

THE SOUTH PACIFIC COMMISSION FISHERIES NEWSLETTER

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WORKSHOP ON FISH AGGREGATION DEVICES

An informal workshop was held in Honolulu on 23 October 1980 to discuss the problem of losses of fish aggregation devices (F.A.D.'s). The workshop was convened by the Director of the Honolulu Laboratory of the Southwest Fisheries Centre, Mr R.S. Shomura. Representatives of the following organisations took part: the Hawaii National Marine Fisheries Service, the Hawaii Department of Fish and Game, the Inter-American Tuna Commission and representatives of the fisheries departments of American Samoa, Guam, Northern Marianas and Palau.

The report¹ of the workshop covers the following items:

- (1) Construction details of F.A.D.'s currently in use.
- (2) The possible causes of mooring line failures.
- (3) Modifications necessary to reduce further losses of F.A.D.'s.
- (4) Catch results around F.A.D.'s in Hawaii and the build-up of fish populations around F.A.D.'s.

It was felt that the information in this report would be of considerable value to the many countries in the Region planning to deploy F.A.D.'s in the near future. For this reason, with the kind permission of Mr Shomura, relevant sections of the report covering items 1, 2 and 3 are reproduced below.

Gear Construction and Losses

The workshop report gives detailed information about the various designs of F.A.D. presently used by each of the organisations represented at the workshop. All consist of a buoy with a mooring line consisting of lengths of chain and polypropylene rope arranged in various configurations, but usually consisting of a length of chain at the top, followed by a length of polypropylene rope and with a second length of chain at the bottom attached to the anchor. A weight is usually attached at the middle of the rope section to prevent the rope from floating to the surface. Typical of the designs presently in use is that employed by the Hawaii Department of Fish and Game (Fig. 1).

Causes of Mooring Line Failures

A total of 33 F.A.D.'s deployed by the represented organisations had been lost by October 1980. Of these losses, 17 definite and 4 probable causes of mooring line failure could be identified (Table 1). 12 causes of failure could not be determined since the buoys were not recovered. Reasons for failure included errors in design and construction as well as incorrect placement.

Table 1: Causes of F.A.D. Mooring Line Failures

	Definite	Probable	Total	Cause
1. Shackle	2		2	Construction
2. Rope splice	1	1	2	Construction
3. Cable grip	1	2	3	Construction/Design
4. Nico-press sleeve	4		4	Design
5. Rope twist	1		1	Design
6. Rope cut by propeller	1		1	Design
7. Rope chafing	4	1	5	Setting error/Design
8. Buoy set too deep	1		1	Setting error
9. Run over by tug boat	2		2	Accidental/Design
	<u>17</u>	<u>4</u>	<u>21</u>	

1. Copies of the complete report, titled *Report on fish aggregating devices workshop*, can be obtained from the Director, National Marine Fisheries Service, Southwest Fisheries Centre, Honolulu Laboratory, P.O. Box 3830, Honolulu, Hawaii, 96812.

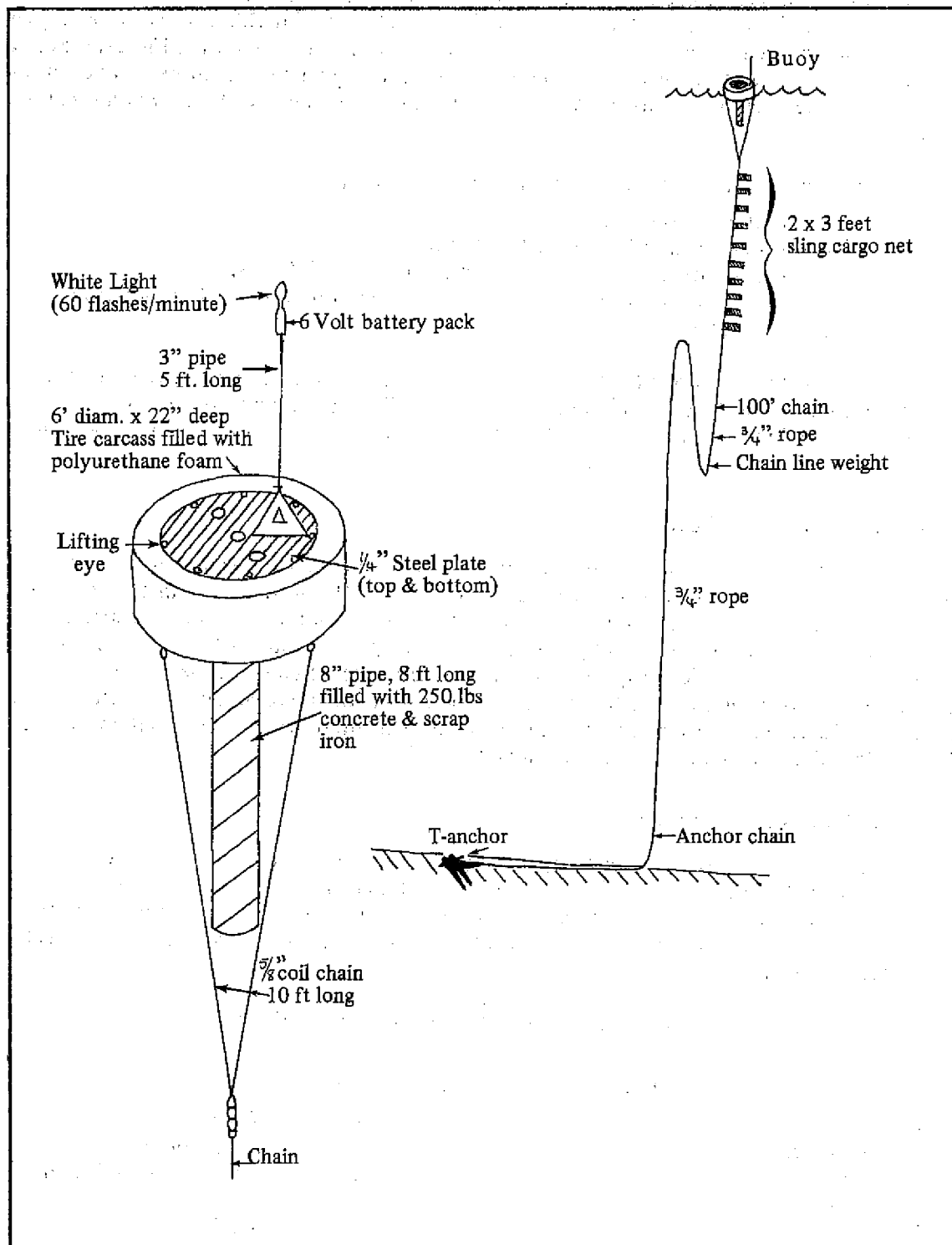


Figure 1: Hawaii Fish and Game FAD.

Comments on types of gear failure itemised in the table:

- (1) **shackle failure** - usually occurred as a result of the pin working itself loose. This can be delayed to some extent by securing the pin with galvanised wire, but there is always the possibility that the wire used could be too small and corrode within a short time or that some of the shackles could be overlooked and not secured at all.
- (2) **poor splicing** - particularly single, short splices, or loose splices are more likely to fail. This is especially so when using slippery synthetic ropes made of such materials as polypropylene and nylon.
- (3) **cable grip failure** - this was probably due to insufficient or uneven tightening of the two bolts. The buoys, in this case, were not in position long enough for corrosion to set in, but the small bolts on the grip could corrode in due time.
- (4) **nico-press sleeve failure** - this resulted from electrolysis caused by using copper sleeves on galvanised steel wire rope.
- (5) **rope twist** - the absence of a swivel between the top chain section and the rope section resulted in a break in the rope adjacent to the splice. The twist was imparted either by buoy rotation or rotation of the rope or both.
- (6) **rope cut by boat's propeller** - resulted from failure to attach sufficient weight to the rope. This allowed the excess line to float to the surface, where it was run over by a boat.
- (7) **rope chafing** - was largely due to misplacement of the buoys. The buoys were placed too close to bottom ledges or anchored in depths much shallower than intended. In the latter case, chafing is believed to have occurred when the intermediate weight reached the bottom. Rope chafing may also occur when the currents are strong enough to drag the anchor. One buoy was dragged into water shallower than the intermediate weight and was eventually lost.
- (8) **setting too deep** - this buoy was set in waters deeper than intended due to lack of proper instrumentation, i.e. depth recorder and navigational instruments.
- (9) **rope run over by tugboat** - the rope section of the mooring lines of two buoys were severed by tugboat towlines. In one instance the tugboat approached too close to a buoy out of curiosity; in another incident, the tugboat, most likely, failed to notice the buoy.

Corrective Measures

Most of the failures listed above can be prevented if mooring lines are carefully designed and constructed. Failures stemming from the use of cable grips and copper sleeves and steel wire rope need not reoccur if these items are not used in construction. Incidences of rope being severed by propellers also need not occur if all are aware of the buoyancy of polypropylene rope and adjust it with an intermediate weight. Setting the buoys too shallow, resulting in rope chafing, and setting them too deep, resulting in complete submergence, need not occur if the buoys are set with the aid of proper navigational and depth sounding equipment.

Other failures involving shackles, rope splices and rope twists are more serious since they can occur in future moorings. These require extreme care in construction. Shackle failure can be reduced if the pins are secured and coated with epoxy or fibreglass resin. The epoxy and resin will inhibit corrosion and also freeze the pin and prevent it from working itself loose. An alternative would be to replace all shackles with oversized split chain links. These should also be coated with epoxy or resin.

Because of the numerous rope splices required to construct a deep mooring line, it is imperative that the splices are securely made. This is especially critical with synthetic rope since this type of rope is prone to slip. For added security, the rope ends should be double-spliced with each splice made at least 15 to 18 inches long and seized with twine at two or three places.

Line breaks due to twisting can be avoided by the addition of a sufficient number of swivels at critical places. These are at the ends of the top and bottom chain sections and at the lower end of the intermediate weight. Additional swivels may be added to the top of the intermediate weight and midway on the rope below the intermediate weight.

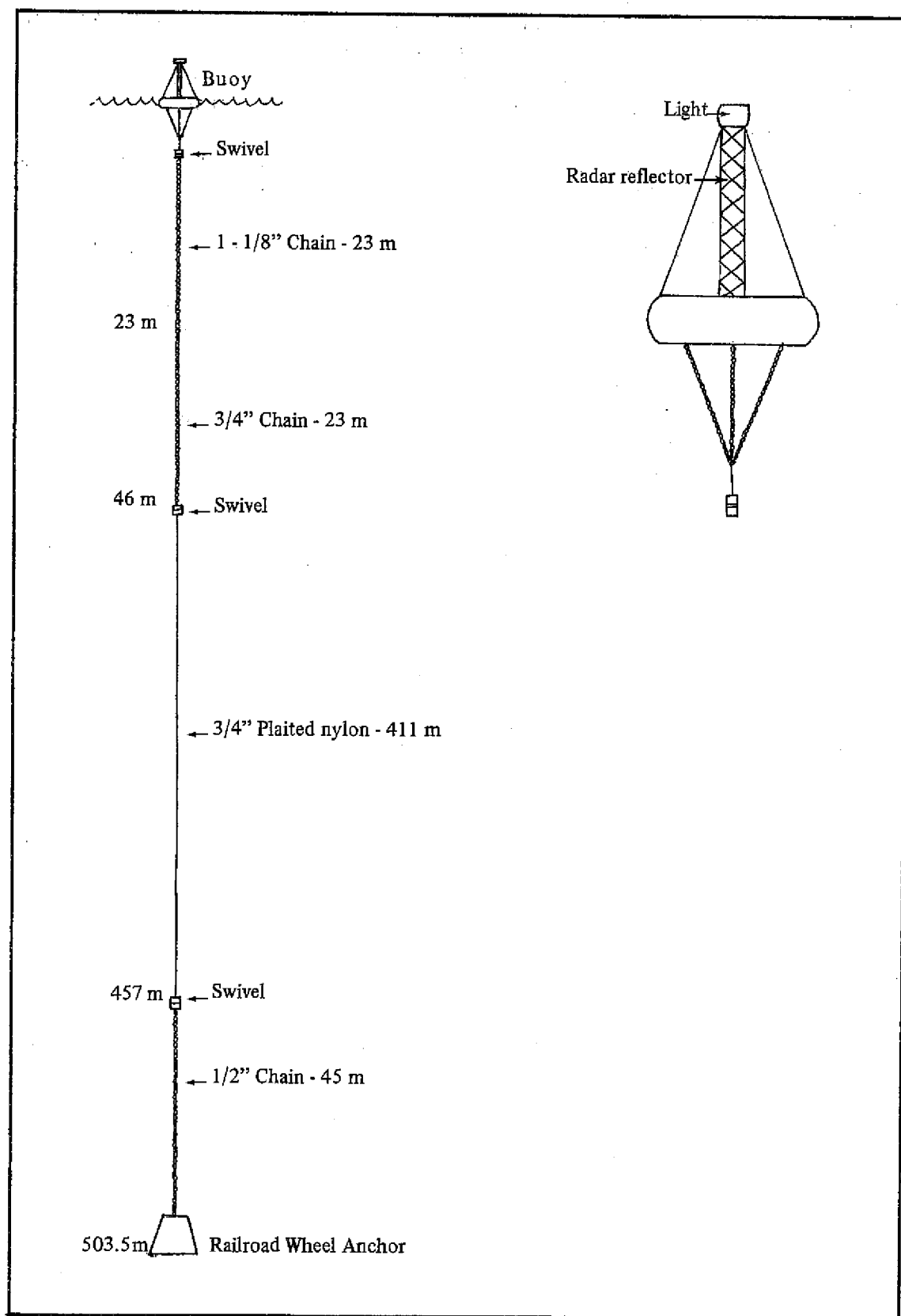


Figure 2: Suggested ideal mooring.

The swivels presently used, chain-link type, were suggested as being of inferior quality. Galvanised, barrel-type swivels with bearings were considered better since they were free to turn under heavy load.

One other problem that needed consideration was the avoidance of electrolysis which occurs when fittings made of different metals are placed next to each other. All fittings, thus, should be of uniform metal.

Suggested Ideal Mooring

Mr I. Blogg (ALA-PAC, Seattle) who has had wide experience with long-term deep water moorings, presented his ideas on ideal moorings. For moorings in excess of 500 m, he preferred a round buoy (Fig. 2) with a line scope of 1:1, with bearing race swivels at the buoy, and at the top and bottom of the rope section. Because strain on the mooring line was concentrated in the upper 100 ft, the first section to approximately 20 fathoms should be of chain. For shallower moorings, he suggested an all-chain tether consisting of a heavier chain section at the bottom attached to a dome-shaped anchor, the last to prevent the chain from winding around it. To overcome the weight problem, part of the mooring line could be of wire rope jacketed with a coating of epoxy. Epoxy fitted sockets and swivels were to be used at the ends of the wire rope. Such a mooring could withstand a current force of up to 4 knots.



SOME ECONOMIC ASPECTS OF THE DEVELOPMENT AND MANAGEMENT OF FISHERIES IN THE CENTRAL AND WESTERN PACIFIC*

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INTRODUCTION

In this the era of 200-mile zones and extended fisheries jurisdiction, the countries of the central and western Pacific have unprecedented interest in the fisheries in their waters. This interest is at the moment concentrated on development, but undoubtedly other management issues will become increasingly significant.

Even though fishing has played a major role in the cultures and traditions of all Pacific Islands, very few large scale fisheries have been established to meet local demand. Most of the major fisheries which have been developed are export-oriented and, even though fish exports from the region are very substantial and still increasing, the quantities of fisheries products imported into the area in recent years has not decreased. A need therefore exists within Pacific Islands for development of fisheries to meet local demand. A further need exists to develop export industries of any type that will help Pacific states to self reliance. The relatively recent acceptance of the principles of extended fisheries jurisdiction undoubtedly offers new scope for the development of offshore fisheries based in Pacific Islands. It certainly greatly increases the total area of the Pacific under the control of Island states (Table 1). It also increases the potential for involvement by Island states in the management of the resources in these extended zones.

**Table 1: Population, land and sea area (200-mile zones) of the countries in the area of the
the South Pacific Commission**
(After Sevele and Bollard, 1979)

Country	Population (mid 1978)	Land Area (sq. km)	Sea Area (sq. km)	Sea Area
				Land Area
American Samoa	31,500	197	390,000	1,980
Cook Islands	18,500	240	1,830,000	7,625
Fiji	607,000	18,272	1,290,000	71
French Polynesia	141,000	3,265	5,030,000	1,541
Guam	90,000	541	◇	N.A.
Kiribati	56,000	684	3,550,000	5,190
Nauru	7,000	21	320,000	15,238
New Caledonia	138,000	19,103	1,740,000	91
Niue	3,700	259	390,000	1,506
Norfolk Island	1,900	36	400,000	11,111
Papua New Guinea	2,990,000	462,243	3,120,000	7
Pitcairn Island	100	5	800,000	160,000
Solomon Islands	214,000	28,530	1,340,000	47
Tokelau	1,600	10	290,000	29,000
Tonga	93,000	699	700,000	1,001
Trust Territory of the Pacific Islands	133,000	1,832	6,200,000	3,384
Tuvalu	7,400	26	900,000	34,615
Vanuatu	101,500	11,880	680,000	57
Wallis & Futuna	10,000	255	300,000	1,176
Western Samoa	153,000	2,935	120,000	41
South Pacific Commission area	4,798,200	551,033	29,390,000	53

◇ Included in T.T.P.I.

* This paper was first presented at the Twentieth South Pacific Conference, held in Port Moresby, Papua New Guinea, in October 1980.

While all of the countries of the region are striving for greater fisheries development in their area and greater involvement in the fisheries which go on in the oceans surrounding them, the problems faced by individual countries vary tremendously. The problems of stocking a trout stream for subsistence fishing in the highlands of Papua New Guinea have little in common with subsistence coastal fisheries in small islands. Similarly, the problems of developing a skip-jack pole-and-line fishery in a country with abundant baitfish resources, such as Solomon Islands, are different from those of a bait-poor nation, such as Nauru, which must rely on alternative fishing techniques to exploit the highly migratory species which pass through its waters.

Even though all Pacific Islands share a common dependence on the sea, there exists a diversity of social and economic requirements within the region. This diversity, coupled with the innumerable types of fisheries and variability in governments' objectives for development, makes it impossible to consider any single fisheries development or management strategy as most applicable.

In fact, many alternative definitions for even the terms of development and management could easily be given and certainly the objectives of each could be argued. However, in order to focus discussion of this most important issue on regional perspectives, it has been assumed that the objectives of development and management of fisheries will be to increase the benefits to the peoples of the region. It has also been assumed that any increase in benefits will include at least some economic component, but that the prerogative will remain with governments to ascertain the division of social, political and/or economic motives. In-depth discussion of the details of fisheries economics has therefore been avoided in favour of general presentation of the types of economic decisions governments will face. The objectives of discussing a theme of this type are, then, to assist in identifying the many alternatives available and in recognising the major problems associated with them.

DEVELOPMENT

The options available for the development of fisheries depend to a large extent upon the nature of the fisheries resources and the types of harvesting strategies which are applicable. Fisheries currently in operation in the south western Pacific range from extremely small-scale subsistence activities to the operation of some of the world's most sophisticated tuna fishing vessels. Pacific states are therefore faced with many options for fisheries development. When considering these it is probably beneficial to divide the types of fisheries into categories. While some of these divisions must be arbitrary, the following six types can be identified:

Recreational or sport fisheries

These are often overlooked but play an important role in the life-style of many Pacific Islanders. Even though in most cases the catch is eaten, recreational fishing is not undertaken primarily for any monetary, or even food, return, and is principally for relaxation and enjoyment. This is particularly so for game fishing activities. Sport fishing enthusiasts can, of course, influence fisheries management decisions, particularly when the species being sought are the same as those taken in other fisheries.

Subsistence fisheries

These can be defined as those in which an individual or family group is involved in exploiting the fisheries resources in order to provide food for the family group. Subsistence fisheries exist in every coastal village throughout the Pacific region.

Artisanal fisheries

These normally involve an individual or a family group who catch enough fish to provide a surplus for sale to other locals. These fisheries do not normally have substantial backup facilities, nor are they dependent upon sophisticated marketing structures. The most common examples are the handline fisheries for many species of reef fish and deep water snappers.

Commercial fisheries

These can be defined as those in which the fishery is highly organised and income from fishing activities provides the dominant source of monetary return for the participants. Commercial fisheries normally have large-scale support facilities and marketing infrastructures. There are relatively few of these in the Pacific Islands, but examples can be found in the Tongan tuna longline fishery and the New Caledonian ring net fishery for mackerel.

Export fisheries

These can involve local fishermen fishing independently, large-scale joint ventures, or foreign enterprises fishing to supply markets outside the country. The degree of input from foreign sources varies greatly; for example, the lobster fishery in the western province of Papua New Guinea has involvement from local fishermen catching lobsters by hand on reef flats at night and delivering them to the processing plant for subsequent export; also involved in this fishery are the large joint-venture prawn trawling vessels which trawl for lobsters on a seasonal basis and process them on board the ship.

Foreign fisheries

The most common form of foreign fisheries in the Pacific area is that by distant-water tuna fishing vessels exploiting the resources of the 200-mile zones with a minimum of contact with the coastal states. Catches by these fleets dominate fisheries production from the region as a whole (Table 2).

Table 2: Local catches and catches by distant-water fleets in the waters of the countries of the South Pacific Commission
(after Kearney 1979b)

Country	Local Total Fish Catch (tonnes)	Local Tuna Catch (tonnes)	Longline Catch ⁸ in 200 Mile Zone by Foreign Fleets in 1976 (tonnes)	Pole-and-Line ⁸ Catch by Japanese Fleet in 200 Mile Zone in 1976 (tonnes)
American Samoa	220 ('78) ^{1 2}	20 ('78) ²	387	29
Cook Islands	-	-	2,866	10
Fiji	11,594 ('77) ^{1 3}	7,262 ('77) ^{1 3}	1,553	233
French Polynesia	2,386 ('74) ⁴	1,293 ('74) ⁵	7,264 ₆	0 ₆
Guam	-	-	-	-
Kiribati	1,344 ('77) ¹	786 ('77) ¹	11,349	16,570
Nauru	0	0	1,845	8,224
New Caledonia	499 ('77) ^{1 3}	186 ('77) ^{1 3}	1,800	58
Niue	20 ('78) ¹	10 ('78) ⁵	289	4
Norfolk Island	-	-	700	2
Papua New Guinea	68,000 ('78) ¹	47,720 ('78) ⁸	6,312	10,533
Pitcairn Island	-	-	1,090	0
Solomon Islands	17,444 ('76) ⁵	15,787 ('76) ⁸	2,709	17,248
Tokelau	-	-	450	1,645
Tonga	1,117 ('77) ¹	300 ('77) ⁵	816	18
Trust Territory of the Pacific Islands	10,000 ('76) ⁵	5,284 ('76) ⁸	20,601	38,360
Tuvalu	80 ('78) ¹	40 ('78) ¹	1,886	7,611
Vanuatu	10,500 ('76) ⁷	10,000 ('76) ⁷	1,012	93
Wallis & Futuna	-	-	386	155
Western Samoa	1,700 ('76) ¹	850 ('76) ¹	160	24
Total	124,904	89,538	63,475	100,817

1. Figures from Crossland and Grandperrin 1979.

2. Excluding unloadings to the Pago Pago canneries.

3. This includes only the catches which passed through markets.

4. From Kearney 1977.

5. Estimated by the author.

6. Catches included under Trust Territory of the Pacific Islands.

7. Mainly longline catches transhipped at Santo.

8. From Kearney 1979.

It is important before rushing into the development of any fishery to ascertain the real objectives of the development. The diversity in the economies of the countries of the south western Pacific means that the goals of development and management for similar types of fisheries in different countries could well vary greatly. It is important for planners to decide whether the real objective of the development strategies is to provide: food for nationals (at either the village or urban level), employment, import replacement, a source of foreign exchange, or perhaps some combination of these. Because the decision as to which of these objectives should be pursued is often a political one, it is important that governments be aware of all of the options available to them and of the constraints which may make development of any one type of fishery particularly difficult.

There is no doubt that one of these goals, or combinations of several, is applicable to all of the Island countries of our region. All the Island states are importers of fisheries products (Table 3) and, even though some have exports which exceed imports, all would benefit from the development of substantial export industries and all would appreciate increased food production and employment for their people.

Table 3: Commercial, local and foreign fish catches, and fish imports and exports for some countries in the area of the South Pacific Commission
(after Kearney 1979b)

Country	Commercial fish catch for domestic consumption (tonnes)	Total locally registered fish catches (tonnes)	Total fish catch from 200 mile zone (tonnes)	Total fish imports (1976) (A\$'000)	Total fish exports (1977) (A\$'000)
American Samoa	220	220	636	496	67,979
Cook Islands	N.A.	N.A.	2,876+	N.A.	-
Fiji	4,332	11,594	13,380	7,000	4,705
French Polynesia	2,386	2,386	9,650	2,200	-
Kiribati	1,344	1,344	29,263	76	-
Nauru	0	0	10,069	N.A.	-
New Caledonia	499	499	2,357	1,100	121
Niue	20	20	313	50	-
Norfolk Island	N.A.	N.A.	702+	-	2
Papua New Guinea	20,000	68,000	84,845	8,463	20,919
Solomon Islands	1,657	17,444	37,401	150	7,895
Tokelau	N.A.	N.A.	2,095+	N.A.	-
Tonga	1,117	1,117	1,951	96	5
Trust Territory of the Pacific Islands	4,716	10,000	68,961	N.A.	3,265
Tuvalu	80	80	9,577	N.A.	-
Vanuatu	500	10,500	11,605	930	12,011
Western Samoa	1,700	1,700	1,884	700	-
Total	38,571+	124,904+	287,565+	21,261+	116,902+

Regardless of the goal, some problems are common to the development of many different types of fisheries, while others are unique to specific situations. Development planners will need to take account of a great number of variables when deriving fisheries development policies. These will include the availability of skilled fishermen, labour, markets, capital, infrastructures for handling and processing the catch, boats and gear, fuel and backup facilities such as slips and dry docks, as well as detailed analyses of the interactions between variables, particularly in so far as they relate to the attainment of economic objectives.

Consideration of each of the fishery types listed with all of the requirements for labour, fuel, vessels, etc., would lead to an enormous matrix of possibilities which would be more likely to confuse than to provide guidelines for development planners. However, consideration of which constraints are most likely to be influential on each of the categories of fisheries, does provide interesting guidelines. Dealing with each type in turn:

- (a) *Recreational and sport fisheries* generally require extremely limited input by governments. Conversely, these fisheries normally have little impact on government policies unless they are very highly developed and the participants form a substantial political lobby that influences management decisions in other fisheries. Governments in most Pacific Islands face few problems with the development of these fisheries in the short term.
- (b) *Development of subsistence fisheries* is normally along traditional lines although improvements in gear and technology do progressively influence catches. There is a need to ensure that good quality, reasonably priced gear is available, but beyond that an active role by governments in development of subsistence fisheries is not normal. Any management policies, particularly in so far as these may relate to restricting fishing in certain areas and certain species, are normally covered by local council or village authorities. Governments, of course, normally provide research input where necessary to ensure that the levels and methods of exploitation are not detrimental to the well-being of the people concerned.
- (c) *Artisanal fisheries*: All Pacific states have experienced considerable difficulty with the development of economically viable artisanal fisheries. The upgrading of subsistence fisheries, to enable increased catches to provide surplus which can be sold, has usually been the result of increased use of improved fishing gear such as nylon nets and motorised vessels. Introduction of this gear has often increased catches in the short term, but in some cases the high catch rates have not been able to be maintained, for example, the turtle fisheries in many Pacific Islands.
- (d) *The development of commercial fisheries* in the Pacific Islands remains the biggest problem facing fisheries planners. If import replacement is to be achieved on a large-scale, then commercial enterprises capable of catching and processing substantial quantities of local fish are obviously necessary. To establish these, even in cases where a resource is proven, requires far more than just the employment of large numbers of fishermen. It is the development of infrastructures necessary for the creation and maintenance of commercial-scale fisheries which has proved the most common problem in fisheries development throughout the South Pacific. There appears to be no short-term solution to this problem.

Not only are there capital constraints and difficulties in obtaining skilled entrepreneurs and managers, but there are also technical reasons why commercial fisheries are difficult to develop in this region (Kearney, 1979b). The coastal resources of the Island states of the Pacific are mostly those of tropical reef or lagoon environments. These environments harbour a great diversity of marine organisms and many families of fish, crustaceans and molluscs are represented. However, the relative productivity of marketable fish and other seafoods from such reef areas is not great. Furthermore, tropical reef areas are not suitable for trawling and they seldom harbour extensive resources of pelagic species vulnerable to seining. As a result, large catches are not regularly taken and infrastructures for handling even moderate quantities of fisheries products are normally not established. When a large catch is taken, the facilities are normally inadequate to handle it all. Development is, therefore, severely hampered by the lack of a major single fishery which could provide the backbone of commercial catching and processing enterprises. This lack of a major fishery, coupled with the restricted market outlets as a direct function of smallness, means

that fishing vessels tend to be small and fishermen are required to diversify their gear and techniques to make best use of the variety of species available. It is therefore not surprising that even though there is great diversity in the coastal fisheries resource in Island states, the total harvest from them is not great (Table 3).

Furthermore, for the small-scale coastal fishermen there are many processing and marketing problems which hinder this type of development. The most notable are:

- (i) There is great species diversity in tropical marine environments and seldom is it possible to develop a fishery solely on one species. Processors and customers alike can therefore not become accustomed to dealing regularly with a single species.
- (ii) The species diversity requires versatility in the handling and processing techniques used in order to maintain quality.
- (iii) The remoteness of many island areas normally results in abnormally high purchase, maintenance and fuel costs for all processing and refrigeration equipment.
- (iv) The ambient temperature in tropical environments strains the available refrigeration which is limited in most cases.
- (v) Ciguatera poisoning is a common phenomenon in most island areas. This prevents the sale of certain species of fish to local knowledgeable consumers. It also completely prohibits the export of fish between some countries because of the uncertainty on the part of foreign buyers.

The above problems mainly concern the development of commercial fisheries for coastal resources. In addition, there are several major issues which governments need to consider before large-scale fisheries for offshore species are planned; some of these issues are also relevant to the development of export, or even foreign, fisheries and are discussed later.

- (e) *Export fisheries.* It often seems surprising that numerous export fisheries have been developed in the Pacific Islands when it has proved difficult to provide enough fish for local consumption (Table 3). It is the very nature of the differences between export-oriented and local fisheries which emphasises the real problems of developing and managing fisheries in this region.

Furthermore, export fisheries are only established when a substantial external market exists for a relatively high priced product and commercial interests from the country of destination, presumably a more developed country, will often provide expertise and management support for the collection and processing of the product. Requirements for entrepreneurs and highly developed marketing and other technical skills in the developing country are therefore decreased. As a result, export fisheries are often developed when commercial enterprises to meet local demand have not been possible.

- (f) *Distant-water fishing nations* presently fish in the 200-mile zones of all the Island countries of the central and western Pacific. Catches in this region by these foreign nations are completely dominated by tunas and other highly migratory species. All of the Island states of the region have a strong desire to increase their involvement in the fisheries which go on in the waters surrounding them and the international acceptance of extended fisheries jurisdiction has undoubtedly given them new rights and powers to do so.

Increased involvement by coastal states does not necessarily imply increased participation by nationals in the fisheries themselves. In the short term, it is likely that Island states will benefit from licence fees, entry fees and catch taxes, or the like, imposed upon the distant-water fishing vessels, but a potential for increased participation by coastal states in future development certainly exists.

Development of fisheries for offshore resources has several problems in common with commercial, export or foreign activities. The significance of highly migratory species, predominantly tuna, is clearly shown in Table 2. It can be seen that tuna (local, longline and Japanese pole-and-line) account for 253,830 tonnes of a total recorded fish catch of 289,196 tonnes (88 per cent) from the 200-mile zones of the Island states in the area considered.

Even though 'local tuna catches' in Table 2 amount to 89,538 tonnes, it must be noted that the greater part of this total is taken by foreign vessels fishing independently of, or in joint-venture with, the coastal state; the catch is recorded as local by the individual countries because it is landed or transhipped in the respective country.

The tuna catches in Table 2 are particularly significant for two major reasons: firstly, the totals show the tremendous economic potential of tunas for many of the individual states; secondly, the present low level of participation by coastal states indicates considerable potential for development. The real problem then, is how to increase the involvement of the Island states in these fisheries. A whole range of possibilities exists, from the development of wholly owned, operated and controlled local fisheries, through numerous joint-venture alternatives, to the generation of revenue from totally foreign fleets. Of course, no one of these possibilities need to be pursued exclusively and some balance of local and foreign enterprises could be the most rewarding.

If the coastal states pursue the option of developing their own fisheries for the offshore resources, then some of the major problems they will need to overcome include:

- (i) *Seasonal fluctuations in the abundance of the resource.* Even though the area of ocean under the control of individual coastal states has increased dramatically as a result of 200-mile zones of extended jurisdiction, these areas represent only a part of the habitat of the highly migratory species. The abundance of these resources in any one 200-mile zone fluctuates markedly with season, particularly in the higher latitudes. It may, therefore, be impossible for most small Island states to maintain a fleet year-round, particularly as most of them have no other suitable fisheries in which to employ vessels and crew during off-peak seasons. Co-operation with neighbouring states, preferably on a broad regional basis, could help to alleviate this problem.

Highly migratory resources often show marked year to year variations in abundance in addition to seasonal variability. Companies or countries with limited financial resources find it very difficult to withstand successive poor seasons, or even a single very bad one.

- (ii) *The requirement for large expensive vessels.* An average (300 tonne) pole-and-line or longline vessel used in the distant-water fisheries of the central and western Pacific now has a replacement value which substantially exceeds A\$1,000,000 and even in 1976 cost almost A\$1,000,000 per year to operate. In 1980, an average United States tuna purse seiner of 1,000 tons costs approximately A\$7,000,000 to build and A\$2,000,000 per annum to run.

Small states generally do not have suitable slipping and docking facilities for larger fishing vessels, nor do they carry extensive stocks of spare parts and ancillary equipment.

- (iii) *Cost and availability of fuel.* In 1976, it cost approximately A\$140,000 per annum for fuel for a 350 tonne pole-and-line vessel, A\$100,000 for a 276 tonne longliner and A\$240,000 for a 1,100 ton purse seiner (Kearney 1979a). The fuel costs for any one of these vessels exceed the entire national fuel bill for 1977 for each of two of the Island states of the South Pacific (Tuvalu and Niue) and represent a substantial fraction of the fuel consumption of several others. Fuel prices have increased dramatically since 1976. Fishing fleets throughout the world are facing serious economic problems as a result of the world's worsening oil situation and Island states are no exception. They may even be more disadvantaged, for should they undertake a major fisheries development scheme their fuel purchasing policy would need major review to ensure that fuel is obtainable. Fuel is not only becoming more expensive, but is also becoming increasingly difficult to obtain, making it difficult for any non-oil producing country to plan the development of fisheries which will necessitate substantial increases in fuel consumption.

Fuel is also far more expensive in remote areas. This makes it disadvantageous for foreign flag vessels to bunker there and hence difficult for small states to encourage these vessels to call and unload their catch. It also means that Island states have an extra economic disadvantage to contend with when catching fish to sell on an internationally competitive market.

- (iv) *Problems of smallness and economies of scale.* There are many problems of smallness and economies of scale relevant to fisheries development in the Pacific Islands. Enumeration of these problems is unnecessary; however, one example relevant to the specific problems of developing a major fishing facility is probably warranted.

In a previous study (Kearney, 1975) based on data from the Papua New Guinean skipjack fishery, it has been estimated that approximately 8,000 tonnes of tuna per annum were required to maintain the economic viability of the catching sector; this would require at least ten catcher boats. In addition to the problems of funding a venture of this size, most Island states do not have sufficient skilled fishermen, or other technical or management personnel, available to facilitate this scale of development. If a live-bait and pole fishery, capable of catching 8,000 tonnes of tuna per annum, is to be developed, then live-bait resources sufficient to support bait catches well in excess of 240 tonnes would be required (Kearney, 1975). Most Island states do not have bait-fish resources of this magnitude and even for some that do, a catch of 240 tonnes per annum would be several times their present total commercial fish catch. Furthermore, experience suggests that the development of tuna fishing industries in the western Pacific is suspect unless there is some processing associated with it. If the fish are not processed but merely exported frozen, then the remoteness of most small states means that freight costs as high as A\$200 per tonne can be anticipated and these may severely jeopardise the entire operation. The minimum annual requirement for a viable tuna cannery is around 5,000 tonnes, depending on the locality, and 15,000 tonnes is probably closer to the optimum size in most areas. Not only does this type of processing facility pose additional financial and manpower problems, but it requires water and power resources which are beyond most very small Island countries.

MANAGEMENT

While most of the problems of development and management of fisheries in the Pacific Islands are at present related to development, there is no doubt that management issues will assume great importance in future years. Economic considerations will undoubtedly be a prime factor in determining future management policies, but these policies will also be substantially influenced by social and political motives. On the basis that the management objectives will be to maximise the benefits for the people of the countries concerned, it can be anticipated that the maintenance of the resources at levels which will provide optimum yields will be essential. The necessity, therefore, of basing all future management decisions on sound resource survey and assessment results, is unavoidable.

Management of the resources exploited by inshore subsistence, artisanal and commercial fisheries will need to concentrate on the maintenance of the exploited stocks. Major concerns will be the preservation of breeding and nursery grounds such as mangrove areas, reef flats and intertidal zones, and the maintenance of fishing effort at levels which prevent overexploitation.

The management of fisheries for offshore, highly migratory species, i.e. the commercial export and foreign fisheries, will, in the short term, probably be aligned with development and will concentrate on increasing the involvement of Pacific Island states in these fisheries. It is reasonable to assume that, in the immediate future at least, participation by Island states in this management will be along the lines indicated by the most recent Law of the Sea conferences. Articles 56, 61 and 62 of the Informal Composite Negotiating Text (ICNT 1977) are most relevant; these refer specifically to the increased rights and obligations of coastal states and others exploiting the resources:

- (i) *Increased rights of coastal states.* The increased rights of coastal states in the exclusive economic zone are clearly defined in Article 56,
 - '(a) Sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the bed and sub-soil and the superjacent waters'. Additionally (Article 61.1), 'The coastal states shall determine the allowable catch of the living resource in its exclusive economic zone', and (Article 62.3) 'The coastal state shall determine its capacity to harvest the living resources of the exclusive economic zone'.
- (ii) *Obligations of coastal states.* Considering the obligations of coastal states, Article 62.1 states 'The coastal state shall promote the objective of optimum utilisation of the living resources in the exclusive economic zone', and Article 62.2 adds 'Where the coastal state does not have the capacity to harvest the entire allowable catch, it shall . . . give other states access to the surplus of the allowable catch'.
- (iii) *Obligations of nationals fishing in an exclusive economic zone other than their own.* The obligations of nationals or other states fishing in the exclusive economic zone are numerous but most importantly include compliance 'with the conservation measures and with the other terms and conditions established in the regulations of the coastal state. These regulations shall be consistent with the present Convention and may relate, *inter alia*, to the following:
 - (a) Licensing of fishermen, fishing vessels and equipment, including payment of fees and other forms of remuneration . . .
 - (b) Determining the species which may be caught, and fixing of quotas of catch . . .
 - (e) Specify information required of fishing vessels, including catch and effort statistics and vessel position reports . . .
 - (h) The landing of all of the catch by such vessels in the ports of the coastal states . . .
 - (k) Enforcement procedures' (Article 62.4).
- (iv) *The need to conserve the resource base.* Article 61.3 endorses the need 'to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yields, as qualified by relevant environmental and economic factors, including the economic needs of coastal fishery communities and the special requirements of developing countries'.

Acceptance of these principles is of major political and economic significance to all Island states. From an economic viewpoint it is significant that Article 62.1 promotes the *optimum* utilisation of the resources, as determined by the coastal state, while Article 61.3 endorses the need to maintain resources at levels of *maximum* sustainable yield. These Articles, therefore, emphasise the great need for Island states to have not only the best possible information on the size and dynamics of the fishery resources, but also to be aware of the alternatives for optimising economic returns. In many cases coastal states do not at present have all the necessary expertise to evaluate all of the options for economic benefit or to assess the costs such as surveillance and enforcement associated with management. Regional organisations have a vital role to play in this regard.

The highly migratory nature of the major resources means that their conservation, whether for the maintenance of maximum yields or for protection of stocks or subpopulations, will require the co-operation of all countries involved in their exploitation. International politics and resource diplomacy can be anticipated to become increasingly important in the management of oceanic fisheries of the region as a whole. Again the input of expertise from regional organisations will be of major benefit.

CONCLUSIONS

There is undoubtedly a great potential for increased fisheries development in the central and western Pacific. Island states can be anticipated to become more involved with management of resources exploited for domestic consumption and to play an increasingly important role in the management of the valuable resource of highly migratory species of the region.

While the goals of both development and management will inevitably be aligned with attainment of economic returns, there is no doubt that social and political motives will play a major role. Achievement of these goals will require planning based on consideration of numerous complex variables. However, few fisheries development or management objectives will be achieved if policies are not based on sound knowledge of the magnitude and dynamics of the underlying fisheries resources.

In view of the shortage of fisheries expertise in many Pacific Islands, it is anticipated that the regional organisations will play a vital role in providing governments with the best possible resource assessments and with guidelines and assistance in optimising the returns from exploitation. Governments involved with offshore fisheries will be negotiating with more developed distant-water fishing nations and will therefore require the highest quality advice. Regional organisations have a responsibility to ensure that the best possible advice is available. Full support from governments will be required to ensure that these organisations have access to the most up-to-date statistics and other relevant data and that highly qualified staff are available. As all countries in the region will be relying on at least some assistance for development and regional maximisation of yields, the highest standards must be maintained; bad advice is not cheap at any price.

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TINNED TROCHUS MAKES DELICIOUS DISHES¹

In recent years, the flesh of trochus caught in the lagoons and on the reefs of Tahiti was either thrown back into the sea or given to farmers for pig feed.

Quite rightly believing that this was 'casting pearls to swine', a group of six people decided to make use of the trochus fishing season in January and February 1980, to try and market this meat which, from the culinary point of view, compares very favourably with abalone.

Under the direction of Joël Buillard, Messrs Asin, Mako Jourdain, Roger Amiot, André Porlier and Steven Ellacott, they set themselves up as a non-profitmaking association, *Hotu Polinesia*, with the declared purpose of studying and marketing local produce, and bought eight tonnes of meat of this tasty gastropod and proceeded to tin it.

Forty employees worked for two months, and 17,000 tins, each containing 240 g of trochus meat finally appeared on the local market.

However, as everyone knows, man is a creature of habit and slow to accept news ideas. A local restaurant finally took the risk of putting this new local product on its menu.

Representatives of the press, radio and T.V. were invited to sample five different trochus dishes. Their guinea pig role was by no means a hardship since all the guests were greatly impressed with the trochus fritters, chicken and trochus, trochus with oyster sauce and trochus salad they were served. As an additional treat, the chef had prepared a *rori* (bêche-de-mer) dish which delighted gluttons and gourmets alike.

Thus it was shown that trochus, which had never enjoyed much popularity in Tahiti, could more than hold its own in Chinese cuisine. However, there is also room for trochus in French gastronomy, and, to prove this point, another local restaurant adapted three traditional French recipes for this shellfish.

'Mornay' (in cheese sauce), 'à l'Américaine' (with hot tomato sauce) and herb and garlic butter are among the mainstays of French seasoning and they do great things for trochus, turning it into a dish fit for a king or at least worthy of featuring prominently on any restaurant menu.

As a result of these two trials, home cooks at a loss for ideas can now add glamour to their special occasion meals and delight their guests by giving pride of place to the trochus of Tahiti.

Tinned trochus meat is available from more than 130 retailers in French Polynesia. It costs 200 francs a tin, a price which most people in Tahiti can afford, and very probably the 17,000 tins produced for sale will not be enough to go round until the next fishing season.

In this connection, *Hotu Polinesia* regrets that fishing operations are not spread out over a longer period of time so as to provide more permanent employment for the canning factory workers.

We shall have to wait till 1981 for the experiment to be repeated and, hopefully, an attempt made to capture foreign markets where this delicacy is much in demand.

1. This article originally appeared in *La Dépêche de Tahiti* on 12 September 1980. The South Pacific Commission is grateful to *La Dépêche* for granting permission to use the article in the *Fisheries Newsletter*.

LIST OF *TROCHUS* AND GREEN SNAIL SHELL BUYERS

In response to numerous requests for information about markets for *Trochus* and green snail shell, we are publishing the following list of commercial shell buyers. We hope this information will be of value both to fisheries departments and to private individuals involved with the marketing of these shells. Persons intending to deal with any of these buyers are advised to first arrange for a bank to check buyer's credentials. We are grateful to Mr B. Parkinson of the Department of Commerce (Business Development), Papua New Guinea, for supplying information for this list.

Europe

Clarke and Smith (Eastern) Ltd
Borne House
62/63 Mark Lane
LONDON, EC3R 1700
Great Britain

Jemah Products Ltd
(Import Purchase Division)
Hopkins Lane
Newton Abbot
DEVON
Great Britain

Contact: Mr S.G. Harris

A. Koppels and Co.
Hubarlaan 22
HILVERSUM
Netherlands

Contact: Mr A. Crick

Mr M. Messenger, K.G.
Postfach 1228
D-7530 PFORZHEIM
West Germany

Fiji

Banno Oceania
17 Cumming St
SUVA

Tabua (Fiji) Ltd
11 Kanjee Bldg
Walu Bay
SUVA

Seaking Trading Co.
P.O. Box 3932
Samabula
SUVA

Japan

Aoi Trading Corporation
3rd Floor
Takahashi Bldg
1-3-11, Tsukiji Chuo-Ku
TOKYO

Japan (cont'd)

Daido Co. Ltd
(Daido Kosan K.K.)
Nishi P.O. Box 5567
OSAKA 550-91

Contact: Mr N. Ohno

Dainihon Tsusho Ltd
48, 2-Chome, Kyobashi
Higashiku
OSAKA

Contact: Mr S. Kimura

Hayama Trading Co. Ltd
Room 502, 5th Floor Roop Bldg
18-1, 1-Chome
Kawaramachi Higashi-Ku
OSAKA

Contact: Mr K. Tabuchi,
Managing Director

International Transaction Service Co. Ltd
(K.K. Kukusai Koryu Sabis)
3-1-11, Masakicho
Chiyoda-Ku
TOKYO

Kawata Taraka Co. Ltd
45 Harima-Cho, Ikuta-Ku
KOBE
(P.O. Box 402 Port)

Contact: Mr T. Shibata

Kobe Fresh Co. Ltd
P.O. Box Kobe Port 2063
KOBE

Contact: Mr M. Suzue,
President

Kurashiki and Co. Ltd
71, Uehonmakhi 7-Chome
Tennojiku
OSAKA

Contact: Mr V. Kurashiki

U.I. Incorporated
Hinomaru Bldg
13-10, 3-Chome Kuramae
Taito-Ku
TOKYO

Contact: Mr M. Hara

United Trading Co. Ltd
Kitayaesu Bldg, 2-11
3-Chome Nihonbashi, Chuo-Ku
TOKYO 103

Contact: Mr J.E. Hamilton,
Vice President

Mr Syoziro Waramura
Hotatugaik Nakamachi 3-9-22
Toyonaka
OSAKA

Korea

Chang-sun Chung
Kang Sook Company
Central Post Office Box 419
SEOUL 100

South-East Asia

Eastern Pearl International Co.
Room 1101-2 Seaview Commercial Bldg
21-24 Connaught Rd, West
HONG KONG

Contact: Mr D. Lam

Etat Enterprise Pty Ltd
Unit 434
3rd Floor People's Park Complex
New Bridge Rd
SINGAPORE 1

Contact: Mr V. Tan

Unique Commercial Distributors Ltd
1810 Dominion Centre
37-59 Queens Rd, East
HONG KONG

Contact: Mr Lo

U.S.A.

Handy Trading Co. of America
8560 Venice Boulevard
LOS ANGELES, California, 90034

Contact: Mr A. Dresden

Tai Won Trading Company
P.O. Box 25138
W. LOS ANGELES, California, 90025



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