)}\times 100\%$
Fishing A tuna longliner (J-V)	60	420	5,652,240	4,213,740	4,778,965	3,598,000	−1,180,965	−10.89
Fishing B tuna longliner (I)	48	384	5,133,504	3,786,686	4,300,036	3,269,000	−1,031,036	−10.08
Fishing B tuna longliner (J-V)	48	384	5,133,504	3,786,686	4,300,036	3,598,000	−702,036	−3.68
Fishing C tuna longliner (J)	30	420	14,413,260	15,863,806	17,305,132	16,989,216	−315,916	7.81
Fishing C tuna longliner (J-V or J)	20	280	9,608,840	9,511,360	10,472,244	3,490,060	−6,982,184	−62.66
Cold store complex (I:600MT)[c]	1	17	6,138,119	4,068,955	4,682,767	7,129,500	2,446,773	49.86
Cold store complex (I:600MT)[d]	1	17	6,138,119	4,397,955	5,011,767	7,129,500	2,117,733	44.50
Cold store complex (I:600MT)[e]	1	17	6,138,119	4,290,015	4,903,827	7,129,500	2,225,673	46.26
Cold store complex (J-V:600MT)[c]	1	17	6,138,119	4,079,649	4,693,461	7,842,450	3,148,989	61.30
Cold store complex (J-V:600MT)[d]	1	17	6,138,119	4,408,649	5,022,461	7,842,450	2,819,989	55.94
Cold store complex (J-V:600MT)[e]	1	17	6,138,119	4,300,709	4,914,521	7,842,450	2,927,929	57.70
Cold store complex (J:600GT)[c]	1	17	6,138,119	3,962,012	4,575,824	7,842,450	3,266,626	63.22
Cold store complex (J:600GT)[d]	1	17	6,138,119	4,291,012	4,904,824	7,842,450	2,937,626	57.86
Cold store complex (J:600GT)[e]	1	17	6,138,119	4,183,072	4,796,884	7,842,450	3,045,566	59.62
Freezing and canning (I)[c]	1	63	6,751,931	4,570,617	5,245,810	7,743,960	2,498,150	47.00
Freezing and canning (I)[d]	1	63	6,751,931	4,899,617	5,574,810	7,743,960	2,169,150	42.13
Freezing and canning (I)[e]	1	63	6,751,931	4,791,677	5,466,870	7,743,960	2,277,090	43.73
Freezing and canning (J-V)[c]	1	63	6,751,931	4,584,325	5,259,518	8,657,880	3,398,362	60.33
Freezing and canning (J-V)[d]	1	63	6,751,931	4,913,325	5,588,518	8,657,880	3,069,362	55.46
Freezing and canning (J-V)[e]	1	63	6,751,931	4,805,385	5,480,578	8,657,880	3,177,302	57.06
Freezing and canning (J)[c]	1	63	6,751,931	4,454,457	5,129,650	8,657,880	3,528,230	62.26
Freezing and canning (J)[d]	1	63	6,751,931	4,783,457	5,458,650	8,657,880	3,199,230	57.38
Freezing and canning (J)[e]	1	63	6,751,931	4,675,517	5,350,710	8,657,880	3,307,170	58.98
Cannery (I)[c]	1	216	9,207,179	5,918,844	6,839,562	9,691,500	2,851,938	40.98
Cannery (I)[d]	1	216	9,207,179	6,247,844	7,168,562	9,691,500	2,522,938	37.40

Cannery (I)[c]	1	216	9,207,179	6,139,904	7,060,622	9,691,500	2,630,878	38.57
Cannery (J-V)[c]	1	216	9,207,179	6,153,869	7,074,587	10,622,500	3,547,913	48.53
Cannery (J-V)[d]	1	216	9,207,179	6,482,869	7,403,587	10,622,500	3,218,913	44.96
Cannery (J-V)[e]	1	216	9,207,179	6,374,929	7,295,647	10,622,500	3,326,853	46.13
Cannery (J)[c]	1	216	9,207,179	5,773,471	6,694,189	10,622,500	3,928,311	52.67
Cannery (J)[d]	1	216	9,207,179	6,102,471	7,023,189	10,622,500	3,599,311	49.09
Cannery (J)[e]	1	216	9,207,179	5,994,531	6,915,249	10,622,500	3,707,251	50.26
Freezer-carrier (I:600GT)[c]	2	46	4,362,166	5,364,074	5,800,291	7,129,500	1,329,209	40.47
Freezer-carrier (I:600GT)[d]	2	46	4,362,166	5,693,074	6,129,291	7,129,500	1,000,209	32.93
Freezer-carrier (I:600GT)[e]	2	46	4,362,166	5,585,134	6,021,351	7,129,500	1,108,149	35.40
Freezer-carrier (J-V:1200GT)[c]	2	60	1,588,310	6,853,726	7,012,557	16,989,216	9,976,659	638.13
Freezer-carrier (J-V:1200GT)[d]	2	60	1,588,310	7,182,726	7,341,557	16,989,216	9,647,659	617.42
Freezer-carrier (J-V:1200GT)[e]	2	60	1,588,310	7,074,786	7,233,617	16,989,216	9,755,599	624.21
Freezer-carrier (J:1200GT)[c]	2	60	1,588,310	6,598,888	6,757,719	16,989,216	10,231,497	654.17
Freezer-carrier (J:1200GT)[d]	2	60	1,588,310	6,927,888	7,086,719	16,989,216	9,902,497	633.46
Freezer-carrier (J:1200GT)[e]	2	60	1,588,310	6,819,948	6,978,779	16,989,216	10,010,437	640.26

[a]Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; I, J-V, and J represent Indonesian, joint-venture, and Japanese ownerships.

[b]Based on 7000 tons of tuna production. Total cost includes everything but corporation tax.

[c]Fish were purchased from Indonesian fishermen.

[d]Fish were purchased from joint-venture enterprises (Fishing A or B).

[e]Fish were purchased from joint-venture enterprises (Fishing C).

Appendix Table 12. Characteristics of the 48 Selected Fishery Arrangements

Arrangement[a]	Number of units fishing/ processing	Number of employment fishing/ processing	Investment: A (US$)	Total cost excluding interest: B (US$)	Total cost: C (US$)	Gross value: D (US$)	Profits: D−C (US$)	Rate of return on capital: $\frac{(D-B)}{(A)} \times 100\%$	Technology transfer effects (point)
1 Fishing (A:J-V) Cold store (I)	60/1	420/17	11,790,359	5,013,695	6,192,731	7,129,500	936,769	17.95	103.0
2 Freezing and canning (I)	60/1	420/63	12,404,171	5,515,356	6,755,773	7,743,960	988,187	17.97	103.0
3 Canning (I)	60/1	420/216	14,859,419	6,863,584	8,349,526	9,691,500	1,341,974	19.03	103.0
4 Freezer-carrier (I)	60/2	420/46	10,014,406	6,308,814	7,310,255	7,129,500	−180,755	8.20	96.5
5 Fishing (A:J-V) Cold store (J-V)	60/1	420/17	11,790,359	5,024,389	6,203,425	7,842,450	1,639,025	23.90	89.5
6 Freezing and canning (J-V)	60/1	420/63	12,404,171	5,529,065	6,769,482	8,657,880	1,888,398	25.22	89.5
7 Canning (J-V)	60/1	420/216	14,859,419	6,877,549	8,363,491	10,622,500	2,259,009	25.20	89.5
8 Freezer-carrier (J-V)	60/2	420/60	7,240,550	7,797,466	8,521,521	16,989,216	8,467,895	126.95	81.0
9 Fishing (A:J-V) Cold store (J)	60/1	420/17	11,790,359	4,960,722	6,139,758	7,842,450	1,702,692	24.44	70.0
10 Freezing and canning (J)	60/1	420/63	12,404,171	5,453,167	6,693,584	8,657,880	1,964,296	25.84	70.0
11 Canning (J)	60/1	420/216	14,859,419	6,772,181	8,258,123	10,622,500	2,364,377	25.91	70.0
12 Freezer-carrier (J)	60/2	420/60	7,240,550	7,596,598	8,320,653	16,989,216	8,668,563	129.72	60.0
13 Fishing (B:I)	48/0	384/0	5,133,504	3,786,686	4,300,036	3,269,000	−1,031,036	−10.08	48.0
14 Fishing (B:I) Cold store (I)	48/1	384/17	11,271,623	4,586,641	5,713,803	7,129,500	1,415,697	22.56	91.0
15 Freezing and canning (I)	48/1	384/63	11,885,435	5,088,302	6,276,846	7,743,960	1,467,114	22.34	91.0
16 Canning (I)	48/1	384/216	14,340,683	6,436,530	7,870,598	9,691,500	1,820,902	22.70	91.0

17 Freezer-carrier (I)	48/2	384/46	9,495,670	5,881,760	6,831,327	7,129,500	298,173	13.14	84.5
18 Fishing (B:I) Cold store (J-V)	48/1	384/17	11,271,623	4,597,335	5,724,497	7,842,450	2,117,953	28.79	77.5
19 Freezing and canning (J-V)	48/1	384/63	11,885,435	5,102,011	6,290,555	8,657,880	2,368,325	29.93	77.5
20 Canning (J-V)	48/1	334/216	14,340,683	6,450,495	7,884,563	10,622,500	2,737,937	29.09	77.5
21 Freezer-carrier (J-V)	48/2	384/60	6,721,814	7,370,412	8,042,593	16,989,216	8,946,623	143.10	69.0
22 Fishing (B:I) Cold store (J)	48/1	384/17	11,271,623	4,528,733	5,655,895	7,842,450	2,186,555	29.40	58.0
23 Freezing and canning (J)	48/1	384/63	11,885,435	5,021,178	6,209,722	8,657,880	2,448,158	30.60	58.0
24 Canning (J)	48/1	384/216	14,340,683	6,340,192	7,774,260	10,622,500	2,848,240	29.86	58.0
25 Freezer-carrier (J)	48/2	384/60	6,721,814	7,164,609	7,836,790	16,989,216	9,152,426	146.16	48.0
26 Fishing (B:J-V)	48/0	384/0	5,133,504	3,840,656	4,354,006	3,598,000	−736,006	−4.34	48.0
27 Fishing (B:J-V) Cold store (I)	48/1	384/17	11,271,623	4,586,641	5,713,803	7,129,500	1,415,697	22.56	91.0
28 Freezing and canning (I)	48/1	384/63	11,885,435	5,088,302	6,276,846	7,743,960	1,467,114	22.34	91.0
29 Canning (I)	48/1	384/216	14,340,683	6,436,530	7,870,598	9,691,500	1,820,902	22.70	91.0
30 Freezer-carrier (I)	48/2	384/46	9,495,670	5,881,760	6,831,327	7,129,500	298,173	13.14	84.5
31 Fishing (B:J-V) Cold store (J-V)	48/1	384/17	11,271,623	4,597,335	5,724,497	7,842,450	2,117,953	28.79	77.5
32 Freezing and canning (J-V)	48/1	384/63	11,885,435	5,102,011	6,290,555	8,657,880	2,367,325	29.92	77.5
33 Canning (J-V)	48/1	384/216	14,340,683	6,450,495	7,884,563	10,622,500	2,737,937	29.09	77.5
34 Freezer-carrier (J-V)	48/2	384/60	6,721,814	7,370,412	8,042,593	16,989,216	8,946,623	143.10	69.0
35 Fishing (B:J-V) Cold store (J)	48/1	384/17	11,271,623	4,533,668	5,660,830	7,842,450	2,181,620	29.35	58.0
36 Freezing and canning (J)	48/1	384/63	11,885,435	5,026,113	6,214,657	8,657,880	2,443,223	30.56	58.0
37 Canning (J)	48/1	384/216	14,340,683	6,345,127	7,779,195	10,622,500	2,843,305	29.83	58.0
38 Freezer-carrier (J)	48/2	384/60	6,721,814	7,169,544	7,841,725	16,989,216	9,147,491	146.09	48.0

Appendix Table 12 continued

Arrangement[a]	Number of units fishing/processing	Number of employment fishing/processing	Investment: A (US$)	Total cost excluding interest: B (US$)	Total cost: C (US$)	Gross value: D (US$)	Profits: D−C (US$)	Rate of return on capital: $\frac{(D-B)}{(A)} \times 100\%$	Technology transfer effects (point)
39 Fishing (C:J)									
No processing	30/0	420/0	14,413,260	15,226,710	16,668,036	16,989,216	321,180	12.23	30.0
40 Fishing (C:J-V)									
Cold store (I)	20/1	280/17	15,746,959	10,311,315	11,886,011	7,129,500	−4,756,511	−20.21	353.0
41 Freezing and canning (I)	20/1	280/63	16,360,771	10,812,976	12,449,053	7,743,960	−4,705,093	−18.76	353.0
42 Canning (I)	20/1	280/216	18,816,019	12,161,204	14,042,806	9,691,500	−4,351,306	−13.13	353.0
43 Freezer-carrier (I)	20/2	280/46	13,971,006	11,606,434	13,003,535	7,129,500	−5,874,035	−32.04	346.5
44 Fishing (C:J-V)									
Cold store (J-V)	20/1	280/17	15,746,959	10,322,009	11,896,705	7,842,450	−4,054,255	−15.75	339.5
45 Freezing and canning (J-V)	20/1	280/63	16,360,771	10,826,685	12,462,762	8,657,880	−3,804,882	−13.26	339.5
46 Canning (J-V)	20/1	280/216	18,816,019	12,175,169	14,056,771	10,622,500	−3,434,271	−8.25	339.5
47 Freezer-carrier (J-V)	20/2	280/60	11,197,150	13,095,086	14,214,801	16,989,216	2,774,415	34.78	331.0
48 Fishing (C:J)									
Freezer-carrier (J)	20/2	280/60	11,197,150	12,840,248	13,959,963	16,989,216	3,029,253	37.05	30.0

[a]Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations: I, J-V, and J represent Indonesian, joint-venture, and Japanese ownerships.

Appendix Table 13. Goal Values of the 48 Selected Fishery Arrangements (in US dollars/MT)

Arrangement[a]		(1) Investment (I)	(2) Employment (I)	(3) Total cost (I)	(4) Fishermen's income (I)	(5) Foreign exchange earnings (I)	(6) Profits (I)
1 Fishing (A:J-V)	Cold store (I)	1,280.61	22.64	543.32	257.00	761.50	218.18
2	Freezing and canning (I)	1,368.29	25.93	623.76	257.00	849.28	225.52
3	Canning (I)	1,719.04	36.86	851.43	257.00	1,127.50	276.07
4	Freezer-carrier (I)	1,026.90	24.71	702.97	761.50	761.50	58.53
5 Fishing (A:J-V)	Cold store (J-V)	842.17	22.43	443.10	257.00	568.58	117.07
6	Freezing and canning (J-V)	886.01	25.71	483.53	257.00	627.70	134.89
7	Canning (J-V)	1,061.39	36.57	597.39	257.00	770.13	161.36
8	Freezer-carrier (J-V)	517.18	25.29	608.68	257.00	1,231.72	604.84
9 Fishing (A:J-V)	Cold store (J)	403.73	22.21	345.21	257.00	260.86	−88.21
10	Freezing and canning (J)	403.73	25.29	345.21	257.00	260.86	−88.21
11	Canning (J)	403.73	36.21	345.21	257.00	260.86	−88.21
12	Freezer-carrier (J)	403.70	21.43	345.21	257.00	260.86	−88.21
13 Fishing (B:I)		733.36	27.43	614.29	467.00	0	−147.29
14 Fishing (B:I)	Cold store (I)	1,610.23	28.64	816.26	467.00	1,018.50	202.24
15	Freezing and canning (I)	1,697.92	31.93	896.69	467.00	1,106.28	209.59
16	Canning (I)	2,048.67	42.86	1,124.37	467.00	1,384.50	260.13
17	Freezer-carrier	1,365.52	30.71	975.90	1,018.50	1,018.50	42.60
18 Fishing (B:I)	Cold store (J-V)	1,171.79	28.43	716.04	467.00	802.08	77.64
19	Freezing and canning (J-V)	1,215.64	31.71	756.40	467.00	861.20	95.52
20	Canning (J-V)	1,391.01	42.57	870.33	467.00	1,003.63	121.92
21	Freezer-carrier (J-V)	846.81	31.29	881.62	467.00	1,465.22	565.40
22 Fishing (B:I)	Cold store (J)	733.36	28.21	621.30	467.00	467.00	−154.30
23	Freezing and canning (J)	733.36	31.29	621.30	467.00	467.00	−154.30
24	Canning (J)	733.36	42.21	621.30	467.00	467.00	−154.30
25	Freezer-carrier (J)	733.36	27.43	621.30	467.00	467.00	−154.30
26 Fishing (B:J-V)		366.68	20.57	311.00	257.00	260.86	−54.00
27 Fishing (B:J-V)	Cold store (I)	1,243.55	21.79	509.11	257.00	761.50	252.39
28	Freezing and canning (I)	1,331.24	25.07	589.55	257.00	849.28	259.73
29	Canning (I)	1,681.99	36.00	817.23	257.00	1,127.50	310.27
30	Freezer-carrier (I)	989.85	23.86	668.76	761.50	761.50	92.74
31 Fishing (B:J-V)	Cold store (J-V)	805.12	21.57	408.89	257.00	568.58	151.28
32	Freezing and canning (J-V)	848.96	24.86	442.11	257.00	627.70	176.31
33	Canning (J-V)	1,024.33	35.71	563.18	257.00	770.13	195.57
34	Freezer-carrier (J-V)	480.13	24.43	574.47	257.00	1,231.72	639.04
35 Fishing (B:J-V)	Cold store (J)	366.68	21.36	311.00	257.00	260.86	−54.00
36	Freezing and canning (J)	366.68	24.43	311.00	257.00	260.86	−54.00
37	Canning (J)	366.68	35.36	311.00	257.00	260.86	−54.00
38	Freezer-carrier (J)	366.68	20.57	311.00	257.00	260.86	−54.00
39 Fishing (C:J)	No processing	0	0	0	0	91.01	0
40 Fishing (C:J-V)	Cold store (I)	1,563.22	16.93	949.98	249.29	769.21	−180.77
41	Freezing and canning (I)	1,650.91	20.21	1,030.42	249.29	856.99	−173.43
42	Canning (I)	2,001.66	31.14	1,258.10	249.29	1,135.21	−122.89
43	Freezer-carrier (I)	1,309.51	19.00	1,109.63	769.21	769.21	−340.42
44 Fishing (C:J-V)	Cold store (J-V)	1,124.78	16.71	849.76	249.29	568.58	−289.59
45	Freezing and canning (J-V)	1,168.63	20.00	890.20	249.29	627.70	−271.78
46	Canning (J-V)	1,344.00	30.86	1,004.20	249.29	770.13	−245.45
47	Freezer-carrier (J-V)	799.80	19.57	1,015.34	249.29	1,231.72	198.17
48 Fishing (C:J)	Freezer-carrier (J)	0	0	0	0	91.01	0

[a] Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; I, J-V, and J represent Indonesian, joint-venture and Japanese ownerships.

(7) Investment (J)	(8) Fleet utilization (J)	(9) Employment of fishermen (J)	(10) Economic dislocation (J)	(11) Tuna supply (J)	(12) Total profits (J)	(13) Fishermen's profits (J)	(14) Traders' profits (J)	(15) Technology transfer effects
403.73	90.53	171.43	403.73	0	−84.35	−84.35	0	147.14
403.73	90.53	171.43	403.73	0	−84.35	−84.35	0	147.14
403.73	90.53	171.43	403.73	0	−84.35	−84.35	0	147.14
403.73	90.53	171.43	403.73	0	−84.35	−84.35	0	137.86
842.17	90.53	171.43	495.99	2,427	117.07	58.54	58.54	127.86
886.01	90.53	171.43	485.03	1,944	134.88	67.44	67.44	127.86
1,061.39	90.53	171.43	441.18	0	161.36	80.68	80.68	127.86
517.18	90.53	171.43	577.23	2,427	604.84	302.42	302.42	115.71
1,280.61	90.53	171.43	386.38	2,427	331.45	165.73	165.73	100.00
1,368.29	90.53	171.43	364.46	1,944	368.82	184.41	184.41	100.00
1,719.04	90.53	171.43	276.77	0	425.98	212.99	212.99	100.00
630.63	90.53	171.43	548.87	2,427	1,326.58	663.29	663.29	85.71
0	0	0	733.36	0	0	0	0	68.57
0	0	0	733.36	0	0	0	0	130.00
0	0	0	733.36	0	0	0	0	130.00
0	0	0	733.36	0	0	0	0	130.00
0	0	0	733.36	0	0	0	0	120.71
438.44	0	0	733.36	2,427	224.93	0	224.93	110.71
482.28	0	0	733.36	1,944	242.74	0	242.74	110.71
657.66	0	0	733.36	0	269.21	0	269.21	110.71
113.45	0	0	733.36	2,427	712.69	0	712.69	98.57
876.87	0	0	733.36	2,427	466.66	0	466.66	82.86
964.56	0	0	733.36	1,944	504.03	0	504.03	82.86
1,315.31	0	0	733.36	0	561.19	0	561.19	82.86
226.90	0	0	733.36	2,427	1,461.79	0	1,461.79	68.57
366.68	0	0	733.36	0	−54.00	0	−54.00	68.57
366.68	0	0	733.36	2,427	−50.15	0	−50.15	130.00
366.68	0	0	733.36	1,944	−50.15	0	−50.15	130.00
366.68	0	0	733.36	0	−50.15	0	−50.15	130.00
366.68	0	0	733.36	0	−50.15	0	−50.15	120.71
805.12	0	0	733.36	2,427	151.28	0	151.28	110.71
848.96	0	0	733.36	1,944	169.09	0	169.09	110.71
1,024.33	0	0	733.36	0	195.57	0	195.57	110.71
480.13	0	0	733.36	2,427	639.04	0	639.04	98.57
1,243.55	0	0	733.36	2,427	365.66	0	365.66	82.86
1,331.24	0	0	733.36	1,944	403.03	0	403.03	82.86
1,681.99	0	0	733.36	0	460.19	0	460.19	82.86
593.58	0	0	733.36	2,427	1,360.78	0	1,360.78	68.57
2,059.04	276.35	1,200.00	0	2,427	−45.13	−45.13	0	42.86
686.35	184.23	171.43	686.35	0	−498.73	−498.73	0	104.29
686.35	184.23	171.43	686.35	0	−498.73	−498.73	0	104.29
686.35	184.23	171.43	686.35	0	−498.73	−498.73	0	104.29
686.35	184.23	171.43	686.35	0	−498.73	−498.73	0	95.00
1,124.78	184.23	171.43	919.91	2,427	−289.59	−144.79	−144.79	485.00
1,168.63	184.23	171.43	908.95	1,944	−271.78	−135.89	−135.89	485.00
1,344.00	184.23	171.43	865.10	0	−245.45	−122.65	−122.65	485.00
799.80	184.23	171.43	1,001.16	2,427	198.17	99.09	99.09	472.86
1,599.59	184.23	971.43	0	2,427	341.74	341.74	0	28.57

APPENDIX C

Goal Programming Results

Appendix Table 14. Goal Programming Result I: The Best Arrangements for Four Combined Goals (Employment, Foreign Exchange Earnings, Total Profits, and Technology Transfer) for Indonesia including Indonesian Capital Constraints

	Optimal arrangements[a]		
Availability of Indonesian capital	Fishing C (J)—NP	Fishing B (J-V)—FCR (J-V)	Fishing B (I)—FCR (J-V)
Less than US$1 million	10,000	0	0
Less than US$2 million	7,917	2,083	0
Less than US$3 million	5,833	4,166	0
Less than US$4 million	3,750	6,250	0
Less than US$5 million	1,667	8,333	0
Less than US$6 million	0	9,455	545
Less than US$7 million	0	6,730	3,270
Less than US$8 million	0	4,005	5,995
Less than US$9 million	0	1,281	8,719
Less than US$10 million	0	0	10,000
No limit	0	0	10,000

[a]Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; J, J-V, and I represent Japanese, joint-venture, and Indonesian ownerships; NP and FCR refer to no processing and freezer-carrier operations.

Appendix Table 15. Goal Programming Result II: The Best Arrangements for Four Combined Goals (Employment, Food Supply, Fishermen's Profits, and Traders' Profits) for Japan including Indonesian Capital Constraints

	Optimal arrangements[a]		
Availability of Indonesian capital	Fishing C (J)—FCR (J)	Fishing B (J-V)—FCR (J)	Fishing B (I)—FCR (J)
Less than US$1 million	10,000	0	0
Less than US$2 million	7,525	2,475	0
Less than US$3 million	5,050	4,950	0
Less than US$4 million	2,574	7,425	0
Less than US$5 million	99	9,901	0
Less than US$6 million	0	7,082	2,918
Less than US$7 million	0	4,043	5,957
Less than US$8 million	0	1,003	8,997
Less than US$9 million	0	0	10,000
Less than US$10 million	0	0	10,000
No limit	0	0	10,000

[a]Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; J, J-V, and I represent Japanese, joint-venture, and Indonesian ownerships; FCR refers to freezer-carrier operations.

Appendix Table 16. Goal Programming Result III: The Best Arrangements for Eight Combined Goals (Indonesian Employment, Foreign Exchange Earnings, Total Profits, and Technology Transfer; and Japanese Employment, Food Supply, Fishermen's Profits, and Traders' Profits) for Indonesia and Japan including Indonesian Capital Constraints

	Optimal arrangements[a]			
Availability of Indonesian capital	Fishing C (J) – FCR (J)	Fishing B (J-V) – FCR (J-V)	Fishing A (J-V) – FCR (J-V)	Fishing B (I) – FCR (J-V)
Less than US$1 million	10,000	0	0	0
Less than US$2 million	7,917	2,083	0	0
Less than US$3 million	5,833	4,167	0	0
Less than US$4 million	3,750	6,250	0	0
Less than US$5 million	1,667	8,333	0	0
Less than US$6 million	0	4,595	5,405	0
Less than US$7 million	0	0	7,485	2,515
Less than US$8 million	0	0	4,455	5,545
Less than US$9 million	0	0	1,424	8,576
Less than US$10 million	0	0	0	10,000
No limit	0	0	0	10,000

[a] Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; J, J-V, and I represent Japanese, joint-venture, and Indonesian ownerships; FCR refers to freezer-carrier operations.

Appendix Table 17. Characteristics of the Best Arrangements for both Indonesia and Japan (US$/MT)

		Indonesia					Japan			
Arrangement[a]	Indonesian capital required	Employment	Foreign exchange earnings	Total profits	Technology transfer	Employment	Food supply	Fishermen's profits	Traders' profits
Fishing C (J) — no processing	0	0	91	0	43	1200	2427	−45	0
Fishing B (J-V)	337	21	261	−54	69	0	?	0	−54
Fishing A (J-V)	404	21	261	−88	85	171	?	−88	0
Fishing B (I)	733	27	467	−147	69	0	?	0	0
Fishing C (J) — FCR (J)	0	0	91	0	29	971	2427	342	0
Fishing B (J-V) — FCR (J-V)	480	24	1232	639	99	0	2427	0	639
Fishing A (J-V) — FCR (J-V)	517	25	1232	605	116	171	2427	302	302
Fishing B (I) — FCR (J-V)	847	31	1465	565	99	0	2427	0	713

[a]Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; J, J-V, and I represent Japanese, joint-venture and Indonesian ownerships; FCR refers to freezer-carrier operations.

Appendix Table 18. Goal Programming Result IV: The Best Arrangements for Two or More Combined Goals for Indonesia and Japan

Groups of run	Combined interests: Common Indonesian interests	Combined interests: Special Japanese interests	Best arrangements[a]
1	Foreign exchange earnings	None	Fishing B (I)—FCR (J-V)
		Fishermen's profits	Fishing B (I)—FCR (J-V)
		Traders' profits	Fishing B (I)—FCR (J-V)
		Tuna supply	Fishing B (I)—FCR (J-V)
		Fleet utilization	Fishing B (I)—FCR (J-V)
2	Foreign exchange earnings	None	Fishing C (J-V)—FCR (J-V)
	Technology transfer	Fishermen's profits	Fishing B (I)—FCR (J-V)
		Traders' profits	Fishing B (I)—FCR (J-V)
		Tuna supply	Fishing C (J-V)—FCR (J-V)
		Fleet utilization	Fishing C (J-V)—FCR (J-V)
3	Employment	Fishermen's profits	Fishing B (I)—FCR (J-V)
	Foreign exchange earnings	Traders' profits	Fishing B (I)—FCR (J-V)
	Technology transfer	Tuna supply	Fishing C (J-V)—FCR (J-V)
		Fleet utilization	Fishing C (J-V)—FCR (J-V)
4	Employment	Fishermen's profits	Fishing A (J-V)—FCR (J)
	Fishermen's income	Traders' profits	Fishing B (I)—FCR (J)
	Technology transfer	Tuna supply	Fishing C (J-V)—FCR (J-V)
		Fleet utilization	Fishing C (J-V)—FCR (J-V)
5	Capital investment	Fishermen's profits	Fishing A (J-V)—FCR (J-V)
	Foreign exchange earnings	Traders' profits	Fishing B (I)—FCR (J-V)
		Tuna supply	Fishing B (J-V)—FCR (J-V)
		Fleet utilization	Fishing B (J-V)—FCR (J-V)
6	Capital investment	Fishermen's profits	Fishing A (J-V)—FCR (J-V)
	Foreign exchange earnings	Traders' profits	Fishing B (I)—FCR (J-V)
	Technology transfer	Tuna supply	Fishing C (J-V)—FCR (J-V)
		Fleet utilization	Fishing C (J-V)—FCR (J-V)
7	Capital investment	Fishermen's profits	Fishing A (J-V)—FCR (J-V)
	Employment	Traders' profits	Fishing B (I)—FCR (J-V)
	Foreign exchange earnings	Tuna supply	Fishing C (J-V)—FCR (J-V)
	Technology transfer	Fleet utilization	Fishing C (J-V)—FCR (J-V)
8	Capital investment	Fishermen's profits	Fishing A (J-V)—FCR (J)
	Employment	Traders' profits	Fishing B (J-V)—FCR (J)
	Fishermen's income	Tuna supply	Fishing C (J)—NP
	Technology transfer	Fleet utilization	Fishing C (J)—NP

Appendix Table 18. (continued)

Groups of run	Combined interests: Common Indonesian interests	Combined interests: Special Japanese interests	Best arrangements
9	Total cost	Fishermen's profits	Fishing A (J-V)—FCR (J-V)
	Foreign exchange earnings	Traders' profits	Fishing B (I)—FCR (J-V)
		Tuna supply	Fishing B (J-V)—FCR (J-V)
		Fleet utilization	Fishing B (J-V)—FCR (J-V)
10	Total cost	Fishermen's profits	Fishing A (J-V)—FCR (J-V)
	Foreign exchange earnings	Traders' profits	Fishing B (I)—FCR (J-V)
	Technology transfer	Tuna supply	Fishing B (J-V)—FCR (J-V)
		Fleet utilization	Fishing B (J-V)—FCR (J-V)
11	Employment	Fishermen's profit	Fishing A (J-V)—FCR (J-V)
	Total cost	Traders' profits	Fishing B (I)—FCR (J-V)
	Foreign exchange earnings	Tuna supply	Fishing B (J-V)—FCR (J-V)
	Technology transfer	Fleet utilization	Fishing B (J-V)—FCR (J-V)
12	Employment	Fishermen's profits	Fishing B (J-V)—FCR (J)
	Total cost	Traders' profits	Fishing B (J-V)—FCR (J)
	Fishermen's income	Tuna supply	Fishing A (J-V)—CS (J)
	Technology transfer	Fleet utilization	Fishing B (J-V)—C (J)

[a] Fishing A, B, and C are based on 20-, 30-, and 80-GT vessel operations; I, JV, and J represent Indonesian, joint-venture, and Japanese ownerships; FCR, NP, CS, and C refer to freezer-carrier, no-processing, cold store, and canning operations.

NOTES

1. See J. E. Bardach and Y. Matsuda, "Fish, Fishing, and Sea Boundaries: Tuna Stocks and Fishing Policies in Southeast Asia and the South Pacific," *GeoJournal* 4.5 (1980): 467–478.
2. S. Masuda, "Tuna and Skipjack Fishery under the New 200 Mile Regime," *Suisan Shūhō* 96 (1977): 14–19.
3. See M. Morisawa, "Four Years Old Fisheries under the 200 Mile Regime," *Current Marine Topics* 16 (1980): 35–49.
4. See H. Djalal, "Implementation of Agreements with Foreigners." Discussion paper at the Second Committee of the Third United Nations Conference on the Law of the Sea, 1978.
5. See K. Ōuchi and Y. Matsuda, "Legal, Political and Economic Constraints on Japanese Strategies in Distant Water Tuna Fisheries in the South China Sea and Western Pacific." Unpublished manuscript, East-West Center, 1980.
6. See H. Ōamabara, "A Type of Fishing Ground Use by Fisheries Licensing System: Tuna-Shipjack Fisheries," *Gyogyō Keizai, Kenkyū* 10 (3): 28–45.
7. S. Masuda, ed., *Tuna and Skipjack Fishery* (Tokyo: Suisan Sha, 1963), p. 67.
8. Djalal, Ibid.
9. See S. Zimbo, "Fishing Security of Japanese Tuna Longline Vessels at the Banda Sea," *Foreign Fisheries Cooperation* 19: 6–15.
10. Masuda, 1977, Ibid.
11. Ōuchi and Matsuda, Ibid.
12. See M. M. Hufschmidt, "New Approaches to the Economic Analysis of Natural Resources and Environmental Quality," in *Economic Approaches to Natural Resource and Environmental Quality Analysis,* ed. Maynard M. Hufschmidt and Eric L. Hyman (Dublin, Ireland: Tycooly Press Ltd.), in press.
13. See S. M. Lee, *Goal Programming for Decision Analysis* (New York: Petrocelli, 1972.)
14. V. L. Aprieto, *Fishery Management and Extended Maritime Jurisdictions: The Philippine Tuna Fishery Situation.* East-West Environment and Policy Institute Research Report No. 4 (Honolulu: East-West Center), in press.

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