South Pacific Commission

Coastal Fisheries Programme

CAPTURE SECTION REPORT

OF

TUNA FISHERIES DEVELOPMENT

EAST NEW BRITAIN, PAPUA NEW GUINEA

PHASE I

FAD DEPLOYMENT PROJECT

15 NOVEMBER 1992 – 31 MAY 1993

PHASE II

PILOT TUNA LONGLINE PROJECT

1 JUNE 1993 – 15 SEPTEMBER 1994

by

S. Beverly
Consultant Masterfisherman

and

L. Chapman
Fisheries Development Adviser

Original text: English

South Pacific Commission cataloguing-in-publication data

Beverly, S

Capture section report of tuna fisheries development assistance East New Britain, Papua New Guinea / by S. Beverly and L. Chapman

1. Fisheries—Equipment and supplies 2. Fish aggregation device—Papua New Guinea. FAD I. Title II. South Pacific Commission

639.2'9585 AACR2
ISBN 982-203-511-X

Prepared for publication and printed at
South Pacific Commission headquarters
Noumea, New Caledonia, 1996

SUMMARY

The waters of Papua New Guinea, including the archipelagic waters of the New Guinea Islands Region, harbour a rich tuna resource that has not been exploited commercially by longline vessels for almost a decade. In the latter part of 1991, Government and private-sector interests in the New Guinea Islands Region began exploring the possibility of establishing a domestic tuna longline industry. As part of this effort the PNG Islands Region Secretariat and the East New Britain (ENB) Provincial Government sought the assistance of staff from the South Pacific Commission's Coastal Fisheries Programme to design a tuna fisheries development strategy, and to secure the technical and financial assistance necessary to initiate such a programme. Subsequently, at the request of the East New Britain Provincial Government and the Government of Papua New Guinea (GPNG), on behalf of its Department of Fisheries and Marine Resources (DFMR), a formal request for SPC assistance was made.

In November of 1992, under SPC's Offshore Fisheries Development (OFD) Project, a consultant Masterfisherman with experience in longline fishing and fish aggregating device (FAD) deployment, Stephen Beverly, was recruited by SPC and assigned for an initial six months (Phase I) to East New Britain, attached to GPNG's Kokopo Fisheries Project, near Rabaul. Funding for Phase I was provided by the United Nations Development Programme.

Phase I of the project involved the deployment of several FADs in close proximity to rural fishing communities near Rabaul and in the Duke of York Islands, with the intention of assessing the tuna resource in the area and stimulating development of an artisanal tuna fishery. Three FADs were deployed using the project vessel, *F/V Kuriap*. Five additional FADs were donated and deployed by a foreign purse-seine fishing company, Mar Fishing Company, active in the area.

The FAD deployments were technically successful, with a workable mooring system and low-cost FAD raft developed from locally available materials. Extensive bottom surveys were conducted and good deployment sites selected. DFMR staff crewing the *F/V Kuriap* were trained in all aspects of FAD survey, rigging, and deployment. However, most of the FADs were cut loose by vandals soon after being deployed, even though two had proved to be very successful with both artisanal fishermen and sportsfishermen.

Early FAD losses lessened the impact of the FAD deployment programme. However, several things were learned from the operation: FADs could be of significant benefit to fishing communities in the Rabaul, Duke of York Islands area; any future FADs would have to be 'man-proof' or 'vandal-proof'; considering current and weather conditions and vandalism, it would be best in the future to deploy one or two FADs using heavy-duty materials rather than several light-weight FADs; and large commercial fishing companies, particularly purse-seine companies, are willing to donate FADs and even deploy them for artisanal use.

The United States Agency for International Development (USAID) provided funding for Phase II to be conducted. The aims and goals of Phase II were to demonstrate that sashimi-grade yellowfin tuna and bigeye tuna with export market potential could be landed consistently and economically in ENB using a small (15 m) vessel fitted with a monofilament longline reel and manned by a local crew. The longer-term goals were to market tuna internationally and eventually privatise the operation, or to generate enough local interest so that the private sector would step in and develop a fresh-chilled sashimi tuna export venture, if not in ENB then at least somewhere in PNG. One further goal was to identify the present constraints to such a venture so that Government and industry, working through such bodies as PNG's Fishing Industry Association (FIA), would be able to work towards resolving them. This phase extended over fifteen and a half months, between June 1993 and September, 1994.

The first set made during these trials yielded a catch of 1200 kg of yellowfin tuna (*Thunnus albacares*) and 150 kg of billfish for the 300 hooks set. Catch rates were consistent throughout the trials, although peaks were evident in the months of July, August and December. Yellowfin tuna predominated in the catch, although a small number of bigeye tuna (*T. obesus*) were taken. Other species taken included different species of billfish, mahi mahi (*Coryphaena hippurus*), barracuda (*Sphyraena* spp.), and several shark species. The yellowfin tuna were almost all of prime market-

able size, ie., around 50 kg. Anything over 30 kg is considered to be of prime weight on the Japanese market.

Project fishing operations have shown that there is no question about the presence of a tuna resource in the waters surrounding East New Britain. The resource is abundant and fishing is regular throughout the year. Catch per unit of effort (CPUE) for 12 months of fishing (August 1993 to July 1994) was about twice the average for the area monitored by SPC. CPUE for the project was 118 kg/100 hooks for all species and 92 kg/100 hooks for yellowfin tuna alone, with individual yellowfin tuna averaging 43 kg each (processed weight). Catch rates for the months of July, August, and December were phenomenal, with some fish weighing over 70 kg, gilled and gutted. Bigeye tuna catches were not nearly so dramatic, but yellowfin tuna was the target species for most of the fishing trials. The high CPUE is likely to be due to the fact that there has been no commercial longline activity in PNG for a number of years. However, the success of the project's fishing trials must also be attributed to the introduction of monofilament longline fishing techniques.

Trial marketing to Japan was carried out through a fish exporter in Cairns, Australia. Most fish, however, were marketed locally in Kokopo and Rabaul, and a small sashimi market was developed at two of Rabaul's hotels.

Two trial shipments were sent to the auctions in Japan, one of 250 kg and one of 600 kg. The fish were received favourably by the Japanese buyers and the prices paid showed that PNG fish have a good market value. The fish from the project were in a size range to place them in a high bracket in the Japanese market, although not in the highest bracket held by bluefin tuna (*T. maccoyii* and *T. thynnus*) and high-fat content bigeye tuna and yellowfin tuna from more temperate regions.

The major constraints to establishing a domestic tuna longline fishery in East New Britain were identified as being high air-cargo rates, the lack of a suitable and regular air service between PNG and Japan as well as internally, and Government procedures and requirements. Local airlines had no previous experience with exporting fresh seafood products except for a very small live lobster and reef-fish export venture, also operating out of ENB. Similarly, local manufacturers of packing materials had no experience with the special requirements of the fish export industry. As a result, trial marketing just reached the critical 'break-even' point, although this is difficult to determine on an aid-funded project. A more comprehensive study of the feasibility of overseas marketing of sashimi-grade tuna from an ongoing domestic longline fishery is needed. It is envisioned that this may occur with the ENB Provincial Government's efforts to privatise the longline fishing and shore-side processing operations.

The airport at Rabaul is too small for large-capacity aircraft and the present fleet of Air Niugini's F28 aircraft is inadequate for transshipping large amounts of cargo. The project also found that the Government regulations and requirements in place at the time were difficult to work with and limiting. These issues were being addressed through the Fishing Industry Association (FIA), and it was anticipated that the current fisheries regulations would be reviewed and amended with a view to improving the legal framework under which a local tuna longlining industry could develop and expand.

RÉSUMÉ

Les eaux qui baignent la Papouasie-Nouvelle-Guinée y compris celles de l'archipel de Nouvelle-Guinée sont abondamment peuplées de thonidés que les flottilles de palangriers n'ont pas exploités commercialement pendant près d'une décennie. A la fin 1991, des sociétés publiques et privées de cet archipel ont commencé à explorer la possiblité de créer une filière locale de pêche thonière à la palangre. C'est dans cette optique que le secrétariat de cette région de Papouasie-Nouvelle-Guinée et les autorités provinciales de Nouvelle-Bretagne orientale ont sollicité l'aide du personnel de la section pêche côtière de la Commission du Pacifique Sud afin d'élaborer une stratégie de valorisation de la ressource en thonidés et d'obtenir l'aide technique et financière nécessaire au lancement d'un tel programme. Ultérieurement, à la demande des autorités provinciales de Nouvelle Bretagne orientale et du gouvernement de Papouasie-Nouvelle-Guinée, intervenant au nom du Department of Fisheries Marine Resources (DFMR, service des pêches et des ressources marines), une demande d'aide officielle a été adressée à la CPS.

En novembre 1992, dans le cadre de son projet de développement de la pêche au large, la CPS a recruté en tant qu'expert-conseil, un maître de pêche, un spécialiste de la pêche à la palangre et du mouillage de dispositifs de concentration du poisson (DCP), Stephen Beverly. Elle l'a affecté en Nouvelle-Bretagne orientale au Kokopo Fisheries Project, (projet de Kokopo sur la pêche) du gouvernement de Papouasie Nouvelle Guinée, près de Rabaul pour une première période de six mois (phase I). Le financement de la phase I a été assuré par le Programme des Nations Unies pour le développement.

Dans le cadre de la phase I du projet, plusieurs DCP ont été mouillés non loin de villages de pêcheurs situés près de Rabaul et à proximité des îles du Duc d'York, afin d'évaluer la ressource en thonidés dans cette région et de promouvoir le développement d'une pêche thonière artisanale. Trois DCP ont été mouillés par le navire affecté au projet, le *F/V Kuriap.* Cinq autres DCP ont été offerts et mouillés par une société étrangère de pêche à la senne, la Mar Fishing Company, dont des unité opèrent dans cette région.

Au plan technique le mouillage de ces DCP a été une réussite puisque ces engins sont équipés d'un système d'amarrage qui fonctionne et d'un radeau fabriqué à faible coût à partir de matériaux disponibles localement. Des études approfondies ont été conduites au fond de l'eau et de bons sites de mouillage ont été retenus. Les agents des services des pêches et des ressources marines qui composaient l'equipage du *F/V Kuriap* ont été formés dans tous les domaines de l'exploitation de DCP : études de site, montage et mouillage. Cependant, des vandales ont sectionné les systèmes d'amarres de la plupart des DCP peu après leur mouillage, bien que deux de ces engins aient rendu de très grands services la pêche artisanale aussi bien que plaisancière.

La perte précoce de ces DCP a amoindri l'impact du programme de mouillage de DCP. Cependant, a permis de tirer de cette expérience plusieurs enseignements. Les DCP pourraient être utiles aux pêcheurs de la région de Rabaul et des Îles du Duke d'York. A l'avenir, ils devraient pouvoir résister à tout acte de vandalisme; étant donné la force des courants, les conditions climatiques et ces actes de vandalismes, il serait préférable de ne mouiller qu'une ou deux unités fabriquées à l'aide de matériaux au lieu de plusieurs, plus légères; les grandes sociétés de pêche commerciale, en particulier les sociétés de pêche à la senne, sont disposées à offrir des DCP et même à les mouiller pour que les pêcheurs artisanaux en profitent.

L'agence de État Unis pour le Développement international (USAID) avait alloué des fonds pour la phase II qui avait pour objet de démontrer que du thon jaune et du thon obèse de qualité sashimi ciblant le marché de l'exportation pourraient être débarqués régulièrement et à des conditions commerciales intéressantes en Nouvelle-Bretagne orientale en utilisant une petite unité (quinze mètres) dotée d'un enrouleur de ligne monofilament, et ayant à son bord un équipage composé de pêcheurs locaux. A plus long terme, elle a pour objet de vendre le thon sur le marché international et au bout du compte de privatiser son exploitation ou de susciter suffisamment d'intérêt auprès des sociétés locales pour que le secteur privé intervienne et mette sur pied une société d'exportation de thon de qualité sashimi réfrigéré, en Nouvelle-Bretagne orientale ou sinon dans une autre région de de Papouasie-Nouvelle-Guinée. En outre, elle avait pour objet de définir les obstacles qui entravent actuellement la constitution d'une entreprise afin que les pouvoirs publics et les professionnels de la pêche, oeuvrant au travers d'organismes tels que la Fishing Industry Association (FIA - Association des pêcheurs professionnels) de Papouasie-Nouvelle-Guinée fussent en mesure de rechercher des moyens de les surmonter. Cette phase s'est déroulée pendant plus de quinze mois et demi entre juin 1993 et septembre 1994.

La première pose réalisée lors de ces essais a permis de capturer 1 200 kilos de thon jaune (*thunnus albacares*) et 150 kilos de marlin pour une ligne mère de 300 hameçons. Les taux de prises ont été constants pendant toute la période d'expérimentation bien que des pics aient été enregistrés en Juillet, août et décembre. Les prises de thon jaune sont les plus importantes, bien qu'un petit nombre de thons obèses (*T. obesus*) ait été capturé. D'autres espèces ont été prises notamment différentes espèces de marlins, des mahi mahi (*Coryphaena hippurus*), des barracuda (*Sphyraena* spp.), et plusieurs espèces de requins. Presque tous les thons jaunes pesaient une cinquantaine de kilos et pouvaient donc être vendus à un prix optimal. Au niveau du marché japonais, les spécimens de plus de trente kilos constituent le premier choix.

Les opérations de pêche qui se sont déroulées dans la cadre du projet ont démontré la présence de thonidés dans les eaux qui baignent la Nouvelle-Bretagne orientale. Cette ressource abonde et les prises sont régulières toute l'année. Les prises par unité d'effort (PUE) pendant douze mois d'exploitation (août 1993 à juillet 1994) se sont élevées à environ deux fois la moyenne enregistrée dans la zone surveillée par la CPS. Dans le cadre de ce projet, elles ont été de 118 kilos/100 hameçons, toutes espèces confondues, et de 92 kilos/100 hameçons pour le seul thon jaune avec des spécimens pesant en moyenne 43 kilos chacun (poids traité). Les taux de prises pour juillet, août et décembre ont été exceptionnels puisque certains individus pesaient plus de 70 kilos vidés et éviscérés. Les prises de thon obèse n'ont pas été aussi spectaculaires, mais le thon jaune a été l'espèce la plus ciblée pendant la grande partie de cette phase d'expérimentation. Ces PUE élevées s'expliquent probablement par le fait que pendant plusieurs années, il n'y a eu aucune activité de pêche à la palangre commerciale en Papouasie Nouvelle Guinée. Toutefois, le succès de ces essais de pêche doit aussi être attribué à l'introduction de la technique de pêche à la palangre monofilamement.

La commercialisation, à titre expérimental, sur le Japon a été réalisée grâce à un exportateur de poissons de Cairns (Australie). Toutefois, la majeure partie du poisson a été vendue localement sur le marché de Kokopo et de Rabaul; en outre, un petit marché de sashimi s'est développé dans deux hôtels de Rabaul.

Deux lots, l'un de 250 kilos et l'autre de 600 kilos ont été expédiés, à titre expérimental sur le Japon où ils ont été vendus à la criée. Les acheteurs ont apprécié la qualité de ces produits et les prix qu'ils ont payés montrent que le poisson de Papaousie-Nouvelle-Guinée a une bonne valeur marchande. Les poissons capturés lors des opérations menées dans le cadre du projet se situaient dans une fourchette de taille qui les plaçait dans une tranche élévée du marché japonais quoique pas dans la tranche la plus élevée où l'on trouve le thon rouge (*T. maccoyii* et *T. thynnus*), le thon obèse dont la chair est plus grasse et le thon jaune provenant de régions plus tempérées.

Des taux de fret aérien élevés, de mauvaises correspondances des vols irrégulièrs, tant entre la Papouasie-Nouvelle-Guinée et le Japon qu'à l'intérieur du pays, les formalités et les procédures contraignantes administratives ont été recensées comme des obstacles majeurs à la création d'une filière locale de pêche thonière à la palangre en Nouvelle-Bretagne orientale. Les compagnies aériennes locales n'avaient aucune expérience de l'exportation de produits de la mer frais si ce n'est de celle d'une petite quantité de langoustes et de poissons du récif, au départ de Nouvelle-Bretagne orientale. De même, les fabriquants locaux de matériel de conditonnement n'avaient aucune expérience des normes particulières à respecter en matière d'exportation de poissons. Aussi les efforts de commercialisation à titre expérimental ont-ils tout juste permis d'atteindre le seuil critique de rentabilité bien qu'il soit difficile à déterminer lorsqu'il s'agit d'un projet financé dans le cadre d'une aide. Il faudrait réaliser une étude plus approfondie de la viabilité de la commercialisation sur des marchés d'exportation de thon de qualité sashimi exploité par une filière locale de pêche à la palangre. Une telle étude pourrait être réalisée dans le cadre des efforts des autorités provinciales de Nouvelle Bretagne orientale pour privatiser des opérations de pêche à la palangre et le traitement à terre du poisson.

L'aéroport de Rabaul est trop petit pour accueillir des gros porteurs et la flotte actuelle de F28 d'Air Niugini est inadaptée pour le transport de grandes quantités de marchandises. Les responsables du projet ont également constaté que les règlementations et les normes mises en place alors par les pouvoirs publics étaient source de difficultés et de contraintes. La Fishing Industry Association (FIA - Association des pêcheurs professionnels) s'est penchée sur ces questions, et il a été prévu de revoir et de modifier la réglementation actuellement applicable aux produits de la pêche afin d'améliorer le cadre juridique permettant le développement et l'expansion d'une filière locale de pêche thonière à la palangre.

ACKNOWLEDGEMENTS

The South Pacific Commission acknowledges with gratitude the cooperation provided by the administration and staff of the Department of East New Britain and, in particular: the Premier, Hon. Sinai Brown; the Secretary to Government, Ellison Kaivovo; the First Assistant Secretary for Economic Services, Akuila Tubal; and the Provincial Fisheries Officer, Oliver Teno and all of his staff in Rabaul. SPC would also like to thank the Secretary of the Department of Fisheries and Marine Resources, Joseph Gabut and the staff in Port Moresby; and Richard Howell, Marine Resources Adviser for the United States Agency for International Development, Suva, Fiji.

The Commission also gratefully acknowledges the work performed by the manager of DFMR's Kokopo Fisheries Project, Chris Martinello, and his staff, who provided logistical support, ice making facilities, and marketing arrangements.

The project would not have been possible without the hard work and dedication of the captain and crew of *F/V Kuriap*. The Commission acknowledges with special thanks Captain Nathan Kandil, Engineer Moses Akas, and Seaman Wesley Joram, and all of the others who filled in from time to time as deckhands and fishermen.

In the private sector the Commission would like to acknowledge the assistance of the PNG Fishing Industry Association, and particularly the President, Maurice Brownjohn, for support throughout the project; Islands Aviation of Rabaul and Great Barrier Reef Tuna of Cairns for their help in marketing trials; and Rabaul Travelodge and Hamamas Hotel for giving sashimi tuna a chance on their menus.

The production of this detailed report took a great deal of time and patience. The authors thank all those involved, especially the Fisheries Development Adviser at the time, Peter Cusack, for his input; SPC's part-time artist, Yannick Le-Bars, for his line drawings; and the Project Assistant, Marie-Ange Roberts, for her input and layout of the report.

SPC's role in this project was made possible through funding provided by the United Nations Development Programme and the United States Agency for International Development.

CONTENTS

1. Introduction

1.1 Papua New Guinea and East New Britain Province

Papua New Guinea (PNG), with a total land area of about 476,500 km (Figure 1), is the largest island country in the South Pacific. PNG extends from the equator to 12° S latitude, and from 141° to 160° E longitude, encompassing the eastern half of the New Guinea mainland, the Bismarck Archipelago, Bougainville and Buka. The Bismarck Archipelago, known as the New Guinea Islands Region, comprises the main islands of Manus, New Ireland and New Britain as well as numerous scattered, smaller islands, ranging from tiny atolls to islands like New Hanover which has an area of 1,544 km^2 (Douglas & Douglas, 1989).

East New Britain (ENB), one of 19 provinces in PNG, occupies the north-eastern half of New Britain Island. The province has an area of 19,320 km^2 including the Duke of York Islands. Rabaul is the capital of ENB and has an interesting history: the town was completely wiped out in 1937 by volcanic eruptions and subsequently rebuilt, only to be invaded by the Japanese at the start of World War II. Rabaul was the headquarters of the Japanese invasion forces during the War. The harbour is a drowned volcanic caldera and is the centre of most shipping activity in the New Guinea Islands Region. Rabaul Harbour (Simpson Harbour) was also the main centre of commercial tuna fishing in the 1970s and 1980s.[1]

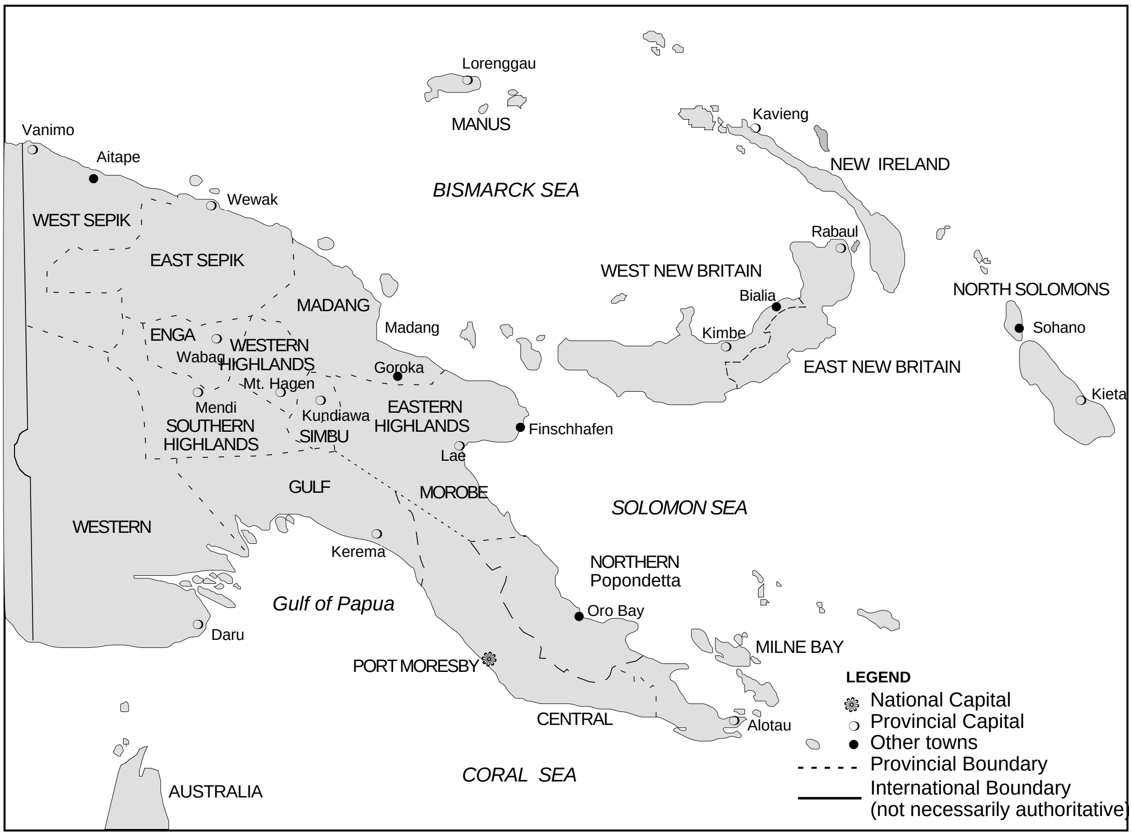


Figure 1: Map of Papua New Guinea

---

[1] In 1994 Rabaul was once again the victim of major volcanic eruptions which destroyed, damaged or buried most of the town.

1.2 TUNA FISHERIES

PNG has a large declared fishing zone (DFZ) of 2,300,000 km (Figure 2) which includes some of the most productive tuna fishing grounds in the western tropical Pacific. Commercial tuna fishing activity began in the 1950s with Japanese longliners, followed by Taiwanese and Korean longliners in the 1960s and 1970s. A locally-based joint-venture pole-and-line fleet fished out of East New Britain and New Ireland during the 1970s. The pole-and-line fleet landed as much as 49,000 t (in 1978) before declining and eventually ceasing operations on a large scale in 1981. A Japanese pole-and-line fleet operated during the same period, but it also stopped fishing in the early 1980s. Since that time, tuna fishing has been dominated by purse-seine vessels from Korea, Taiwan, USA and the Philippines, with catches rising from 12,000 t in 1980 to an estimated 200,000 t in 1989 (Anon., 1992).

With the declaration of PNG's DFZ, all tuna fishing activity by foreign (distant-water) fishing vessels was required to be licensed after March 1978. Access arrangements and fee levels were negotiated. Agreement could not be reached with Japan in 1987, and no significant licensed fishing activity by Japanese vessels has occurred in PNG's DFZ since that time.

Between 1970 and 1987, longline catches ranged from a low of 387 t (1987) to a high of 12,992 t (1981); the annual average catch was 6,596 t. Between 1988 and 1991 a declared catch was reported only in 1990, at a low 38 t (Lawson, 1993).

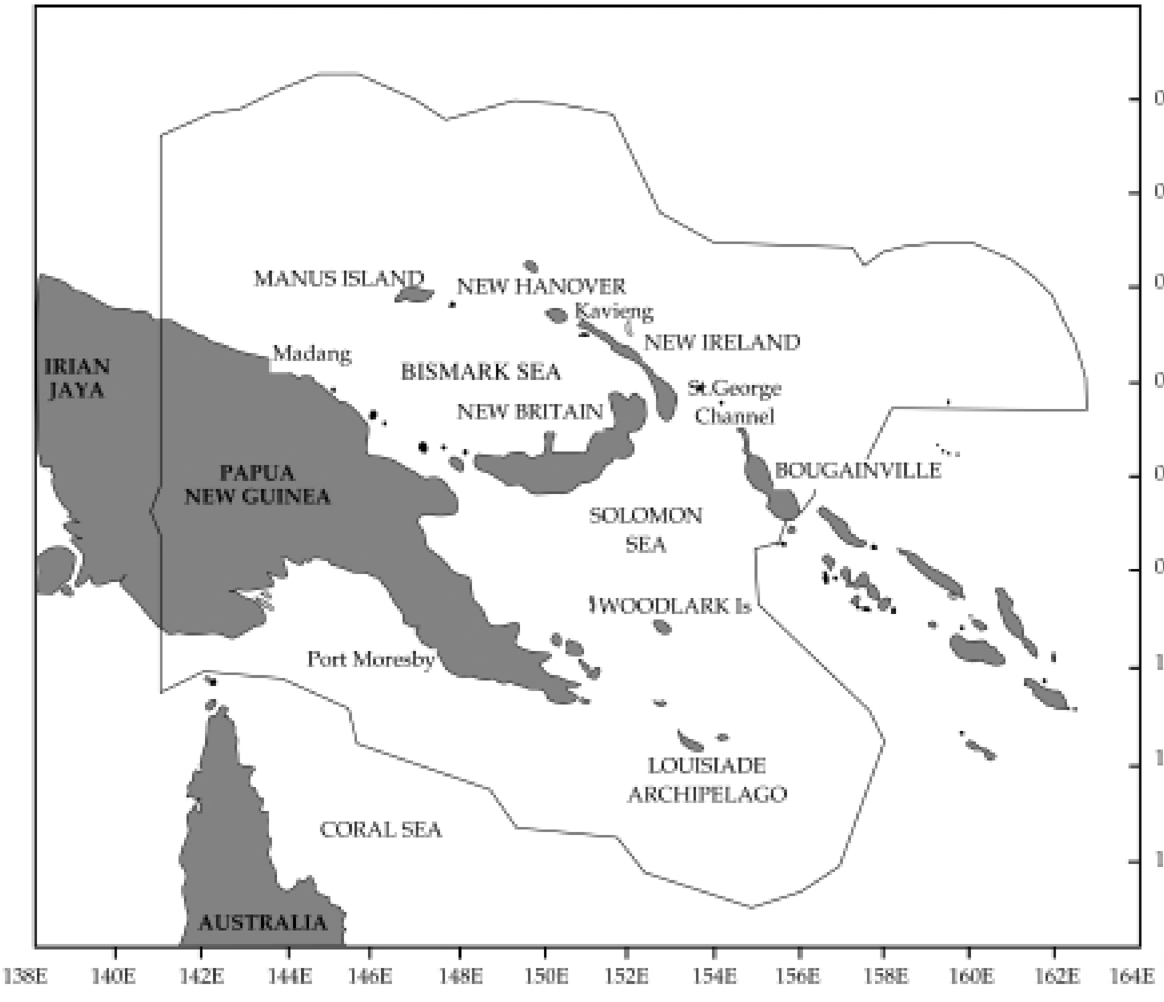


Figure 2: Locality map and Declared Fishing Zone (DFZ) of PNG

1.3 PROJECT INITIATION

The Government of Papua New Guinea (GPNG) has adopted a policy of promoting the re-establishment of a domestic tuna fishing industry and various initiatives are currently in train to promote this aim. The Department of Fisheries and Marine Resources (DFMR) is being re-organised as a statutory body to, among other things, streamline procedures for the licensing and monitoring of fishing vessels.

In line with this policy, GPNG in 1992 requested the assistance of the South Pacific Commission (SPC), on behalf of the Government of East New Britain Province (GENB), to assess local tuna resources, test the feasibility of promoting increased tuna fishing at the artisanal level, and establish a domestic longline fishery targeting sashimi-grade tuna for export marketing. The project which evolved was conducted in two distinct phases, operating from the Kokopo Fisheries Project (KFP) base in East New Britain. Phase I, supported by the United Nations Development Programme (UNDP) through the SPC-executed Offshore Fisheries Development Project, saw the deployment of fish aggregating devices (FADs) in East New Britain waters and some exploratory tuna and bait fishing. During Phase II, supported by the United States Agency for International Development (USAID), longline fishing trials were conducted in East New Britain.

2. Project Infrastructure

2.1 THE PROJECT BASE, STAFF AND EQUIPMENT

At the national level, DFMR provided support by making the KFP office and plant available to the project on a full-time basis, including the services of the manager and staff and the use of telephone, fax, and block-ice-making facilities. GENB provided support staff, including the crew of the project vessel *F/V Kuriap*, operating costs for the project vessel (fuel, maintenance, and provisions), accommodation and transport for the SPC Masterfisherman, and use of Kabakaul Wharf. GENB also purchased a five-tonne-per-day shell-ice machine and, towards the end of the project, arranged to make available the wharf and out-buildings in Rabaul township. SPC provided technical oversight and coordination of project operations and, with the support of UNDP and USAID, was able to provide 22 months of the Masterfisherman's services, materials for rigging and deploying five FADs, shipboard electronics and a ship-to-shore communications system, outfitting of *F/V Kuriap* with monofilament longline fishing gear and additional electronics, provision of two freezer containers and a backup generator, a container load of bait, and some fish-handling equipment.

2.2 THE PROJECT VESSEL *F/V KURIAP*

The vessel provided by GENB to conduct the tuna fisheries development work, the *F/V Kuriap* (Figure 3) was built in Japan by the Yanmar Diesel Engine Co. for GENB Fisheries Division in March, 1984 under a Japan Overseas Fishery Cooperation Foundation grant-in-aid. *F/V Kuriap* (the local name for porpoise) is a fibreglass-reinforced-plastic (FRP) mini-longliner design (see Appendix A for specifications). Briefly, *F/V Kuriap* is an 8.5 Gross Registered Tonne (GRT), 14.5 m (48 ft), multipurpose fisheries survey vessel. It came from Japan equipped with an array of fishing gear and electronics to enable it to be used in a variety of ways.

The fishing gear, fortunately for the Project, was all hydraulically operated via a power-take-off unit mounted in the engine room and controlled by a 24 volt electric clutch. This gear consisted of a small net hauler that could be interchanged with a pinch-puller-type line hauler on the starboard side of the main deck; two bottom-fishing reels mounted on special brackets on the starboard rail; and a capstan for hauling the anchor, mounted on the raised foredeck. In addition, there were two fibreglass outrigger poles, mounted on either side at the quarter and capable of supporting up to three trolling lines each. Three fish holds with a total capacity of 4 t were fitted below the deck, suitable for dry cargo, ice, or live bait.

F/V Kuriap's wheelhouse came equipped with a Furuno 36-mile radar, a Furuno recording paper echo-sounder, and a gyro compass but, unfortunately, no auto pilot. *F/V Kuriap* was thus able to be used for survey work in bait fishing or small driftnet fishing, pole-and-line fishing, horizontal and vertical longline fishing (both surface and deep-bottom), trap fishing, deep bottom-fishing with reels, and surface troll fishing. However, *F/V Kuriap* had been under-utilised by ENB Fisheries Division over the years.

Figure 3: The *F/V Kuriap* on the slipway at Rabaul, PNG

GENB was keen to see the vessel involved in an ongoing fisheries project, especially one that might generate some income to offset operating costs. The vessel was assessed by SPC staff in consultation with longline gear suppliers Ocean Producers International of Hawaii. It was agreed that *F/V Kuriap* would be suitable for use as a longliner if it was equipped with a hydraulic monofilament longline reel and all ancillary fishing gear, as well as extra wheelhouse electronics (see Appendix B for a list of all gear purchased). It was decided that *F/V Kuriap* would be used as the project vessel for both phases of the tuna fisheries development work.

When the SPC Masterfisherman arrived in PNG in November 1992, *F/V Kuriap* had not been to sea for almost six months. This was partly due to the vessel not being 'in survey' during that time because of a faulty seawater pump (one survey requirement for vessels over ten metres in PNG is that they have a working seawater or fire pump). Once this problem was corrected, a temporary periodic survey certificate was granted, valid until 14 July 1993 (when the vessel was due for a four-year survey) and the vessel was ready to begin work on FAD site surveys. In general terms, however, *F/V Kuriap* had been well maintained over the years by ENB Fisheries Division.

During FAD site surveys in Phase I, it became obvious to the Masterfisherman that *F/V Kuriap* would need additional maintenance work before it was ready to venture out on longline fishing trips of several days' duration. One major problem was that the propeller shaft was bent, causing a bad vibration while under way. A discussion with the Captain and crew revealed that this had been caused by a collision with a large log. Archipelagic waters in PNG are known to be hazardous for navigation because of the large number of logs and other debris that may be encountered, particularly after the frequent heavy rains. On many occasions during FAD survey work, large lines of logs were seen, sometimes stretching for several miles. On one FAD site survey trip in

April 1993, a submerged log was struck. The result was that the shaft vibrated even more than it had before and, more importantly, the engine suffered some damage as it had over-revved when the propeller was stopped by the log. This caused damage to cam-followers, push-rods and valves in the main engine.

The PNG Marine Department requires a major survey every four years and annual, or periodic, surveys in between. As *F/V Kuriap* was due for a four-year survey in July 1993, it was decided to haul the boat out in June and do all the repairs and survey work at one time. Under the supervision of the Masterfisherman, slipway workers and fisheries staff spent the month of June 1993 and part of July doing the necessary repairs, including work done in preparation for installing monofilament longline gear (see Appendix C for a complete list of all work carried out). On 21 July 1993, *F/V Kuriap* was granted a four-year survey certificate by the Marine Department.

3. Phase I: FAD Deployments

3.1 INTRODUCTION

Phase 1 activities provided for the rigging and deployment of several FADs, in the hope of promoting increased interest in tuna fishing on the part of artisanal fishermen because of the improved productivity and ease of operation that FADs might provide. It was hoped that this in turn would lead to increased turnover of fish produce for KFP.

The Masterfisherman's task was to fit out the project vessel with the necessary survey and deployment equipment, survey possible deployment zones, select FAD sites, design an appropriate raft and mooring system (making use of readily available materials) and deploy the FADs.

KFP, in collaboration with ENB Fisheries, was to undertake extension activities in target fishing communities to make fishermen aware of the FAD programme, conduct training in FAD fishing techniques, and refurbish and eventually hand over to local fishing groups several KFP craft thought to be capable of fishing effectively at the FADs.

3.2 FITTING OUT THE *F/V KURIAP* FOR FAD SURVEY WORK

F/V Kuriap came equipped with a Furuno recording paper sounder but no satellite navigator, GPS, or similar system. The existing paper sounder was not suitable for FAD survey work as it did not have the necessary range (1,000 m (500 fathoms) or more). Therefore, before any FAD survey work could be carried out new equipment had to be installed.

The survey equipment used comprised: a Furuno FCV 362 colour echo-sounder with a 2,000 m (1000 fathoms) range, a portable transducer housing for side mounting, and a JRC JLR-4110 GPS receiver/plotter, all of which were provided by SPC. *F/V Kuriap's* wheelhouse is quite small, but room was found for installing the above items after some of the old electronics were removed (the paper sounder, and the gyrocompass which was inoperable).

The echo-sounder receiver was originally mounted on the tiny chart table in *F/V Kuriap's* wheelhouse, but was later moved to a more stable position, the former location of the gyro compass. The transducer housing was mounted to a specially fabricated bracket made from 50 mm x 200 mm (2 in x 8 in) rectangular stock steel that was then bolted to the hull through existing holes. The cable was run across the deck and into the wheelhouse via a cable entry port that held several other wires. Power for the echo-sounder was provided by a 24 volt output coming off the circuit breaker that powered formerly the paper sounder. At the conclusion of FAD work, and while the boat was slipped, the transducer was permanently installed on the hull in the position of the transducer supplied with the paper sounder (a good sounder is useful for general navigation and is also useful, although not essential, for longline fishing).

The GPS receiver was mounted onto a window frame in the wheelhouse, thus no holes had to be drilled for its installation. The antenna was attached to a wooden broom handle with the clamps provided and this was then mounted onto the flybridge canopy frame. The antenna cable was run into the wheelhouse through another cable entry port. The GPS was powered by the same source as the echo-sounder (JRC GPS units can take a range of power supplies from 12 to 40 volts). For FAD survey work the GPS was corrected from a position on Australian Chart No. 680, Simpson and Matupit Harbour; the correction factor was 0.35 nm east. No north - south correction was necessary. This was later checked on British Admiralty Chart No. 3553, Gazelle Peninsula and St. George's Channel (the chart used in all FAD survey work during the course of the project) and found to be accurate.

3.3 FAD SURVEY AREA SELECTION

After consulting fisheries officers, members of the East New Britain Game Fishing Club, the crew of F/V Kuriap (two of whom were from the Duke of York Islands), and Chart No. 3553, it was decided that two areas would be surveyed. Since part of the aims of the FAD programme was to assist artisanal fishing communities, the first area selected for surveying was the water surrounding the Duke of York Islands, where many people depend on fishing for their livelihood. Because the waters to the east of the Duke of Yorks are part of the deep basin that forms St. George's Channel, the survey was limited to areas to the north, south and west of the group.

The second survey area selected was just to the north of Rabaul. The survey centred on a place that the locals call 'The Hump', lying at 04° 45' S and 152 ° 14' E. The Hump is a seamount that rises to within 30 m (15 fathoms) of the surface from surrounding depths of up to 1,000 m (500 fathoms). It has a local reputation as being a very productive game-fishing site. Many game fishermen expressed interest in having a FAD somewhere in the vicinity of The Hump to give them at least one more target fishing spot. Selection of this zone was supported by ENB Fisheries.

3.4 FAD SURVEY TECHNIQUE

The method used for surveying the FAD sites consisted of traversing the zone on north – south or east – west lines 0.25 nautical miles (nm) apart. At intervals of 0.25 nm along each of these transects the depth was recorded from the echo-sounder. Thus, depth data were recorded for all 0.25 nm intervals in two directions: north – south and east – west, covering the entire survey zone. This was identical to the method used by SPC in 1992 in surveying for FAD sites off Port Moresby (Beverly & Cusack, 1993).

With a little practice it was fairly easy to keep the boat on track by watching the GPS and following the last three numbers in the read out (resolution was set at .000 of a minute). If an east – west track was desired on, say latitude 04° 00.000' S, the boat was steered to keep the display readout at 000'. If the read-out increased to 005', the boat was too far south and had to be steered a little to the north. Conversely, if the read-out decreased to 995' (03° 59.995' S), the boat was too far north and had to be steered a little to the south. The Captain of *F/V Kuriap* became quite adept at this in a very short time, allowing the Masterfisherman to keep his attention on the echo-sounder and the GPS, and to record data. On each transect, depth data would be recorded at every 0.25 nm interval (i.e. as the last three numbers of the longitude read-out came up as 000', 250', 500' and 750'). When a track was completed the boat was moved south (or north) to the next interval (which would, in this case, be 04° 00.250' S or 03° 59.750' S) and travel would again be in an east – west direction.

As depth data were recorded, other observations, such as 'seamount', 'flat bottom', or 'birds in area', were noted on the data sheet. Later, all of the numbers were transposed onto a large sheet of graph paper. Then contours, or isobaths, were drawn by selecting and then connecting points of similar depth at 100 m (50 fathoms) intervals (Figure 4). Since most depths were something other than a multiple of 100, the position of the 100 m (50 fathoms) interval was deduced by extrapolation. This involved a little guess-work, but when the isobaths were actually drawn any errors were obvious and the contour could be averaged to straighten it out. When all of the isobaths were drawn, the result was a fairly accurate picture of the bathometry and bottom topography in the survey zone. From this information the most suitable FAD anchor sites were selected, as shown in Figure 5.

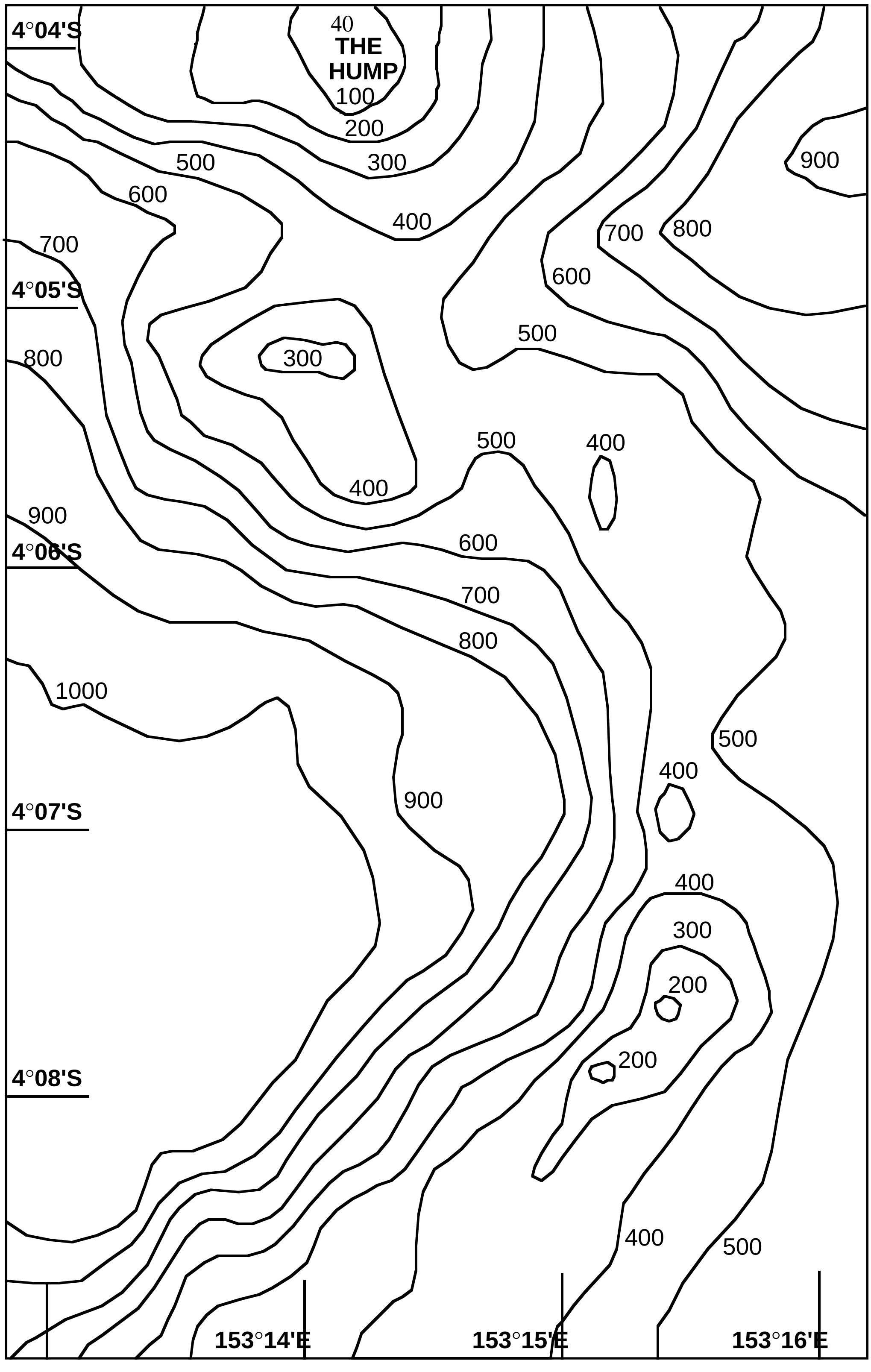


Figure 4: Contour map drawn from site survey south of The Hump (depths in metres)

3.5 FAD SURVEYS AND SITE SELECTION

3.5.1 South of Duke of York Islands

The first survey was made in a zone just to the south of the Duke of York Islands (Figure 5) bordered by 04° 15.00' S to 04° 18.00' S and 152° 27.00' E to 152° 32.00' E. The survey revealed that the bottom was relatively flat in the western part of this area, with depths ranging from 300 to 600 m (150–300 fathoms). The eastern side, however, dropped off to depths of over 2,500 m (1,250 fathoms)—out of range of the FCV 362 echo-sounder being used for the survey. To the south, near the middle of the zone, a ridge was found with a seamount rising to 300 m (150 fathoms) from the surface. The seamount and ridge are located approximately one nautical mile from the steep drop-off that leads to the deep basin.

This type of bottom feature is associated with sea-floor spreading and is referred to by geologists as a Horst and Graben Zone (pers. comm, D. Lindley). Horst and Graben Zones are also a characteristic feature of the Baining Mountains in the Gazelle Peninsula (Lindley, 1988). In other words, the sea floor in this area is likely to have similar features to the adjacent land mass. Such irregular bottom features may contribute to productive tuna fisheries because of associated upwellings, eddies, and current convergences.

The FAD site selected in this zone was on a flat area 650 m (325 fathoms) deep, lying about one nautical mile north of the seamount at 04° 16.75' S latitude and 152° 29.13' E longitude.

3.5.2 North of Pidgeon Islands

The second zone surveyed was north of the Pidgeon Islands (Credner Islands) which lie just to the west of the Duke of York Islands (Figure 5). The zone extends from 04° 11.00' S to 04° 16.00' S and 152° 19.00' E to 152° 22.00' E. The FAD site selected in this zone was in the middle of a flat

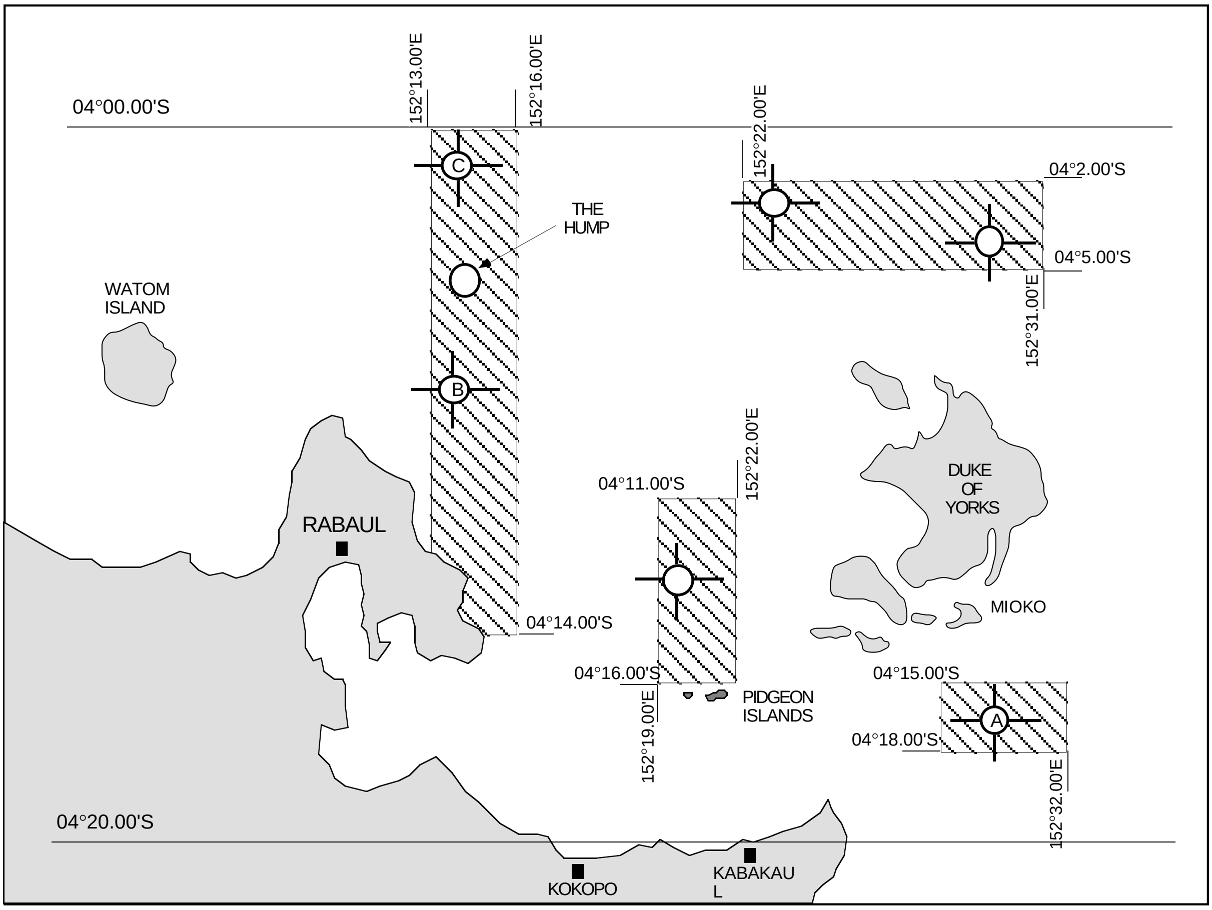


Figure 5: FAD zones and deployment sites surveyed by *F/V Kuriap*

plain at 666 m (333 fathoms) depth and is located along the route taken by Duke of York fishermen on their way to Rabaul, at 04° 13.50' S latitude and 152° 20.00' E longitude.

3.5.3 North of Duke of York Islands

This zone extends from 04° 02.00' S to 04° 05.00' S and stretches over nine miles east - west, from 152° 22.00' E to 152° 31.00' E. Two FAD sites were chosen in the zone to the north of Duke of York Islands: the first at 04° 03.00' S latitude and 152° 23.00' E longitude in 970 m (485 fathoms) depth and the second at 04° 04.00' S latitude and 152° 28.50' E longitude in 870 m (435 fathoms) depth.

3.5.4 The Hump

The survey zone extended from 04° 00.00' S to 04° 14.00' S and 152° 13.00' E to 152° 16.00' E. This survey zone showed a bottom topography that again reflected similar nearby land features. The survey indicated that The Hump is on a ridge forming the eastern rim of a drowned caldera. This caldera is similar in shape and size to the caldera that forms Rabaul Harbour with its surrounding volcanoes (pers. comm. D. Lindley).

Two FAD sites were selected in this zone: one about three nautical miles north of the seamount and the other a similar distance to the south. The FAD site south of The Hump is apparently inside the drowned caldera, in 1066 m (533 fathoms) depth at 04° 07.25' S latitude and 152 °13.50' E longitude. The site north of The Hump lies outside the caldera in 1050 m (525 fathoms) depth at 04° 00.75' S latitude and 152° 14.00' E longitude. Apart from The Hump, several other seamounts were discovered during the survey, all lying on the ridge of the caldera. During the course of these surveys many flocks of seabirds and surface fish schools were encountered, and evidence of bottom-fish schools near the seamounts was seen on the echo sounder screen.

3.6 FAD ASSEMBLY AND RIGGING

3.6.1 Raft

The design for the raft and mooring of the FADs deployed during the project was based on the Filipino payao design, deployed throughout PNG waters by Filipino purse-seine fishing companies (Figure 6) The choice of this type of low-cost raft was determined mainly by the availability of funds for purchasing materials.

The primary floats for the rafts were fabricated by a local steel works company, Rabaul Metal Industries (RMI). In order to keep costs down the floats were constructed from off-cuts from another job. The dimensions, therefore, were somewhat arbitrary at 1.5 m x 0.75 m x 0.5 m (60 in x 30 in x 20 in). This gave a float volume of 0.5625 m^3 (equivalent to 562.5 kg of buoyancy). The floats were constructed of 8 mm (0.25 in) steel plate and were fitted with a bracket at each end for mounting cross beams, a 50 mm (2 in) pipe for mounting a mast, and a 13 mm (0.5 in) steel padeye at each end on the bottom for attaching rigging hardware. RMI sand-blasted the finished floats and coated them all with marine primer and enamel (Figure 7). They were all pressure-tested for leaks via a 13 mm (0.5 in) threaded pipe socket on the top side. These were later sealed with pipe plugs and teflon thread tape. By using off-cuts the project was able to save a considerable amount of money. Five such rafts cost only K 2000 altogether, compared with K 1900 for one FAD raft (three-chambered cylindrical buoy with spar) in the Port Moresby project in 1992. One disadvantage of this less expensive design was that there was only one flotation chamber, and any leak would result in failure of the mooring system.

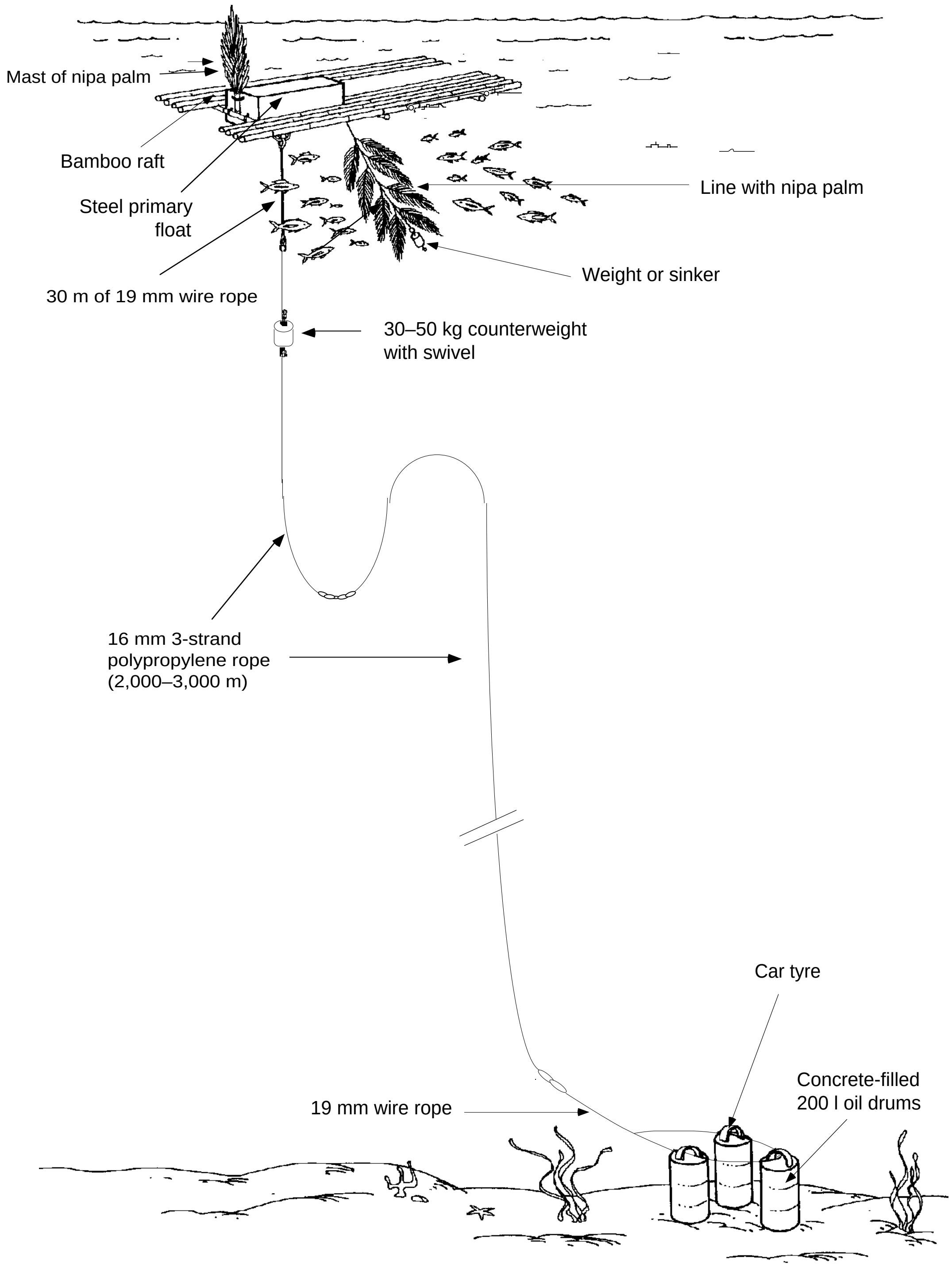


Figure 6: Filipino-style payao

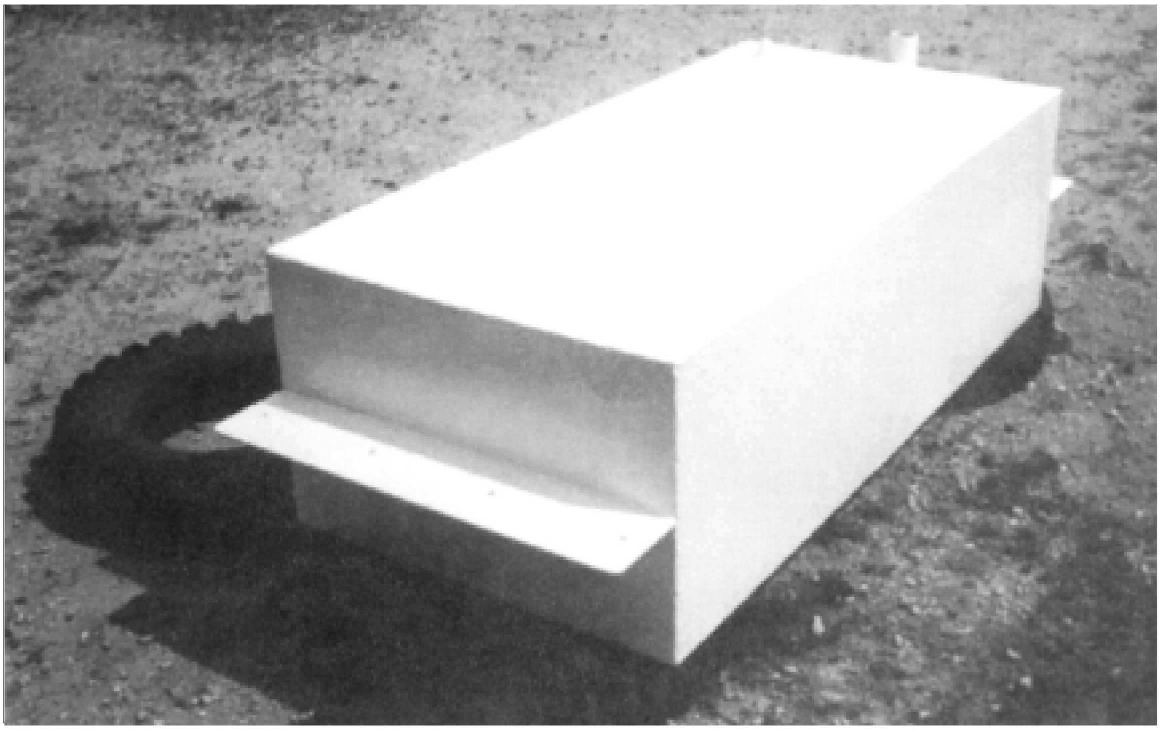


Figure 7: Primary float for payao

Cross beams of a local gum wood, kumarere, 200 mm x 200 mm x 3 m or (8 in x 8 in x 10 ft), were attached by galvanised carriage bolts to the end brackets on the rafts. Bamboo that had been previously soaked in seawater and dried was then lashed to the cross beams going fore and aft (Figure 8). Tarred purse-seine twine was used for the lashings. Lastly, wooden poles with flags were fitted into the pipe brackets on the forward end of the rafts. The rafts were then ready for the rigging.

Figure 8: Completed payao raft

3.6.2 *Hardware*

ENB Fisheries Division had on hand several items left over from a Japanese aid FAD programme that was conducted ten years earlier by the Overseas Fishery Co-operation Foundation (OFCF) around Ataliklikun Bay (Anon, undated [c]). This included several coils of rope, several FAD anchors (half drums of concrete), 19 mm (0.75 in) swivels, galvanised thimbles, 19 mm (0.75 in) chain, and several 200 mm (8 in) pressure floats. The OFCF project also left six large styrofoam cylindrical FAD floats, but these were not deemed suitable for the current project. Everything else was utilised as all materials had been stored properly and were in good condition.

Chain shackles (16 mm (0.6 in) and 25 mm (1 in) black steel weldable screwpin) had to be purchased locally from The Net Shop in Port Moresby. The blacksmith shop at Vunapope Mission in Kokopo donated 250 m (125 fathoms) of used 19 mm (0.75 in) galvanised wire rope for use on the top sections, anchor sections and appendages of the FADs. The wire rope had been on a hauling winch in the mission's slipways.

3.6.3 *Rope*

Sixteen 185 m (100 fathom) coils of 19 mm (0.75 in) three-strand polypropylene rope were on hand at ENB Fisheries Division. This was sufficient for at least three FAD deployments. Ten more coils of 16 mm 0.6 in) polypropylene rope were ordered through a Rabaul distributor, but delivery delays meant this was not landed until after the conclusion of Phase I FAD activities. Ropes were spliced to the required lengths, with an eye-splice (Figure 9) on either end for connections to upper and lower hardware.

Figure 9: Eye splice in rope, with thimble and PVC covering

3.6.4 *Anchors*

In addition to the eight half-drum anchors on hand at ENB Fisheries Division, the project found and recovered 20 steel 200 kg (440 lb) Japanese kedge-type anchors from the site of the old Starkist Tuna plant in Rabaul. Apparently these had been left by the pole- and-line fleet when the fishery was abandoned in the 1980s. These anchors only needed the addition of a pipe stock through the crown to make them functional (Figure 10).

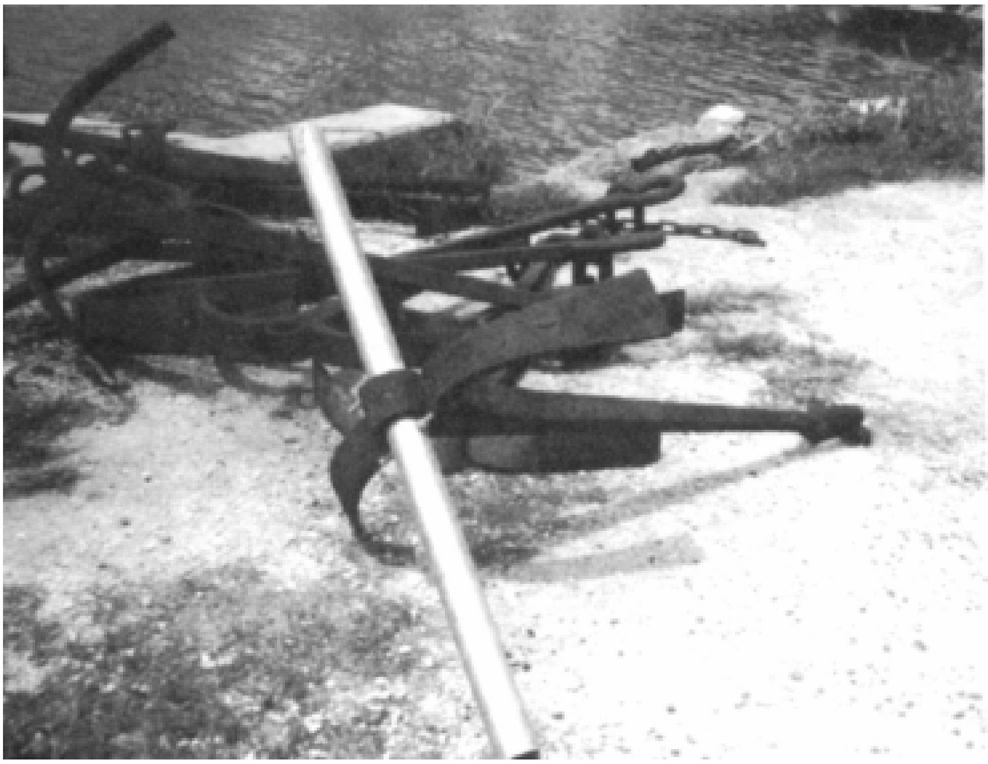


Figure 10: Recovered kedge-type anchors with pipe inserted in crown

3.6.5 Aggregators (appendages)

The aggregators for all of the FADs were made from pieces of an old beach-seine net, sewn onto 10 m (5 fathoms) sections of 19 mm (0.75 in) galvanised wire rope. One of these was suspended from each raft by using a 16 mm (0.6 in) shackle to connect a Flemish eye formed at the upper end of the aggregator line to a padeye welded to the raft. One old tyre was added to the bottom end of each aggregator to weigh it down (Figure 11).

Figure 11: Rigging FAD appendages

3.7 MOORING DESIGN

3.7.1 Payao-style FAD moorings

As only polypropylene rope was available to rig the FAD moorings, the SPC-recommended inverse catenary-curve mooring system, which requires the use of both nylon and polypropylene ropes, could not be used. Instead, it was decided to make use of the Filipino payao mooring system. The payao system is rigged entirely from floating polypropylene rope (apart from upper and lower sections of wire rope) and makes use of a counterweight to ensure that the spare rope built into the mooring to provide scope does not float to the surface, where it could be damaged by vessels or fishing activities.

Having a specific gravity of 0.91, polypropylene rope floats. Its buoyant property can be used to lift weight. Before the length of rope required for each site could be determined it was necessary to determine the buoyancy of the rope and this was done according to the calculation method recommended by SPC for ropes of unknown weight (Gates et al., 1996). A 10 m (5 fathoms) piece of rope was cut, placed on a scale and weighed. The rope section was found to weigh 0.1665 kg, or .01665 kg/m. Buoyancy was then calculated by multiplying this figure by 0.116 (the buoyancy of polypropylene rope in seawater). The buoyancy of this particular rope was calculated to be 0.019314 kg/m, meaning that each metre of rope would buoy up 0.019314 kg in seawater.

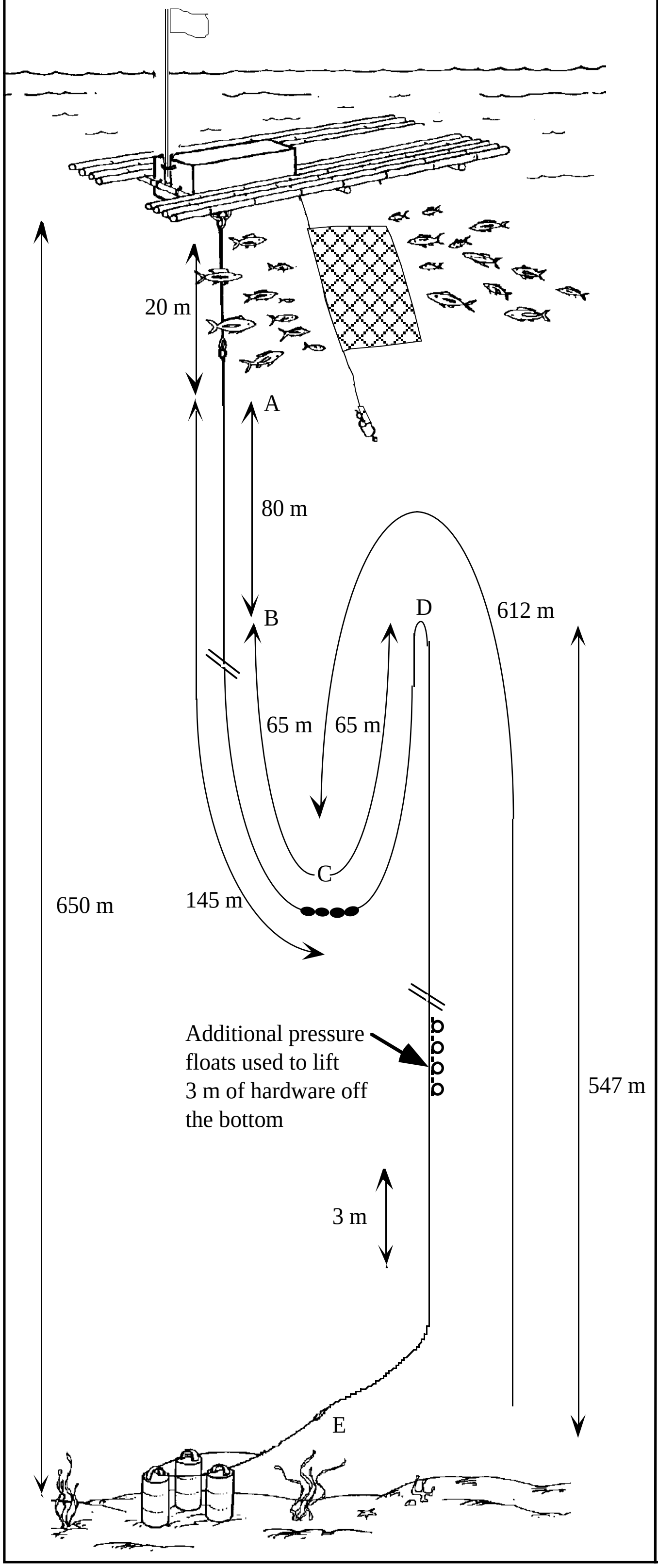
In designing the moorings it was decided that the top of the catenary curve formed by addition of a counterweight would be held 100 m (50 fathoms) below the surface, rather than the standard 180 m (90 fathoms) recommended by SPC for deep-water moorings. This modification was made so that the upper section, down to the counterweight, could later be hauled on board a vessel for inspection and maintenance.

The resulting mooring design used for each of the payaos deployed consisted of the following components, in descending order from the top: FAD raft, 19 mm (0.75 in) shackle, 20 m (10 fathoms) of 19 mm (0.75 in) galvanised wire rope with a Flemish eye formed at either end, 19 mm (0.75 in) shackle, 19 mm (0.75 in) swivel, 19 mm (0.75 in) shackle, a section (ABC) of polypropylene rope with eye splices formed at either end (including galvanised thimble and protective PVC tubing as shown in Figure 9), 19 mm (0.75 in) shackle, 19 mm (0.75 in) chain counterweight, 19 mm (0.75 in) shackle, second section (CDE) of polypropylene rope with added pressure floats and eye splices formed at either end, 19 mm (0.75 in) shackle, 19 mm (0.75 in) swivel, 19 mm (0.75 in) shackle, 10 m (5 fathoms) of 19 mm (0.75 in) galvanised wire rope with Flemish eyes formed at either end, and anchors (a combination of concrete filled half-drums and steel kedge anchors).

3.7.2 FAD A—deployed in the Duke of York survey zone

Figure 12 shows the mooring configuration and calculations for FAD A. Section ABCD of the mooring was 210 m (105 fathoms). The buoyancy of the polypropylene rope used was 0.019314 kg/m (see Section 3.7.1) and the weight of steel in salt water is 0.869 of its weight in air (one kg of steel would weigh 0.869 kg in salt water). Therefore section ABCD would lift 4.67 kg ([210 x 0.019314] ÷ 0.869), and a counterweight of at least this weight would be needed to keep this section from floating to the surface. The counterweight used on all of the moorings consisted of a 1 m (0.5 fathoms) section of 19 mm (0.75 in) chain and two 19 mm (0.75 in) shackles with a total weight of 10 kg (8.69 kg in salt water).

Rope section DE, on the other hand, needed added flotation to ensure that at least three metres of the lower wire rope and connecting hardware would be lifted clear of the bottom. This would prevent any part of rope section DE from coming into contact with the bottom and chafing or becoming entangled in the anchors, either of which would likely result in the early failure of the mooring. Section DE was 547 m (273 fathoms), so its total flotation was 12.16 kg (547 x 0.019314 ÷ 0.869). As 3 m (1.5 fathoms) of the lower wire rope and connecting hardware weighed 20 kg in air (17.38 kg in salt water) it was necessary to add supplementary buoyancy to this rope section.



Rope length calculations:

$$DE = \frac{\text{Weight of hardware to be lifted}}{\text{Buoyancy of rope}}$$

$$= \frac{20 \text{ kg} \times 0.869}{0.019314 \text{ kg/m}}$$

$$= 899.9 \text{ or } 900 \text{ m *}$$

$$AB = \text{Site depth} - (DE + 20 \text{ m} + 3 \text{ m})$$

$$= 650 \text{ m} - 570 \text{ m}$$

$$= 80 \text{ m}$$

$$BCD = \text{Site depth} \times 0.2$$

$$= 650 \text{ m} \times 0.2$$

$$= 130 \text{ m}$$

$$ABC = AB + \frac{BCD}{2}$$

$$= 80 \text{ m} + 65 \text{ m}$$

$$= 145 \text{ m}$$

$$CDE = \frac{BCD}{2} + DE$$

$$= 65 \text{ m} + 547 \text{ m}$$

$$= 612 \text{ m *}$$

* Note that additional flotation is required to lift 3 m of hardware off the bottom.

ROPE SECTIONS		**VERIFICATION**	
Upper chain	20 m		
AB	80 m	Site depth	650 m
BCD	130 m		
DE	547 m		
Lower chain	3 m	Catenary curve	130 m
TOTAL	780 m	**TOTAL**	780 m

Counterweight calculation

The counterweight was required to be of sufficient weight to prevent rope section ABCD (210 m) from floating to the surface. The weight required, comprising chain and connecting shackles, is calculated as follows:

Rope buoyancy:
$= 210 \text{ m} \times 0.019314 \text{ kg/m}$

Weight required to counteract buoyancy of rope section ABCD = 4.06 kg

Weight of steel in sea water = weight in air x 0.869

So, $\frac{4.06}{0.869}$ = weight in air of required hardware
= 4.67 kg

Figure 12: Mooring configuration for FAD A

The pressure floats on hand were 200 mm (8 in) plastic spheres with two ears, rated as pressure-resistant down to 300 m (150 fathoms) depth. A 200 mm (8 in) sphere displaces over four litres of water, so has a buoyancy factor of about 4 kg. Four such floats added to section DE would make the total available flotation on this section of 28.16 kg (12.16 kg for DE + 4 x 4 kg = 16 kg for the floats), more than enough to buoy up the wire rope and hardware. These floats were spliced into section DE at a point that would place them below the depth of the counterweight so that no tangling could occur. This placed the floats at a depth below 145 m (72 fathoms) the depth of the counterweight) but less than their rating of 300 m (150 fathoms).

The anchor used for this FAD consisted of four concrete-filled half 200 l (44 gall) drums connected by a wire rope going through steel rings set in the concrete in each drum.

3.7.3 FADs B and C—deployed in The Hump survey zone

FADs B and C were very similar as they were in depths of 1066 and 1050 m (533 and 525 fathoms) respectively. Deployment was the same as for FAD A. Figure 13 shows the calculations for FAD B (1066 m (533 fathoms). The length of rope DE ([963 m x 0.019314 kg/m] ÷ 0.869 = 21.4 kg of buoyancy) was sufficient to lift 3 m (1.5 fathoms) of hardware (20 kg in air or 17.38 kg in salt water) off the bottom. However, two pressure floats (similar to those used on FAD A) were added to the rope DE below the level of the catenary curve, as a safety measure.

3.8 DEPLOYMENTS

3.8.1 Preparation and deployment technique

Before FADs could be deployed, a wooden bench had to be constructed at the stern of *F/V Kuriap* for launching the anchors. This bench had to be sturdy enough to support up to one tonne of concrete block and/or steel anchors. The resulting bench was designed so that it could also be used as a baiting table during Phase II longlining activities. It was constructed by the crew of *F/V Kuriap* and ENB Fisheries Division staff from a local gum wood, kumarere. It was made to be completely portable and was fitted over the stern of the boat, where it held securely without bolts or lashing (Figure 14).

FAD anchors were loaded onto this bench, and the lower mooring line was then led forward to the deck in front of the wheelhouse. The main mooring line was faked on deck. Because all FADs were deployed using the anchor-last method, the line was laid out with the raft-connection end on top of the pile (note that the connections were already made).

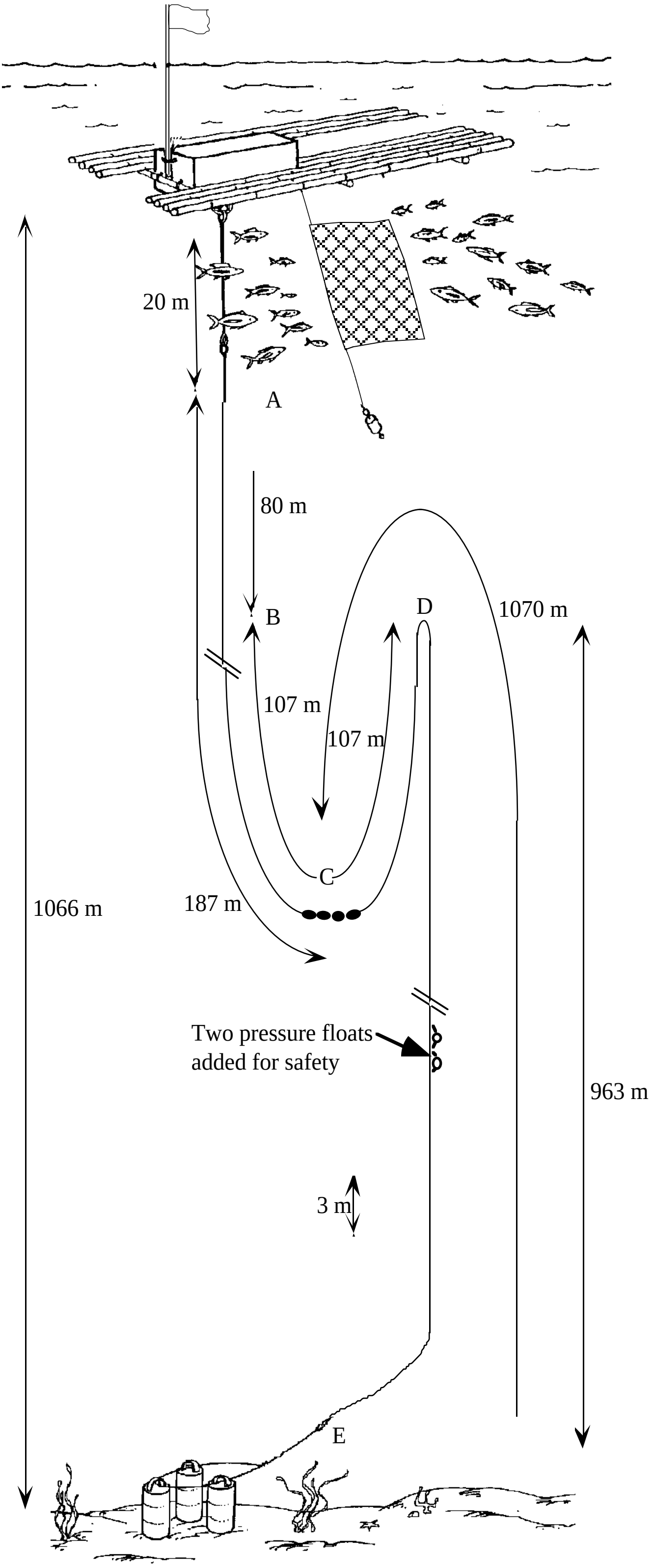
Rafts were towed to the deployment sites, rather than being carried on deck. In preparation for this, the raft-to-mooring connection was completed before leaving the wharf, with the connecting shackle welded closed. All other connecting points in the mooring line were also welded closed at this time. The raft was then launched and rigged for towing to the deployment site. The aggregator was lashed on top of the raft for towing (Figure 15).

As the *F/V Kuriap* approached the deployment site, heading downwind, the raft was set drifting and the mooring line was paid out as the vessel steamed in a large circle. When all of the line was out, the vessel was moved to a position just upwind and up-current of the intended anchor site. The anchor was then released. The SPC Handbook on FAD mooring systems recommends that the position of the deployment be a distance equal to about one third of the site depth up-current of the target site (Boy & Smith, 1984).

3.8.2 Deployments by F/V Kuriap

FAD A was deployed in the above manner by the *F/V Kuriap* on 15 April 1993 at the site south of the Duke of York Islands in 650 m (325 fathoms) (Figure 5). The final position of this FAD half an hour after deployment was:

04° 16.84' S latitude, 152° 29.12' E longitude.



Rope length calculations:

$$DE = \frac{\text{Weight of hardware to be lifted}}{\text{Buoyancy of rope}}$$

$$= \frac{20\text{ kg} \times 0.869}{0.019314\text{ kg/m}}$$

= 899.9 or 900 m

AB = Site depth – (DE + 20 m + 3 m)

= 1066 m – 986 m

= 80 m

BCD = Site depth x 0.2

= 1066 m x 0.2

= 214 m

$$ABC = AB + \frac{BCD}{2}$$

= 80 m + 107 m

= 187 m

$$CDE = \frac{BCD}{2} + DE$$

= 107 m + 963 m

= 1070 m

ROPE SECTIONS		VERIFICATION	
Upper chain	20 m		
AB	80 m	Site depth	1066 m
BCD	214 m		
DE	963 m	Catenary curve	214 m
Lower chain	3 m		
TOTAL	1280 m	**TOTAL**	1280 m

Counterweight calculation

The counterweight was required to be of sufficient weight to prevent rope section ABCD (294 m) from floating to the surface. The weight required, comprising chain and connecting shackles, is calculated as follows:

Rope buoyancy:
= 294 m x 0.019314 kg/m

Weight required to counteract buoyancy of rope section ABCD = 5.68 kg

Weight of steel in sea water = weight in air x 0.869

So, $\frac{5.68}{0.869}$ = weight in air of required hardware
= 6.54 kg

Figure 13: Mooring configuration for FADs B and C

Figure 14: Wooden bench fitted at the stern of *F/V Kuriap*

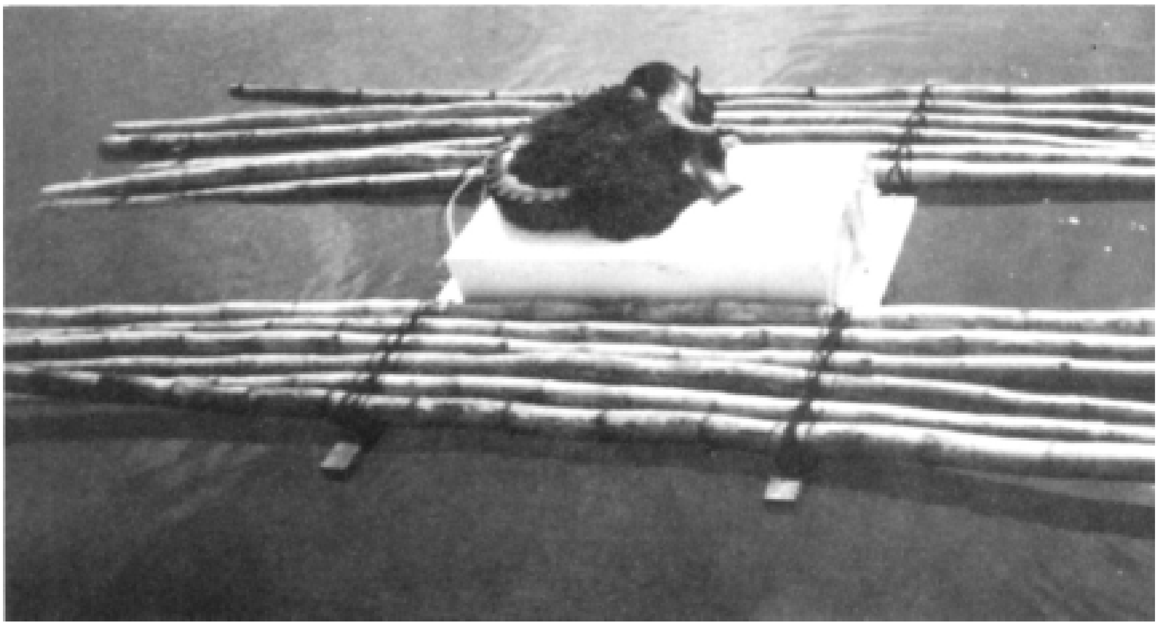


Figure 15: FAD raft ready for towing, with appendage lashed on top

Prior to deploying this FAD, on 10 April 1993, the Masterfisherman and the Manager of KFP visited the Island of Mioko in the Duke of Yorks Group to inform the local fishermen of the Project's intentions and to tell them something about FADs and how they would benefit from them. The village at Mioko is closest to the FAD site south of Duke of Yorks.

The second FAD (B) was deployed on 19 April 1993 at the 1066 m (533 fathoms) site south of The Hump (Figure 5). The anchor used for this FAD consisted of two half-drums filled with concrete and two steel kedge anchors, all connected by a wire rope. Two hours after deployment the FAD had settled at a position of:

04° 07.22' S latitude, 152° 14.07' E longitude.

The third FAD (C) was deployed on 22 April 1993 at the 1050 m (525 fathoms) site north of the Hump (Figure 5). The anchor for this FAD consisted of four half-drums filled with concrete and one kedge anchor. As the current was running easterly at about 1.5 knots on the day of deployment, the line could not be laid out in a circle. Instead it was laid out in a straight line going up-current. The anchor was released when the vessel was about 0.5 nm past the target site. The position of the FAD one hour after deployment was:

04° 00.75' S latitude, 152° 14.06' E longitude.

3.8.3 Deployments by Mar Fishing Company

Mar Fishing Company, Inc. of Zamboanga, Philippines has a fleet of six purse-seiners and four refrigerated carrier vessels operating in the Western Tropical Pacific, including PNG waters. The carrier vessels, as well as transshipping tuna to the company's cannery in the Philippines, also deploy payaos throughout the fishing area of the company's fleet. Mar Fishing Company vessels, in common with other Filipino purse-seine operators in the area, largely rely on moored payaos as fishing targets. The company has deployed many such payaos in PNG waters since it negotiated an agreement with GPNG to fish in PNG's DFZ.

Lately, Mar Fishing Company has been negotiating to secure rights to carry out transshipping in Rabaul Harbour. With this in mind, company representatives offered in mid-1993 to assist Project efforts by supplying and deploying five payaos at selected sites.

This offer was accepted by GENB and the project Masterfisherman selected five sites from the surveys carried out by *F/V Kuriap*. The sites were selected so that both FADs lost from the first deployments (see Section 3.9) would be replaced and three new ones deployed.

During October 1993 Mar Fishing Company's carrier vessel *M/V Filipinas Orient* called in at Rabaul. The Masterfisherman and the manager of KFP paid a visit to the vessel and inspected the payao materials, including the rafts to be used (Figure 16). FAD site positions and depths were provided to the captain. On 10 October 1993 *M/V Filipinas Orient* (Figure 17) deployed five payaos in one day. The method used was basically the same as that used by the Project (anchor last), only on a larger scale. *F/V Kuriap* stood by for one deployment but was not able to keep up with the larger vessel to observe the other deployments.

Later, a Mar Fishing Company representative in Zamboanga faxed the actual deployment positions of the five payaos to KFP. A chart showing the positions of these five FADs was then prepared and distributed to all interested parties in ENB (Figure 18).

The positions were as follows:

Payao (1): 04° 06.87'S, 152° 13.52'E,
Payao (2): 04° 03.16'S, 152° 23.15'E,
Payao (3): 04° 04.15'S, 152° 28.58'E,
Payao (4): 04° 13.58'S, 152° 20.12'E,
Payao (5): 04° 17.04'S, 152° 28.88'E.

The position of Payao (1) corresponded to the deployment by *F/V Kuriap* south of The Hump and that of Payao (5) corresponded to the *F/V Kuriap* deployment south of the Duke of York Islands.

3.9 FAD survival

In mid-June 1993, local fishermen reported that all three of the FADs deployed in April were missing. The initiation of Phase II activities precluded inspection of the FAD sites to confirm these reports. However, a local sportsfisherman later reported that he had caught a large blue marlin at FAD B, located to the north of The Hump, on 11 July 1993. This FAD remained a popular sportsfishing site for the remainder of 1993 and two winning fish (a 64 kg blue marlin and a 200 kg black marlin) were caught at it during the East New Britain Game Fishing Club's annual billfish tournament in September that year, so reports of FAD (B) being missing were incorrect.

In April 1993, the raft from FAD C, deployed south of The Hump, was reported recovered by fishermen from a village on the coast near the FAD site. The fishermen asked that they be

Figure 16: Payaos ready for deployment on board *M/V Filipinas Orient*

Figure 17: *M/V Filipinas Orient* lowers the payao raft for the first deployment

compensated, or rewarded, for return of the raft. The fate of FAD A, deployed south of the Duke of Yorks, remains unknIn October 1993, the same fate befell several of the Mar Fishing Company payaos. Investigation by Kokopo Fisheries Project staff indicated that the missing FADs and payaos were cut loose by local fishermen. In at least one case the motive was said to be expectation of a reward for the FAD raft, but in the other cases it is thought that moorings were cut to obtain anchor ropes for small fishing craft. Payao (3) is known to have been cut loose in late October 1993, barely two weeks after deployment, and the raft towed to a village in Duke of York Islands. Payao (1) was noted as missing on 8 December 1993 during an inspection trip and reports received that it had been cut loose.

On that inspection trip of 8 December, fishing activity was observed on both Payaos (2) and (4), with small fishing craft either trolling near the FADs or tied off to the rafts with the crews handlining. This activity coincided with an annual increase in artisanal fishing effort at this time of year, when villagers seek to increase cash incomes in time for Christmas.

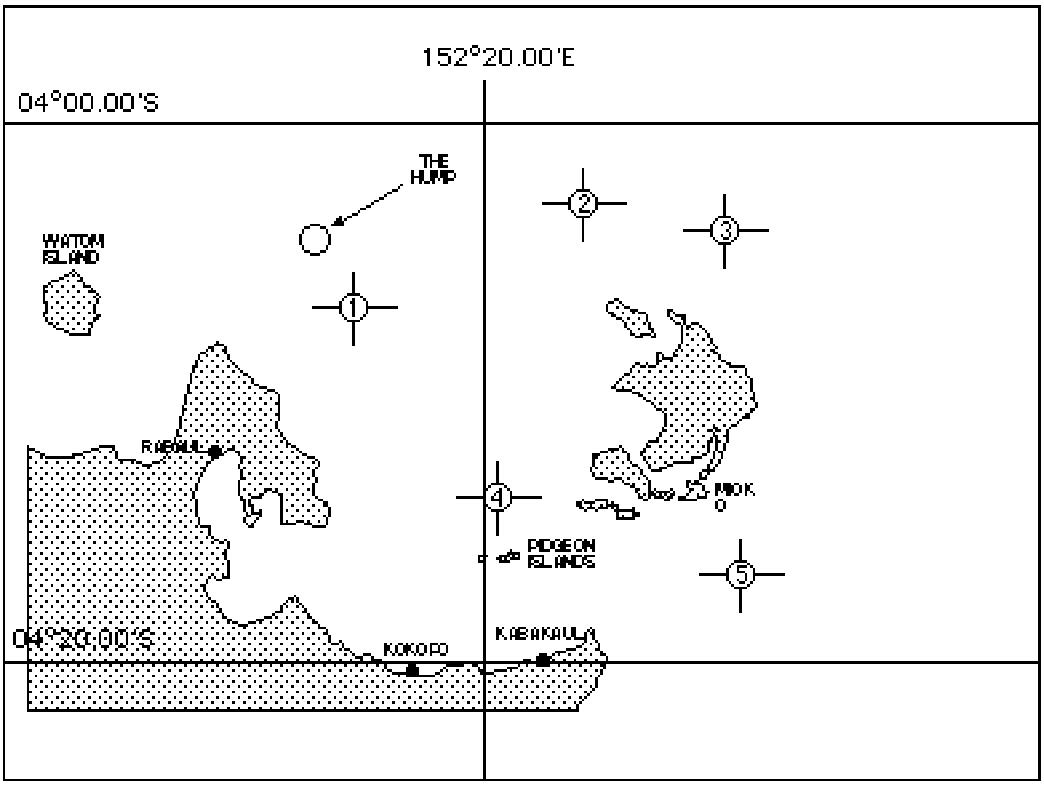


Figure 18: Positions of FADs deployed by *M/V Filipinas Orient*

Payao (5) was reported missing in November 1993, but this proved to be erroneous as the New Britain Game Fishing Club of Rabaul catch records later indicated that this FAD produced catches on 8 December and on Christmas Day 1993.

3.10 FAD IMPACT

The FAD losses that occurred, and the inability, due to time constraints, of project staff and GENB fisheries extension officers to work directly with artisanal fishermen to demonstrate FAD fishing techniques, meant that activities in Phase I did little to promote FAD-based artisanal tuna fishing.

Although efforts were made by KFP and ENB Fisheries staff to inform villagers about the deployments and the intention that the FADs would be used by, and benefit, local fishermen, it is clear that some fishermen either did not receive or did not accept this message. It is possible that the FADs were regarded by some as belonging to foreign boats and thus 'fair game'.

FAD catch record forms, as used in Port Moresby by DFMR (Beverly & Cusack, 1993), were given to an ENB Fisheries officer for distribution to Duke of York fishermen. It is not known if these were subsequently distributed, but no data were received by project staff.

Tangible benefits that arose from this period of work were the refurbishing of *F/V Kuriap*, so that it was ready for commencement of longline fishing trials; the accumulation of a good deal of knowledge of the fishing grounds; the establishment of cooperation with an industrial-scale fishing operation working in the areas; some useful lessons about appropriate FAD mooring design; and realisation of the need to ensure that villagers were thoroughly informed about the intent of local FAD deployments and that extension services could be maintained.

The experience of the FAD project off Port Moresby (Beverly & Cusack, 1993) suggested that FADs could do quite well in PNG. The Port Moresby FAD had been in place for over two years (as of September 1994, 25 months) and it has proved to be a very productive FAD for both the artisanal fishermen from Daugo Island and the sportsfishermen from Port Moresby. Its success is due in part to its durable construction.

The conclusion is that a FAD programme could do well in East New Britain, but only if the FADs were made man-proof. The top section should be chain of at least 19 mm (0.75 in)and at least 30 m (15 fathoms) long. All shackles should be fully welded. The rope should be of 25 mm (1 in) or greater diameter, preferably eight or twelve-strand plaited rope. The raft should be an SPC-design spar buoy with a tamper-proof light.

3.11 RECOMMENDATIONS (PHASE I)

Based on the results of Phase I of this project (construction and deployment of FADs), it is recommended that:

(a) If more FADs are to be deployed in this area, Fisheries Extension Officers provide more education to the local villagers on the value of FADs to them and their community, and the costs associated with setting a FAD for them;

(b) In any future FAD programme, buoys and hardware similar to those used in the Port Moresby project be employed, to reduce the chance of vandalism;

(c) Only one FAD at a time be deployed, in an area where it can be monitored on a regular basis;

(d) Fishing companies such as Mar Fishing Company be encouraged to support domestic FAD programmes through the provision and deployment of FADs;

(e) Once FADs are established, Fisheries Extension Officers train local villagers in different fishing techniques that can be employed to increase catches.

4. Phase II: Tuna Longline Fishing Trials

4.1 FITTING OUT OF *F/V KURIAP*

4.1.1 Hydraulic system

The *F/V Kuriap* came fitted with a power-take-off hydraulic unit that previously ran a small net/line hauler, two bottom fishing reels and an anchor capstan. All but the anchor capstan were removed prior to installing the longline reel. The hydraulic unit operated from a belt-driven power take-off coming off the main engine via a 24 volt electric clutch that was operated from the wheelhouse. The system included a 50 litre tank with a filter system and a pressure regulator with an adjustable by-pass valve. The hydraulic lines exited the engine room through the starboard

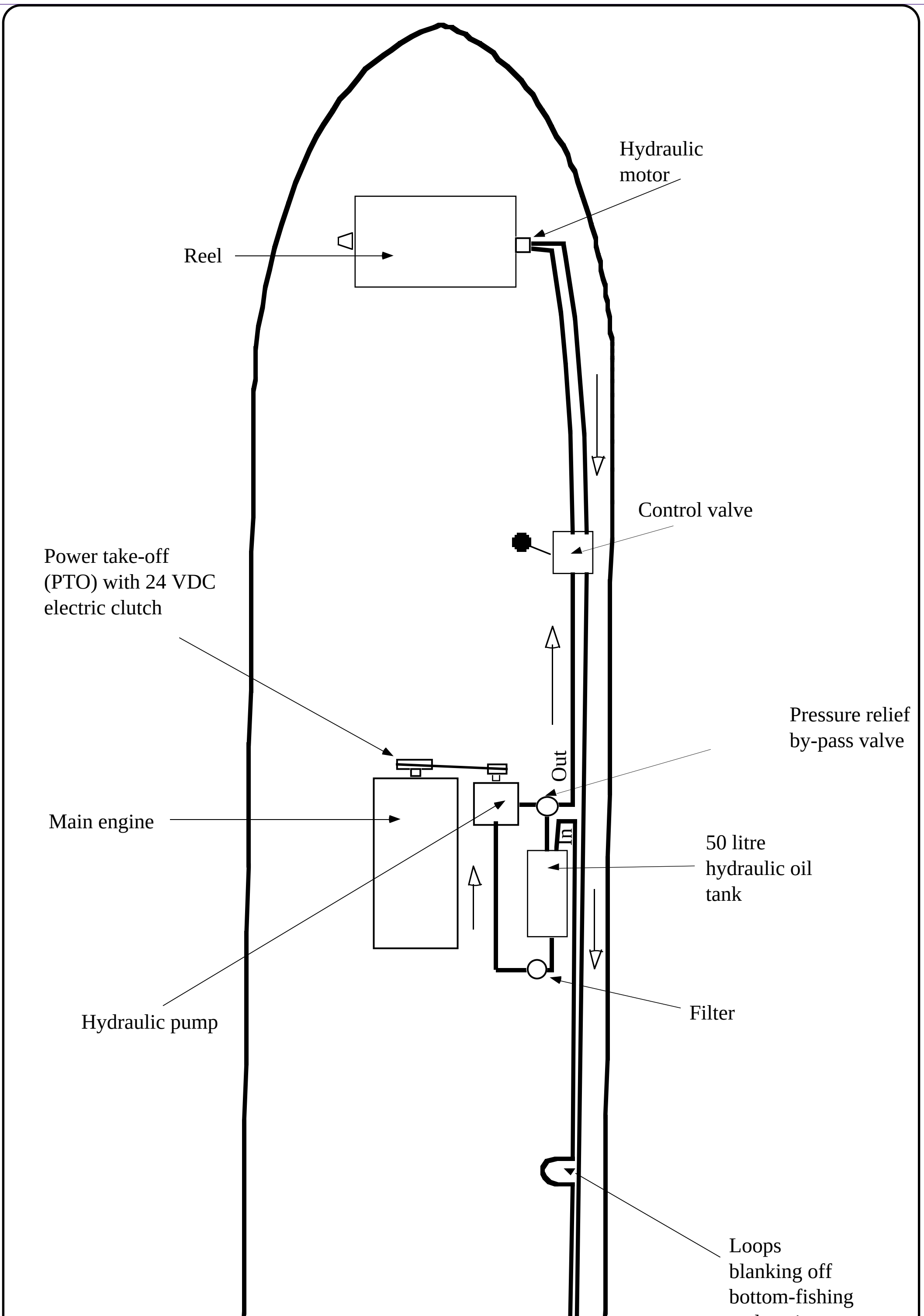


Figure 19: Schematic diagram of F/V Kuriap's hydraulic system

deck and went fore and aft via 13 mm (0.5 in) stainless steel pipes. The entire system was found to be in fair condition and needed only a good servicing, including replacement of the filter system and replacement of all deck hoses and hose fittings. The stations that formerly supplied the bottom reels and anchor capstan were blanked off by looping small hoses to connect in and out ports. A schematic diagram of *F/V Kuriap'* hydraulic system is shown in Figure 19.

4.1.2 Mounting the reel and valve

The monofilament longline reel selected for the *F/V Kuriap* was a Lindgren-Pitman hydraulic 68 cm x 75 cm (27 in x 30 in) aluminium reel with a capacity of 24.4 km (13.2 miles) of 3.0 mm (0.12 in) monofilament nylon (see Appendix B for a complete list of fishing gear and costs.) It was 103 cm (41 in) high and had a footprint (the deck area taken up, including the mounting positions) of 118 cm x 73 cm (47 in x 29 in). The hydraulic requirements for the reel were 12 gpm (gallons per minute) at 1200 psi (pounds per square inch). It had a vane-type hydraulic motor, a manual by-pass valve for setting, and an adjustable pressure-relief valve built in. It had a fairlead mechanism, or level winder, that was belt-driven from the main shaft and operated on a pawl mechanism. A separate control valve for operating the reel was provided.

Actual installation of the reel was simple after a suitable mounting site on the vessel had been selected. The first site considered was on top of the cabin, just aft of the wheelhouse. The position was rejected for two reasons: the operator would not be able to see the reel during setting and hauling, and it might make the boat unstable to have so much weight high above the centre of gravity. The second position considered was the main deck on the port side (hauling was done from the starboard side). This position would eliminate the need for routing the line through a series of blocks during hauling, as the line could go directly from the main block on the davit to the reel. *F/V Kuriap*, however, has very limited deck space and this space was needed for fish handling. In addition, after setting the reel in this position to check the boat's stability, it was found that the weight of the reel caused a slight port list (Figure 20). A boom truck was used for placing the reel in these different positions.

The final position considered was the raised foredeck (Figure 21). Two disadvantages of using the raised foredeck were that the reel would interfere with the operator’s dead-ahead field of vision and the use of the anchor capstan was restricted. After placing the reel on the raised foredeck it was found that the boat’s load line was not affected (Figure 22), so this position was selected. Most of the crew stood watch on the fly bridge when steaming, so the diminished forward visibility was not a great problem.

The reel had four footpads, each with two 13 mm (0.5 in) holes for mounting. Eight 13 mm (0.5 in) holes were drilled through the fibreglass foredeck and the reel was bolted in place using 13 mm x 100 mm (0.5 in x 4 in) stainless steel bolts with flat washers and lock washers. Before final fitting of hydraulic connections the boat was taken on a test run to ensure that the ride would be stable with the reel in this position.

Before connecting the hydraulic system to the reel, the control valve had to be mounted on the starboard rail so that all hoses could be measured accurately. The valve was bolted to a plate of 6 mm (0.25 in) aluminium, which in turn was bolted to the rail adjacent to the position of the davit (Figure 23). This gave sufficient height for easy operation. The control valve handle had three positions; forward, reverse and neutral. Forward and reverse also operated through a range of positions from slow to full speed. There were four ports in the control valve: line-in and line-out from the hydraulic pack, and line-in and out to the reel. Short lengths of hose were used to connect the hydraulic line-in and line-out to the valve.

The davit was mounted where the net hauler had previously been located, so ports were available in the existing hydraulic lines for connecting the valve. Longer hoses were used to connect the valve to the reel. All hoses used were 13 mm (0.5 in) two-wire high-pressure hoses and all fittings were re-usable non-skive fittings. Re-usable fittings were used so that repairs at sea would be simple, requiring only a hacksaw and two shifting spanners (crescent wrenches). Spare hydraulic fittings and hose were kept on board at all times. All hose fittings, the valve, and all steel parts on the reel were coated with red lead and marine enamel after installation was completed.

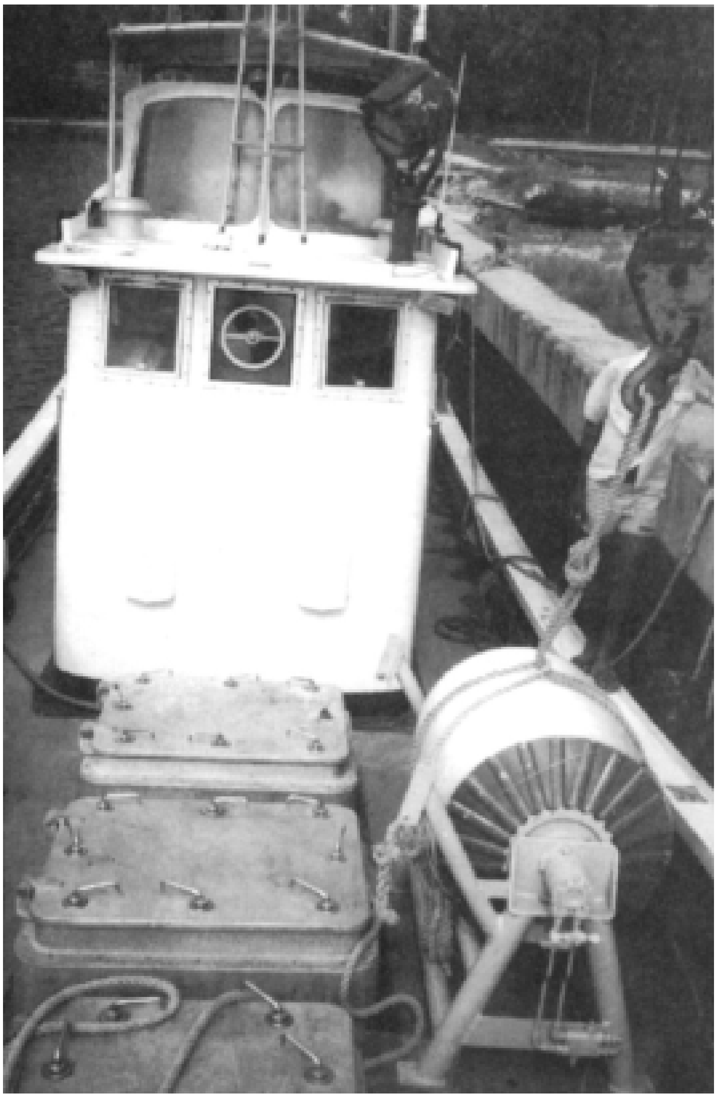


Figure 20: ***F/V Kuriap*** **listing with the reel sitting on the port side**

The L.P. reel and the control valve each had adjustable pressure relief valves. However, the existing hydraulic pack was also fitted with an adjustable pressure relief valve with a by-pass. This is an important feature on a hydraulic monofilament system as it allows the reel to stop automatically if too great a load is placed upon it. It is similar to the drag setting on a game-fishing reel: it prevents the line from breaking if a very large marlin or shark runs with the line.

The by-pass was adjusted by first tying the mainline off so that it could not move, and then putting a load on the reel by opening the control valve and reviving the engine. The adjusting nut on the existing system was then turned so that the by-pass valve opened at about 1200 psi (pounds per square inch) on the gauge (recommended). *F/V Kuriap's* by-pass was actually set at 800 psi to provide a safety margin (During the project several large marlin were landed without any difficulties.) After the reel had been tested, line guides and a davit for the main block had to be fabricated.

4.1.3 Other fittings

The line guides, or open chocks (Figure 24), were used in setting to route the line from the foredeck back to the stern where baiting took place. These chocks were fabricated by a local welding company from 19 mm (0.75 in) round-stock stainless steel. Three of these chocks were needed, two on the starboard rail and one on the wooden bench at the stern. In addition to these chocks, two 100 mm (4 in) aluminium blocks were used to guide the line during setting. These were purchased with the reel. One of these was also used on the davit during hauling. The blocks had ball-bearing sheaves and grease fittings for lubrication. They could be used as open or closed blocks by reversing their position.

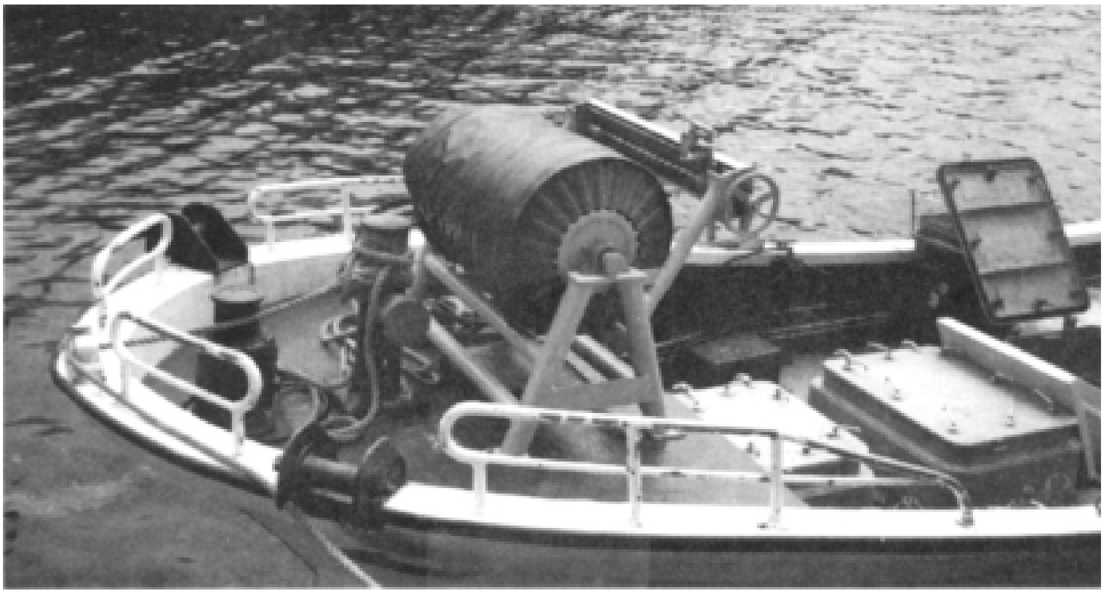


Figure 21: Final position of the reel

Figure 22: *F/V Kuriap*’s load line was not affected by the reel’s positioning

The davit was fabricated locally from 75 mm (3 in) galvanised pipe. It was made so that it could be swivelled inboard when not in use, to avoid contact with the wharf. The base of the old net hauler was used as the base for the new davit. Pad-eyes were welded on the end of the davit for attaching the block. A flood-light was mounted on the davit to illuminate the line during night hauling (Figure 25).

The wooden bench on the stern, originally fitted to deploy FAD anchors, proved to be a good baiting table, so it was left in place for longline fishing. The main fish-hold hatch was replaced with a wood and fibreglass hatch, as the sharp edges and hatch dogs (clamps) on the old hatch

Figure 23: Hydraulic control valve for the longline drum mounted on the starboard rail

damaged the fish. The new wood and fibreglass hatch was designed so that it also provided a landing platform for tunas during hauling. A mattress pad was placed on the hatch to protect the fish when landed.

4.1.4 Radio direction finder

Along with the monofilament longline reel and ancillary fishing gear, a Taiyo ADDF Model TD-L1100 radio direction finder (RDF) and two radio buoys were ordered from Hawaii (Appendix B). A radio direction finder is not an essential item for tuna longline fishing. In the pioneer days, flags were put at intervals of up to every other buoy and a long-range light was put at the far end of the line. Longline fishing was formerly referred to as ‘flagline’ fishing. Boats usually didn’t get out of sight of the line (flags). A radio direction finder eliminates the need to monitor the line constantly and allows the captain to shut the boat down during the soak time, letting the crew have a rest. During this period a relative bearing can be taken from time to time from the RDF, giving the captain confidence that he will be able to return to the end of the line after the soak. Flags and lights, however, are still used, as RDFs and radio buoys do malfunction occasionally. Also a line may part twice during a haul, leaving a section in the middle with no radio buoy attached. Another consideration is that if the line parts during the haul, the operator may not want to run all the way to the first radio buoy, but rather pick the line up at the nearest buoy or flag (or light at night) and carry on from there. Radio buoys are generally attached to either end of the mainline. and often in the middle as well on longer lines of 55.5 to 74 km (30 or 40 miles).

The RDF on *F/V Kuriap* was mounted in the wheelhouse on the small chart table that formerly held the colour echo-sounder. Power supply was taken from the same circuit breaker (24 volt) that powered the sounder. The antenna cable was run through a cable port housing with the earth cables going into the engine room. From there the cable exited the engine room by way of the cable port that was used for the SSB radio antenna cable. The antenna for the RDF was mounted on the uppermost part of the vessel on the main mast, where the anchor light was formerly located. The anchor light was shifted down the mast a little and was attached to one of the spreaders. This did not affect visibility of the light.

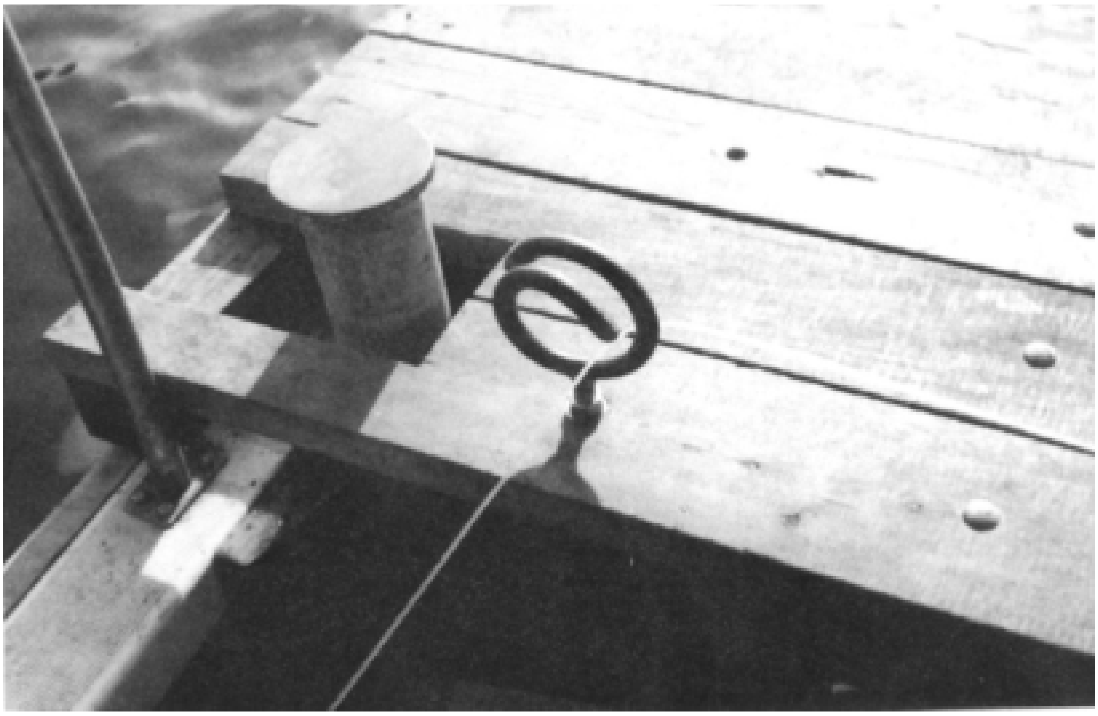


Figure 24: Locally-fabricated line guides

Before fishing commenced, the operation of the RDF was checked using the radio buoys in different locations on the wharf. At the time the test was carried out, it was found that the RDF could also pick up direction signals from local aircraft beacons (at Rabaul and at Tokua). This information could be useful later when testing an RDF or even in getting a bearing at sea for navigational purposes. PNG has a series of radio beacons throughout the country at all major airports that the Taiyo RDF is able to monitor. They are listed in the Radio Operators Handbook (Anon, undated [a], Spectrum Management Department).

Note : on two occasions during the course of fishing trials, the RDF malfunctioned. On each occasion it turned out to be a fault in the antenna cable. One technician thought that lightning might have played a role in causing direct shorts in the cables. However, SPC's electronics technician doubted that this could be the case (East New Britain does have an unusual amount of electrical storm activity). The cause of the malfunctions remains a mystery, as no other symptom showed in the wiring or in the RDF monitor other than erratic signal directions and dead shorts in the antenna cable. New antenna cables cost about US$ 350, so this would be a concern to a small operator. The Project had to purchase two cables in a one-year period.

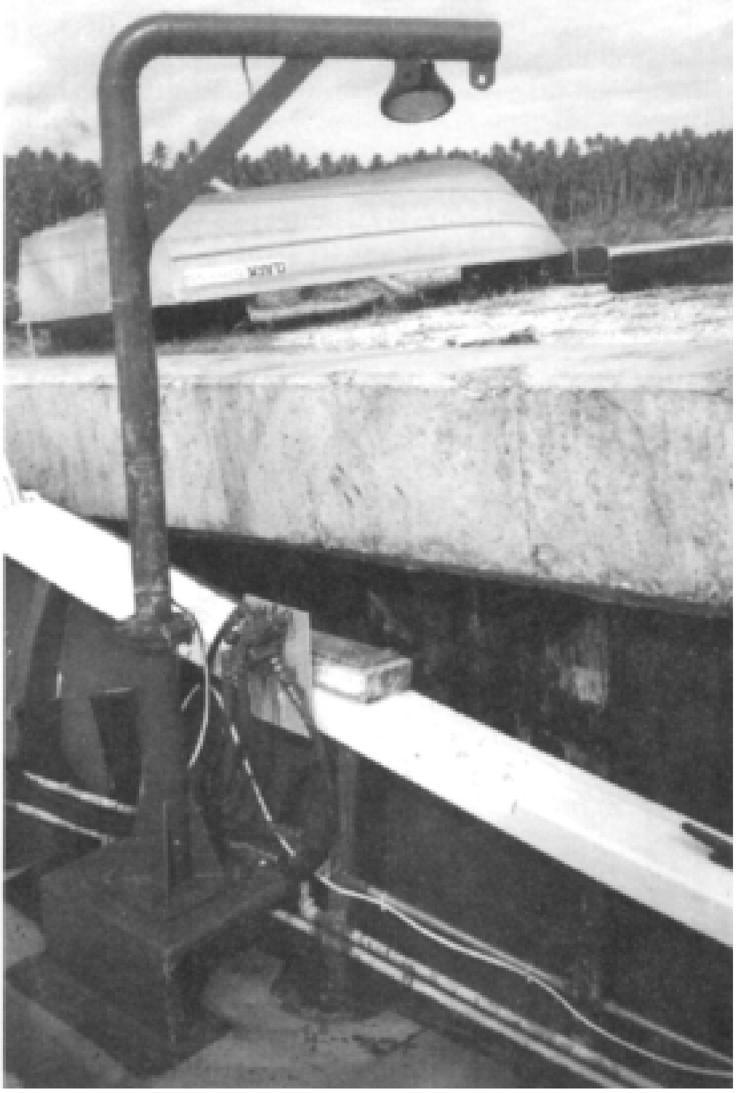


Figure 25: Swivelling davit with mainline block and floodlight

4.2 FISHING GEAR

4.2.1 Gear components

After fitting the reel and rigging the boat for setting and hauling the line, the fishing gear had to be made up. With a monofilament system this is a relatively quick and easy process. The same can be said for crew training and for actual fishing. This is in contrast to longline fishing with Japanese-style basket gear comprising tarred kuralon mainline and tarred branchlines with wire or monofilament leaders. With basket gear it typically takes several weeks or months to make up the gear for one vessel, and two or three years of training for crewmen to become proficient in all jobs on the deck.

4.2.2 Branchlines and bins

The first task for the crew was to make up the branchlines. The branchlines used in the project were very simple. Each consisted of a 12 m (6 fathom) length of 2.1 mm (0.084 in) clear monofilament with a swivel snap at one end and a No. 3.6 tuna hook with ring at the other. The snaps and hooks were attached to the monofilament with an aluminium sleeve. A short 25 mm (1 in) length of protective plastic tubing was put over the loop end of the mono to prevent chafing. This was done on both the hook end and the snap end. A bench press crimper was used to crimp the aluminium sleeves. Crewmen can be trained in this task in about one hour, and preparing several hundred branchlines takes two or three crew only one or two days.

The snaps used for the branchlines were size 8/0. This refers to the size of the swivel. It is important to note that the jaws of the snaps also come in different sizes to accommodate different diameter mainlines. A 9/0 snap was used for floatlines; this snap has a larger swivel but the same-sized jaw as an 8/0 snap. The larger swivel was needed to accommodate the 6.4 mm (0.25 in) tarred kuralon that was used for floatlines.

Branchline bins can be made from wooden boxes, barrels, or plastic rubbish bins. In the case of this project, purpose-built bins were purchased from Hawaii. They were plastic bins with stainless steel racks attached to the rim. The racks had two rows of 4.5 mm (0.18 in) stainless steel rod going all the way around for hanging the swivel snaps that connected the branchlines to the mainline (Figure 26). Each of these bins could hold up to 240 branchlines.

Figure 26: Branchline bin

When storing the made-up branchlines in the bins, the same procedure was adhered to every time, whether new lines were being stowed or hauling was taking place. The first snap was attached at the bottom right-hand side and subsequent snaps were attached side by side, moving to the left, or in a counter-clockwise direction. The mono was coiled using a hand-over-hand motion, letting the line fall naturally into the bin. The hook was then placed in the lower end of the snap with the point facing to the left so that the next hook covered the point. This helped prevent tangles when setting. After one row was full all the way around the last snap was turned upside-down so that the setter or baiter would know where to start when setting. Also a space of about 25 mm (1 in) was left at the end of each rod so that the snaps did not jam up on each other. When setting, the lines leave the bin in a right-hand, or clockwise, direction. The first hook in is the last out and vice-versa.

4.2.3 Floatlines, floats, flags, radio buoys and leadlines

Floatlines were made up using 30 m (15 fathoms) of 6.4 mm (0.25 in) tarred kuralon. A 9/0 snap was eye-spliced onto one end and an eye-splice 10–15 cm (4–6 in) long was formed in the other end. The snap end attaches to the mainline and a float is attached to the other. The floats, or buoys, used were 300 mm (1 ft) orange plastic floats with two ears for line attachment. They are pressure-resistant to 300 m (150 fathoms). A short piece of tarred kuralon was used to attach a 9/

0 swivel snap to each float. In addition, reflective tape was stuck to each float for visibility at night. This is particularly important if the line should part. A search-light will pick up reflective tape from several hundred metres.

Bamboo poles with longline flags were made up with a length of kuralon whipped onto the lower end. This piece of kuralon had a 9/0 swivel snap at the bottom for attachment to the floatlines, and an eye-splice loop at the other end for buoy attachment. Also, on some of the flag poles a bracket was screwed on for holding a strobe light. These brackets were also installed on each radio buoy antenna. Strips cut from inner-tube rubber were wrapped around each flag pole for protection at the level where the buoys would come into contact with the bamboo. The flags and the strobe lights help to locate the line prior to hauling, or if the line should part during hauling.

Thirty metres (15 fathoms) is a typical length for floatlines, but other lengths can be used for different purposes. For targeting broadbill swordfish, floatlines of 10 to 20 m (5 to 10 fathoms) are used. If the target species is bigeye tuna, longer floatlines of 50 or 60 m (25 or 30 fathoms) could be used (see longline configuration below). Leadlines (sinkers) were also made using the tarred kuralon. A 9/0 swivel snap was spliced onto one end of a 2 m (one fathom) piece of line and 2 to 4 kg of lead on the other. These leadlines served three purposes: to sink the mainline for a deeper set, to sink the ends of the mainline adjacent to the radio buoys, and as counterweights to weigh down the bamboo flag poles so that they would stand upright in the water.

All floats were stored on top of the cabin on *F/V Kuriap* just aft of the wheelhouse (Figure 27). On some boats a special cage is made for this purpose. Floatlines were tied in coils usinga quick release longline knot for easy uncoiling during setting. The coiled floatlines were stored in plastic bins.

Figure 27: Floats stored on top of the cabin just aft of the wheelhouse

Radio buoys (placed on each end of the mainline) were modified before use. Netting similar to that found on Japanese glass ball floats was tied around the float collar (Figure 28). The float collar, as it comes from the factory, is not very strong and if left as it is would soon part, causing the buoy to sink and be destroyed. A bridle was therefore made up and attached to the radio buoy, with a heavy-duty longline snap on the end of the bridle for attachment to the mainline.

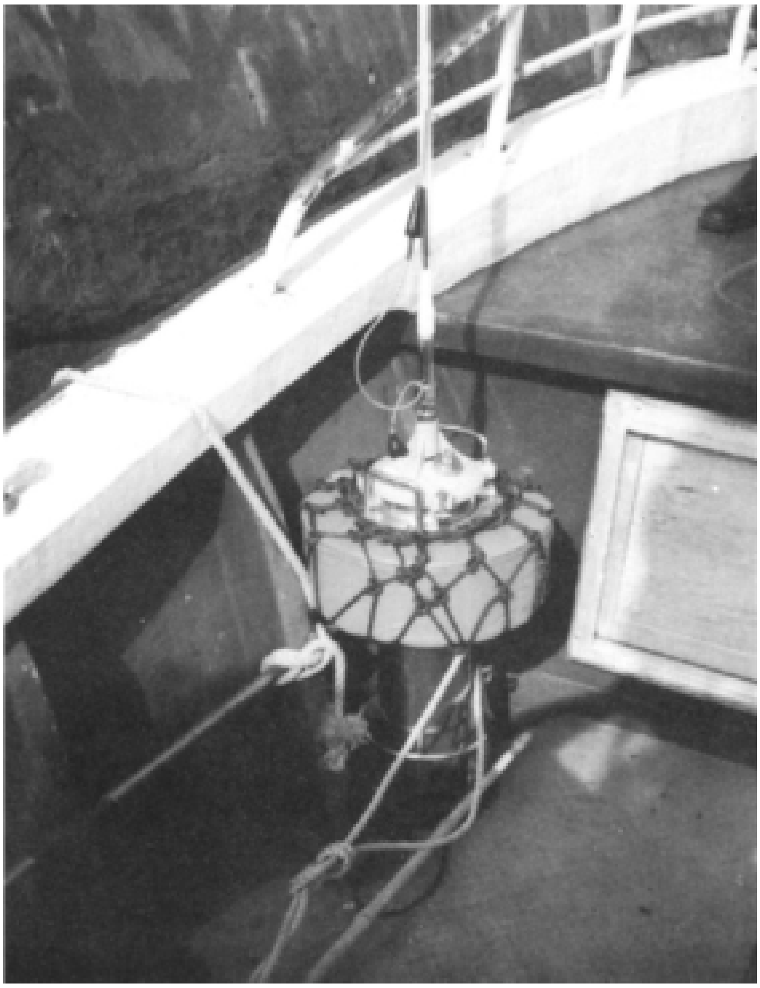


Figure 28: Netting tied around the radio buoy

4.2.4 Other rigging

A kuralon tagline was put at each end of the mainline on the reel. These taglines were about 12 m (6 fathoms) long, with an eye splice at each end. A loop was tied into the monofilament mainline using two figure-eight knots and the kuralon tagline was looped through this knot. The taglines made it easier to attach the bitter end of the mainline to the drum of the reel. A timber hitch is a good knot for this purpose. A tagline on the other end made it easy to secure the last end of the mainline to the full drum when hauling was completed.

Aside from the hooks and lines, several miscellaneous tools and bits and pieces are needed on board for tuna longline fishing. These include: cutters (garden shears work well on monofilament), gaffs, knives, a sharpening stone, a tee spike for killing fish, a wooden club for stunning fish and removing hooks, wet-weather gear, gum boots, V-line gloves (cotton-nylon gloves with plastic webbing), a saw for removing fins, tail-ropes and a foam pad to land fish on. Some of these items can be purchased locally (e.g. garden shears) or made in a workshop (e.g. tee spike).

4.3 Gear configuration

The longline, when set, consisted of the following components in the order listed below:

1. Radio buoy attached to bitter end of mainline,
2. Empty basket : 100 to 200 m (50 to 100 fathoms) of mainline with no branchlines attached,
3. Double buoy on 30 m (15 fathom) floatline attached to mainline with snap,

4. One full basket: 800 m (400 fathoms) of mainline with 15 baited, 12 m (6 fathom) branchlines attached with snaps at 50 m (25 fathom) intervals,

5. Single buoy on 30 m (15 fathom) floatline,

6. One full basket,

7 Double buoy on 30 m (15 fathom) floatline,

8. One full basket,

9. Single buoy on 30 m (15 fathom) floatline,

10. One full basket,

11. Double buoy with flag and strobe light on bamboo pole on 30 m (15 fathom) floatline,

12. One full basket, etc.

The above pattern was repeated for a total of 30 baskets. A basket is the amount of mainline and number of baited hooks between buoys. It takes its name from the original Japanese style of fishing, in which tarred mainline was coiled in bundles or baskets, with each basket containing from six to twelve hooks. The number of hooks in a basket depends on the vessel's style of fishing and may range from five or six to 40 or more. In the configuration described above, 30 baskets carried a total of 450 branchlines. Figure 29 shows schematically what a section of a longline with 15 hooks per basket would look like when set.

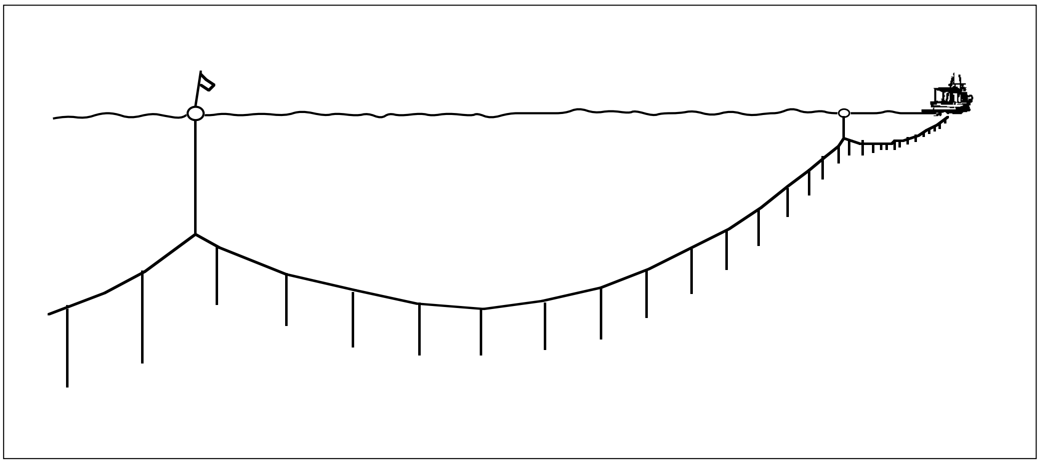


Figure 29: Tuna longline configuration showing 15 hooks per basket

At the end of the line another empty basket was set and another radio buoy attached. The empty baskets were placed on either end to avoid tangles. A shark or a large fish such as a marlin can swim the bitter end of the line for miles or, worse, tangle it badly. In addition, commencing the haul on an empty basket gives the crew time to get everything organised on deck before fish begin to be landed.

A lead weight was attached close to the radio buoys to sink the first 30 or 40 m (15 or 20 fathoms) of the empty basket. This prevented the last, or first, portion of the mainline from lying on the surface where it could be run over by a passing boat, including *F/V Kuriap*.

With 30 m (15 fathom) floatlines, the range of hook depths was somewhere between 50 and 100 m (25 and 50 fathoms). The hooks closest to the buoys were the shallowest and the hooks in the middle of the basket the deepest.

The method of setting that was used on the *F/V Kuriap* (without a line shooter or thrower) is called ‘towing’ the line. The distance travelled by the boat is the same as the length of line paid out. The catenary curve formed between buoys, and thus the depth of hooks, is largely determined by the stretch of the nylon mainline.

To achieve deeper sets for targeting bigeye tuna, a number of changes were made to the above configuration. Using longer floatlines was one way to achieve a deeper set. Fifty metre (25 fathom) floatlines were used on occasion to achieve this. Hook depths, in this case would be between 70 and 120 m (35 and 60 fathoms).

Another method used for achieving a deeper set was to increase the size of the basket from 15 to 30 hooks (from 800 to 1600 m). This increased the length of unbuoyed line and thus also increased the sag of the line and the depth it reached. It is estimated that the deepest hook reached a depth of 200 m (100 fathoms) or more. In addition, a leadline was sometimes attached to the mainline in the middle of the basket. A combination of two or all of the above methods could be used to achieve a really deep set. However, there is a danger that if the line is set too deep the boat will have difficulty recovering it. It has been reported that the tuna longline fleet in French Polynesia sometimes uses floatlines of up to 80 or 100 m (40 or 50 fathoms) and baskets with 30 or more hooks when targeting bigeye tuna and in doing so occasionally has difficulties in retrieving its lines.

4.4 FISHING STRATEGY

4.4.1 Area and time

Yellowfin tuna occur in the water column from the surface throughout the mixed layer down to the upper boundary of the thermocline. They occur in commercial concentrations in areas of upwelling, current convergences, eddies, and in areas of optimum temperature for bait organisms. A certain amount of luck is involved in searching for a good fishing spot. However, advantage can be taken of all available information to optimise chances of getting a good catch. During the project, sets were made on or near seamounts, and in areas following or crossing the 1000 and 2000 m (500 and 1000 fathoms) curves on the charts. Seamounts in the area of The Hump were avoided as they are the domain of local sportsfishermen.

In Wide Bay a current eddy was discovered after the line was set and retrieved. The pattern on the GPS plotter display indicated a spiral or ‘S’ pattern after completion of the haul on at least two occasions. This is an indication that there is a current eddy in the area. Convergences could often be seen by physical evidence on the surface. A ‘scum line’ was usually present where two currents or bodies of water converged. Scum lines contained floating debris, including sticks and large logs. Birds actively feeding on the surface indicated the presence of surface schools of bait species, skipjack tuna or small yellowfin tuna, and larger yellowfin tuna could usually be found in areas where surface schools were spotted.

Sea-surface temperature was also monitored from February 1994, when a Furuno electronic temperature gauge with alarm was installed on *F/V Kuriap*. Fish are usually found on the higher temperature side of a temperature break (where temperature rises or falls rapidly in a short distance). No temperature break was ever observed while steaming in East New Britain waters, however, and sea-surface temperature ranges were only slight: from a low of 28.2° C in July to a high of 30.1° C in the summer months. Fishing was consistently so good, however, that only the basic strategies had to be employed to find good fishing areas. Sophisticated technology such as remote imagery of sea-surface temperature and thermocline monitoring were not required to obtain good catch results in East New Britain waters. It should be noted that the project avoided shipping lanes and stayed at least three miles away from reefs and land.

In general, setting was in the morning, sometime around first light, and hauling took place in the afternoon and evening. It is easier to set going ‘downhill’, or with the wind, and it is easier to haul going ‘uphill’, or into the wind. It was best to position the vessel so that the wind was slightly on the starboard bow during hauling (the hauling station being on the starboard side), so that the vessel was held off the line when pulling fish in. For these reasons the fishing strategy adopted was to commence the haul from the last basket set. This allowed the first hooks set to soak for a much longer time than the last hooks, but it avoided the need to steam the vessel back to the end of the line and gave the crew a chance to rest.

4.4.2 Weather

Prevailing weather in Papua New Guinea, and in particular the New Guinea Islands region, is characterised by two distinct patterns. In the months from April or May until October or November the prevailing winds are south-east trades. From November or December on to March or April is the monsoon season, during which north-west winds and high rainfall predominate. Winds during both seasons are typically 10 to 15 knots, but winds of 25 to 35 knots are not unusual, and local thunderstorms and squalls can produce even higher winds. Cyclones do not generally reach the New Guinea Islands region, even though nearby Milne Bay is often the target of devastating storms. Tropical cyclones, whether passing to the south-east near Milne Bay or centred further away in the South China Sea to the north-west, occasionally cause a slight increase in wave height in the channels in the waters adjacent to East New Britain. Sea-swell height, however, is generally not more than one to two metres, because the islands act as a barrier to long travelling sea swells. While surface currents, which follow the monsoon, can be as strong as 3 knots in St. George's Channel which separates New Britain and New Ireland, wind is the main concern of most mariners navigating in and around Rabaul, and wind direction the main factor that influenced selection of fishing zones during the project.

During the months of August to December 1993, fishing operations were centred to the north-west of the Gazelle Peninsula in the waters adjacent to Cape Lambert (Figure 30). In this area the Baining Mountains provided a wind shadow out to several miles offshore and fishing was excellent. The first set made in August 1993, during which 1.2 tonnes of yellowfin tuna were landed in just one set of 300 hooks, was centred on a seamount just to the south-west of Cape Lambert. After the monsoon season began in late December, fishing operations were moved to the south-east side of the Gazelle Peninsula in and around Wide Bay. In either season a lee could be found in New Britain waters, because the axis of New Britain Island lies approximately south-west to north-east and its long, narrow mountains provide a good barrier to prevailing winds.

One productive fishing area that lacked such good shelter was Wide Bay. During the north-west monsoon season the narrow, low-lying isthmus separating the Gazelle Peninsula from the rest of New Britain Island provided little offshore shelter from wind. This area also has considerable boat traffic going to and from Pomio and the timber companies in Wide Bay. Whilst fishing was being done in this area on 26 January 1994, a storm blew through, starting just after the longline gear had been set. A streak of bad luck coincided with the bad weather during that particular trip. The radio direction finder malfunctioned during the rest break after the line was set. At the same time, winds increased from 10 to 40 knots, accompanied by heavy rain squalls and large seas. The result was that the longline could not be located. *F/V Kuriap* searched for four days before conceding that the entire rig was lost. This accounts for the lower-than-average CPUE during January, as that set was entered into the CPUE calculation even though no fish were caught. Fortunately the project had enough spare gear to rebuild the longline, and fishing operations recommenced on 9 February.

When the monsoon season ended in March/April 1994, fishing efforts were shifted from the Wide Bay area back to the North Coast. The waters from Watom Island west to Cape Lambert proved to be very productive. The main concern while fishing in this area, aside from weather conditions and prevailing winds, was the local shipping lanes. Most coastal vessels stayed fairly close to the reef along the north coast while navigating to and from Rabaul on the Madang route. In order to avoid interactions with the fishing line by other vessels, most sets north of the north coast of East New Britain were set north of the 4° S latitude line. Occasionally a ship enroute to or from Kavieng, New Ireland Province, would cross over this line but, generally no boat or ship traffic was encountered. Likewise, sets to the west of Cape Lambert were far enough offshore to avoid any passing boat traffic.

The fact that wind direction was the main consideration in deciding where to fish is an indication of the abundance of the resource. Most fishermen would probably laugh at such a notion, but it did not seem to matter exactly where fishing operations were carried out as long as a general pattern was adhered to.

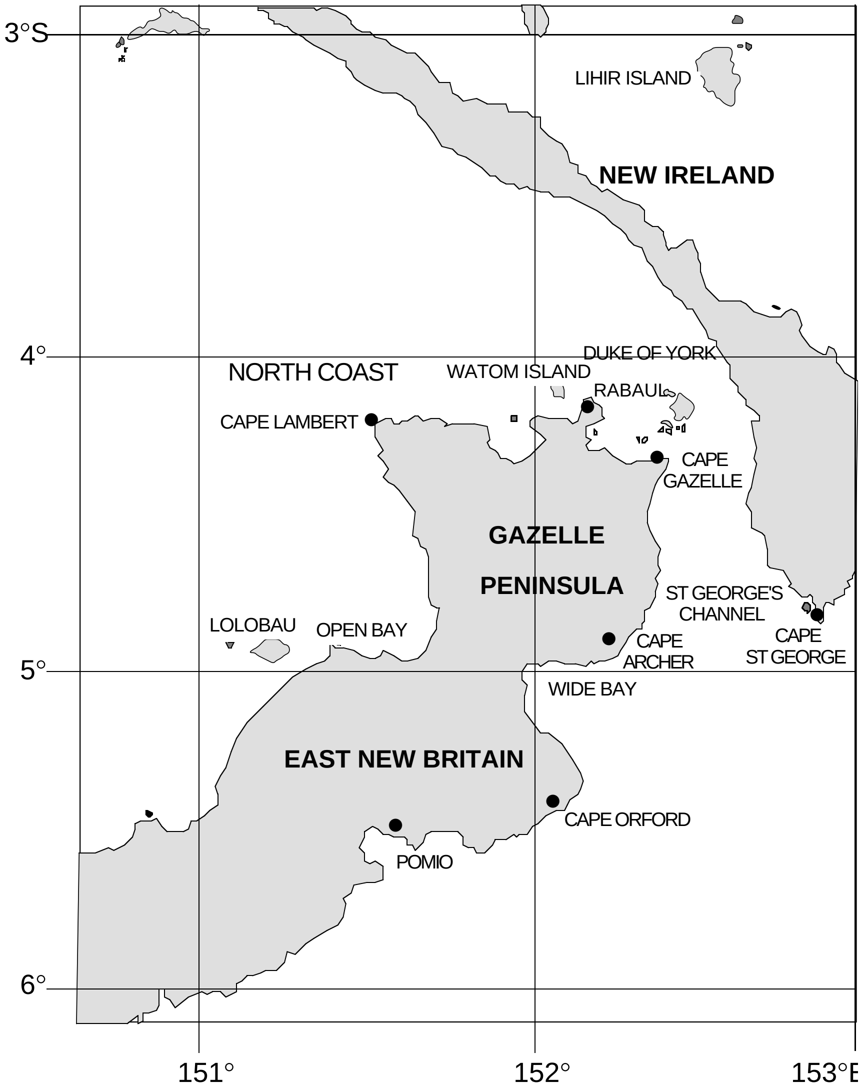


Figure 30: Waters around East New Britain

The line was set at least three miles offshore for three reasons: it avoided the problem that, if set further inshore, the line might have been taken by currents into shallow water where it would have become entangled on the bottom or reef; landowner fishing-rights disputes were avoided by staying away from any traditionally-owned land; and the line was out of sight and range of any vandals or thieves. On one occasion where this general rule was relaxed because of time considerations, about one mile of line, including 45 hooks and four buoys, was stolen by a passing boat. Apparently the thieves did not have a knife on board, as the line was burnt through with a match.

4.5 Longlining operations

4.5.1 Preparation

Before fishing operations started each day the deck had to be laid out properly. This included removing the right number of boxes of bait from the ice hold, stringing the mainline from the reel back aft to where baiting took place, and arranging all buoys, floatlines, flags, radio buoys, leadlines and branchline bins in their proper places (see Figure 31 for deck layout and arrangement of line for setting). In addition, rubber shock cords (bungy cords) were stretched over the racks on the branchline bins so as to create a small hole through which the branchlines could fly out. This prevented the lines from tangling on hooks or snaps when the baited hook was thrown. A pair of cutters was placed within reach of the baiter so that tangles could be cut before a hook flew back into the boat, or worse. It is best simply to cut off any fouled hooks.

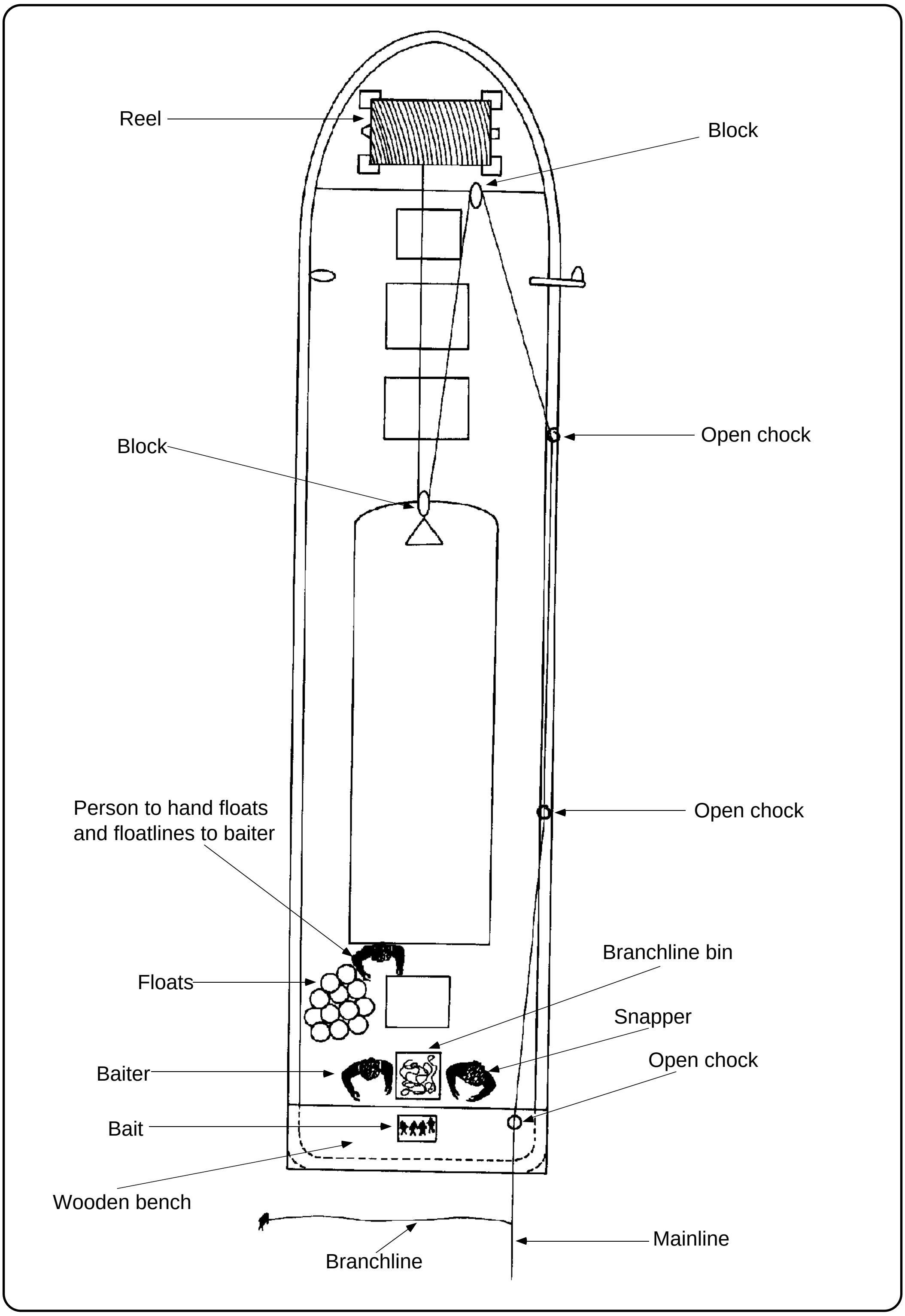


Figure 31: Deck layout and line configuration for setting

4.5.2 Setting technique

After the boat was under way in the setting zone on the desired course and speed, the first radio buoy was thrown over. The reel was set on free spool at this time. This was done by opening the cross-over valve located just below the hydraulic motor on the reel. As the mainline went out over the stern, floatlines and baited branchlines were clipped on at appropriate intervals. The spacing used was usually about 40 hooks per mile (20 hooks per kilometre), and 15 hooks per basket. At 40 hooks per mile the interval between hooks is about 50 m (25 fathoms). The branchlines need to be far enough apart so that they cannot tangle with each other, and so that during hauling, one can be coiled before the next one comes up.

F/V Kuriap did not have a line shooter or thrower, so the distance the boat travelled during setting was the same as the length of line paid out. On small boats of 15 m (50 ft) or less with small reels holding 10–15 miles of line, shooters are impractical and not usually recommended. To get the hook spacing right while towing the line was a simple matter. At five knots and setting 40 hooks per mile, for example, it took about two and a half hours to set 450 hooks in 30 baskets of 15 hooks each, with a total of 480 intervals (more space was given between the last hook in a basket and the buoy adjacent to it to allow more time for coiling floatlines during hauling). Therefore, about 500 intervals needed to be spaced over two and a half hours. This allowed 18 seconds per interval, or 18 seconds between hooks and 36 seconds from the last hook in a basket to a floatline. As the crew became more experienced the boat was speeded up and the interval shortened accordingly. Some boats use a timer with a beeper to set the pace, but with practice this is not necessary.

The line was towed off the starboard side of the stern and baited hooks and floatlines were thrown off the port side. The branchline bins were positioned between two crewmen at the stern (see Figure 31). One man, the baiter, removed a hook from its snap, baited it by piercing the hook down through the top of the head of the sanma (saury) baitfish and forward under the gills, and then threw the baited hook at the proper interval.

The baiter set the pace. The other man, the snapper, then snapped the clip, which he had removed from the rack, onto the mainline. It was important for the snapper to snap the clip just as the baiter threw the bait. If he snapped ahead of time, the baiter could be injured when a hook was pulled from his hand. If the snapper waited too long, the branchline could become tangled with the mainline. To avoid tangles, branchlines were thrown so that they would lie perpendicular to the mainline (Figure 31). A third man handed buoys and floatlines to the baiter. Buoys were set in the same way as the branchlines. The third man’s job was also to bring up more bait as needed, as well as more branchline bins (and coffee!).

When all of the hooks had been thrown, or when the reel was empty, the last radio buoy was thrown. The boat was stopped for this and a loop was tied into the mainline unless the bitter end had been reached. Positions at the start and finish of the set were taken from the GPS, or from radar fixes to landmarks, and were written down or marked on the chart. In addition, current, boat drift and wind direction were always noted. This helped to locate the line after six or seven hours of soaking. If the wind and current were particularly strong during the soak time, *F/V Kuriap* was driven back to the end of the line at least once during the soak. Before the line got out of sight, the signal from the radio buoys was always checked.

An attempt was made whenever possible to set at some angle to the prevailing current. This was done for two reasons. The first was that if the line were to be set parallel to the current, it would tend to collapse in on itself, causing tangles of branchlines with the mainline and possibly also with floatlines. Secondly, as the line moved horizontally through the water, more of an area was fished if the line was set at right angles to the current. If the line moved three miles during the soak, for instance, an area of roughly 30 square miles was fished. If there was no choice in the matter, and the line had to be set with the current, a simple trick was employed to prevent the line from running back on itself with the current. A ‘hook’ was put into the up-current end of the line so that as the end of the line moved in the current, it would slide past itself by a mile or so, forming a loop as it travelled. The ‘hook’ was put into the line by first steaming perpendicular to the current for one mile while setting the beginning of the line, and then changing directions at a 90 degree angle so that the boat was travelling with the current. The completed set would then have an ‘L’ shape.

In the future, when a commercial domestic fleet begins operations, communications between vessels about locations of schools of fish and movements of schools will play an important role in successful fishing. Pilots of the two small domestic airlines flying out of Rabaul have agreed to report any sightings of tuna schools to ENBPTLP in the future. On their inter-island runs, they usually stay below the cloud layer and sometimes fly over tuna schools as a sight-seeing exercise for the tourists.

4.5.3 Hauling technique

After a soak of 5–8 hours the line was recovered. The deck had to be rearranged somewhat and tools laid out before hauling commenced. On *F/V Kuriap*, since all fish were brined, the seawater/ice slurry had to be prepared. This was done by adding sea water to the crushed ice in the fish hold and breaking up clumps of ice until a slurry was formed. The aluminium blocks used in setting were rearranged for hauling in such a way that the mainline was guided from the first block on the davit, which hung over the starboard side, to the level winder or line guide on the reel (see Figure 32 for deck layout and line configuration during hauling).

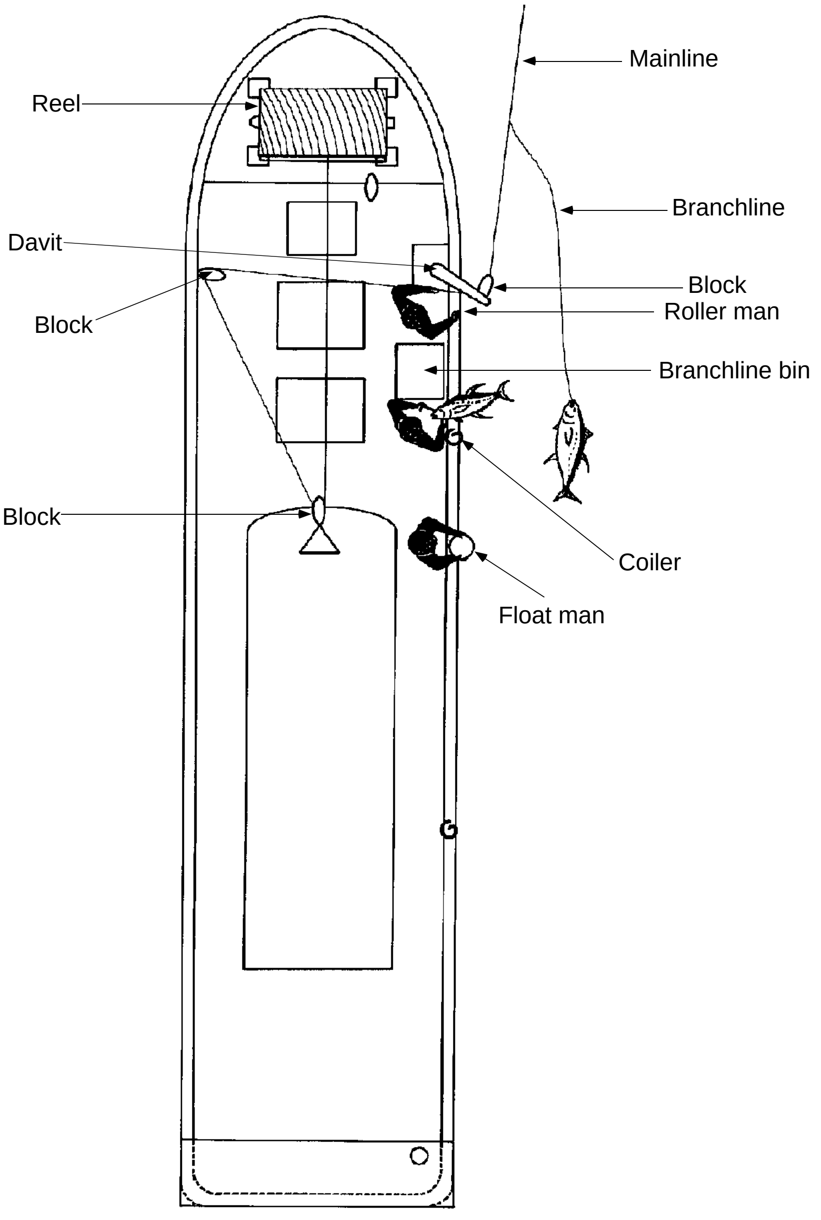


Figure 32: Deck layout and line configuration for hauling

The first radio buoy was then recovered and the end of the mainline detached and passed through the blocks (as shown in Figure 32) and secured to the reel. If the mainline was cut at the end of the set, a blood knot was used to re-attach the two ends (Figure 33). Blood knots were also used if any bad tangles or shark-damaged sections of the mainline needed to be cut out. Once the line was secured to the drum or to the bitter end, hauling commenced.

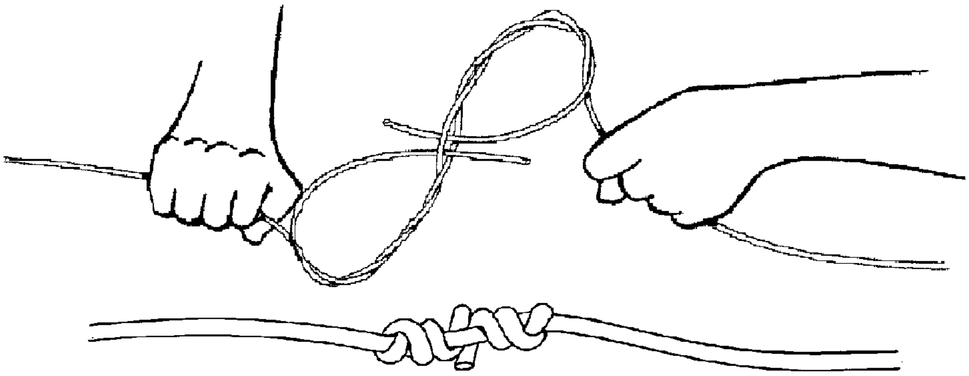


Figure 33: Blood knot: tying the knot, and the finished knot after the ends have been trimmed

The main man on the deck was the roller man, who operated the control valve for the reel (Figure 34). His job was to control the speed at which the line was recovered and to unsnap all branchlines and floatlines as they came up. The boat operator controlled the forward motion of the boat. These two men had to work in tandem in perfect coordination for a smooth haul. Another crewman, the coiler, stood directly behind the rollerman. His job was to take each snap from the roller man and coil the branchlines into the branchline bin.

Figure 34: Roller man operating the control valve for the reel and unsnapping the branchlines from the mainline

Yet another man stood behind the coiler. His job was to pull in all floatlines, coil and stow the lines, and stow the floats. In addition, this man attended to all fish; spiking, bleeding, cleaning, and icing. This whole process was done without stopping (until a branchline holding a fish was reached) as the snaps could be removed from the mainline while it was still moving. The roller man kept one hand on the line (this also allowed him to feel if a fish was on the line) and the other hand on the control valve. The roller man signalled the boat operator via hand signals to speed up, slow down, go to port, go to starboard, or stop.

When a fish was encountered, the roller man yelled ‘fish!’. This was the signal for the boat operator to stop the boat and turn to port (so that the boat would not go over the line). The coiler usually stood by with a gaff as the roller man pulled the fish in by hand. The snap was not removed from the mainline until the fish was gaffed and on board (Figure 35), unless a lazyline, or playline, had been used, which was necessary with a very active, large fish. After the fish was on the deck, hauling resumed. If the float man was still busy with a fish (bleeding, cleaning, and icing) when the next float came up, the coiler man attended to the float. It was better to keep the boat and line moving once hauling had started, as stopping the boat for any length of time could put enough tension on the line to break it or to twist the mainline, thus tangling the branchlines. After the final radio buoy had been hauled in, the end of the line was secured onto the reel. If the fishing trip was over, a cover was put over the line on the reel to protect it against sun damage. Branchline bins were secured and covered or put in a shady spot, and all blocks and other gear were stowed away.

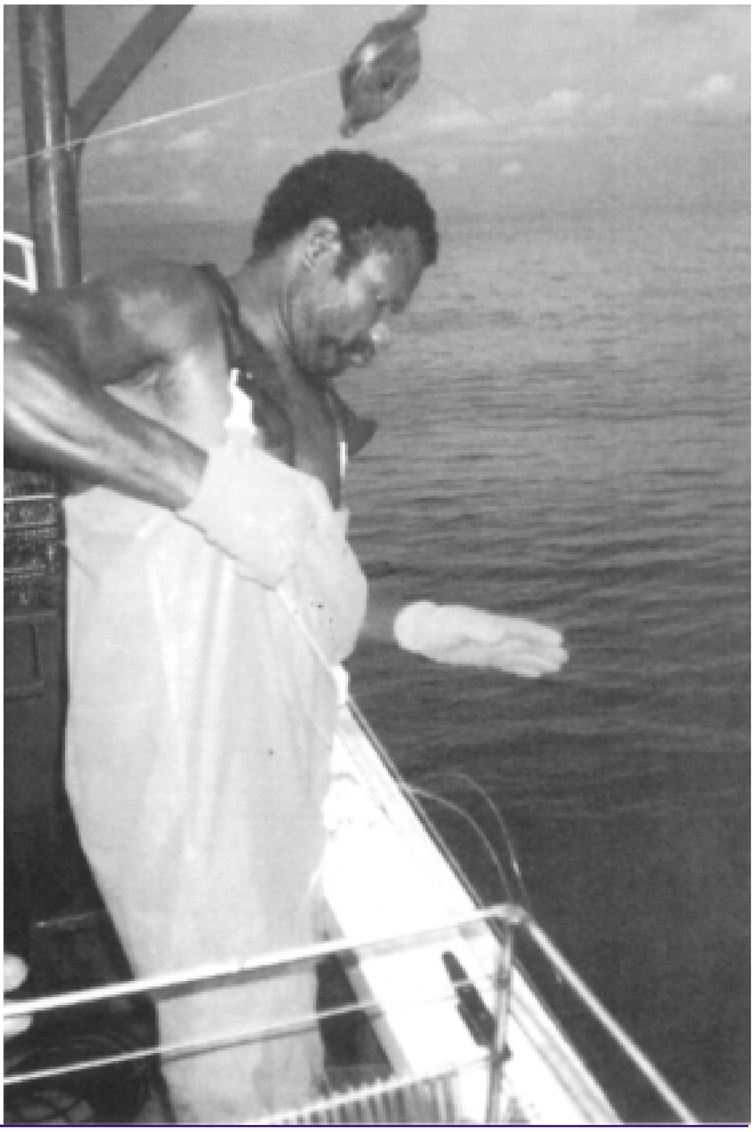


Figure 35: The roller man pulling a fish in by hand

Prior to hauling, all fittings on the reel and level winder and all blocks were greased with high-speed waterproof grease. The V-belt that controls the level winder was replaced for the hauling operation.

4.6 CATCH HANDLING

4.6.1 General

All fish caught during the project were handled according to accepted practices for handling sashimi tunas. However, there is more than one 'accepted' method of killing, bleeding, dressing and icing fish. The variety of styles seen in the Japanese markets contradicts the idea that there is one 'best' way to dress fish (Williams, 1986). At the start of the project, for instance, all fish were bled by cutting the gill membrane just in front of the heart and then inserting a sea-water hose in the mouth to flush out the flowing blood. This method (or a similar method) is in wide use in the longline fishery in Hawaii and is quite effective in removing most of the blood from a tuna. Prior to icing, fins were removed and all fish were subsequently gilled, gutted and scrubbed inside to remove blood and kidneys. This latter procedure is usually not done in the fishery in Hawaii. However, in Hawaii most fish are not sent to overseas markets but are sold on the local auction, where it is acceptable not to gill and gut fish. ENBPTLP did not export fish until late in the project, so this simplified method of bleeding tunas rendered the end product completely acceptable for domestic markets. By-catch species were headed and gutted (billfish) or brined in the round (mahi mahi and small tunas).

As the crew became more proficient at fishing and at fish handling, more sophisticated techniques were used to bleed the fish. The Australian agency that was marketing the fish for the project had its own preferences. The method used for trial export fish was identical in some ways to that found in two sources (Gibson, 1984 and Nakamura et al, 1987). There were a few subtle differences, however. The Great Barrier Reef Tuna Company requested that the caudal keels be removed from all fish, but that all fins be left intact. Additionally, all fish were put in plastic body bags prior to immersion in the brine (in Fiji a common practice is to use a gauze cloth 'mutton' bag).

4.6.2 On-board handling

The techniques employed on board *F/V Kuriap* for all tunas from the time of the first trial export shipments until the conclusion of the project are described below.

Gaffing

As a yellowfin tuna was pulled up to the surface near the rail, two men gaffed it (Figure 36), taking care not to gaff the body or to injure the heart. The first gaff (if the fish was alive) would necessarily be somewhere in the head, while the second gaff could then be stuck in to the open mouth. Tuna should not be gaffed in the lower jaw, as this tends to destroy the isthmus connecting the gills to the lower jaw, which gives the iced fish a distorted shape, and also could damage the heart (see Figure 37). It is better to place the gaff inside the mouth, with the point sticking out through the jaw.

As the gaffed fish was hauled aboard, a third man would grab the tail to enable the fish to be lowered gently to a waiting foam pad.

Stunning

If the landed fish was thrashing, two things could be done. If the trashing was violent and likely to damage the fish or injure the fishermen, the quickest way to settle it down was to hit it with a firm blow to the top of the head with a wooden club or 'fish bat'. This blow only stuns the fish and does not kill it. If the fish was only moving slightly, covering the eye with a gloved hand would usually calm it down. The same club was then used to remove the hook. This was done by grabbing the branchline near the hook and pulling it tight, and then striking the ring end of the hook with the blub. It is a good practice to remove hooks before spiking, as a fish will shudder violently when spiked and the spiker could get hooked or tangled in the branchline.

Figure 36: Two men gaffing a yellowfin tuna the correct way

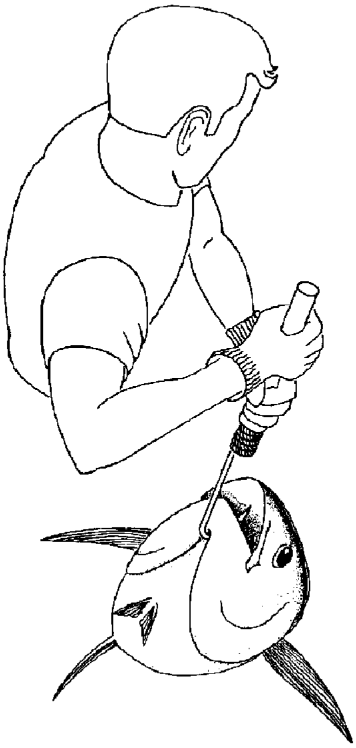


Figure 37: Incorrect gaffing technique

Spiking

The fish was spiked with a stainless steel 'tee spike' made from 10 mm round-stock stainless steel, with a sharp point at one end and a 'tee' handle at the other (Figure 38). A long screw driver would work just as well. The spiker straddled the fish with one foot on either side just behind the pectoral fins, with the fish on its belly, held firmly in place with the spiker's legs. The spike was inserted in the soft spot (Figure 39) between the eyes and pushed back at about a 45 degree angle into the skull. The brain was then destroyed by stirring the spike around.

At this point, some operations use the so-called 'Taniguchi tool' to destroy the spinal cord as well. The Taniguchi tool is a long piece of wire or monofilament that is inserted into the brain cavity of a spiked fish. It then passes into the spinal cord, and as it is pushed down the cord, destroys the remainder of the nervous system. The Great Barrier Reef Tuna Company stated that this was its practice, but ENBPTLP had not progressed to that stage by the end of the project. In any event, whether or not to use the Taniguchi tool seems to be more a matter of preference than anything else. The practice has been adopted and subsequently abandoned by many tuna longline fishermen.

If spikling was done properly, the fish shuddered violently and then went limp, with its mouth agape and its eyes not responding to touch. The skin colour changed from blue to grey.

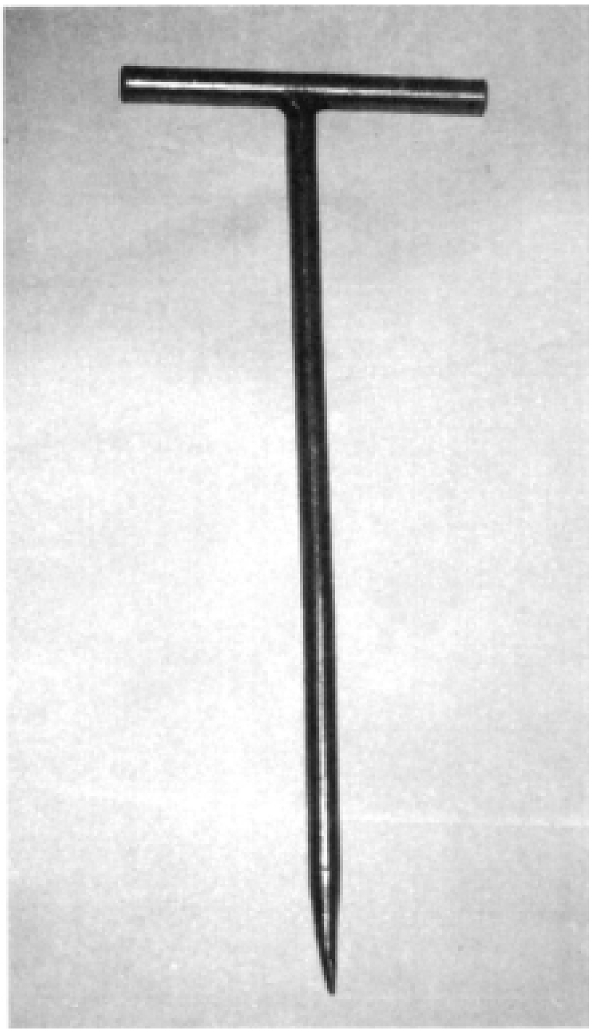


Figure 38: Tee spike made from 10 mm round-stock stainless steel

Figure 39: The spike is inserted in the soft spot between the eyes

## .	Bleeding

A small Japanese bleeding knife (Figure 40) was used to make cuts on either side of the fish in the pectoral fin recess. The cut has to be perpendicular to the body axis of the fish or the blood vessels are likely to be missed. After the blood vessels were seen to be bleeding, a cut was made in the gill membrane on one side of the fish, at about the mid-line, and a sea-water hose inserted. The pressure from the sea-water hose forced blood out of the fish (Figure 41). Pressure from the still-beating heart often had the same effect. That is why it was important not to damage the heart during gaffing. The sea-water hose was left in the fish for about five to ten minutes, or until clear liquid could be seen exiting the cut blood vessels. Further cuts were made during bleeding, on either side of the tail between the third and fourth tail scutes. At this time the caudal keels were also removed.

Figure 40: Japanese-style bleeding knife

Figure 41: Pressure sea-water hose forcing blood out of the cut blood vessels

Gilling and gutting

After bleeding was finished, the gills and guts were removed. This was done by cutting a 'doughnut' cut around the anal opening and then making a slit from this cut forward about 15 cm (6 in) along the belly. A cut was made on each gill cover at the top, going forward to the skull. This allowed the gill covers to be opened more widely for easier removal of gills and guts. Next, all gill membranes were cut loose from the pectoral girdle and the gills were cut loose from the head by carefully cutting the membranes connecting the gills to the skull and to the lower jaw. It was important not to cut the isthmus at the throat during this operation; if it was cut the fish would become distorted during brining, as the back would shrink more than the underside.

After the gills had been freed, they were pulled out through the gill opening. If everything was done properly the guts, which were still attached to the gills, came out with the gills in one piece. The gonads and heart were then removed from the fish.

Cleaning

After the gills and guts had been removed, all loose tissue was cut away from the inside of the gill cavity and all membranes were cut away from the gill collar. Then the inside of the cavity was scrubbed with a stiff plastic or bristle brush and flushed with plenty of sea water. The kidneys, along with any coagulated blood, were scrubbed away from the base of the skull. At this point, the backbone could be seen where the kidneys used to be. Lastly, the entire fish was rinsed one final time to remove any debris or blood. During the whole process, sea water was constantly being used to flush and rinse the fish.

Brining

Before the prepared fish was put in the brine, it was put into a polyethylene plastic body bag (exports only), tied at either end but with holes for water circulation. The purpose of the bag was to protect the fish from chafing against the fish hold or against other fish. A tail rope was choked around the tail to facilitate removal from the hold and shore-side handling. Care was taken when the fish was being placed in the hold not to bend the body or to scrape it against the hatch coaming. If the fish was exceptionally large, two men were used to do this job. If the fish did not slide directly into the brine, as when the hold was nearly full, it was pushed down with a foot, but only at the tail section.

Cleanliness

It was important to keep everything that came into contact with fish clean at all times. After each fish had been handled, all tools, including the gaff heads, spikes, knives, and foam mats, were rinsed with sea-water. The crew on deck wore cotton/nylon gloves and these were also rinsed of blood after each fish had been handled. Fish were never handled with bare hands, as oil from the fisherman’s skin could leave hand-prints on the fish. At the completion of each fishing trip, the fish hold was emptied and scrubbed with sea water and a mixture of soap and bleach. The soap and bleach were rinsed completely away after washing.

4.6.3 Shore-side handling

Unfortunately, *F/V Kuriap* did not come equipped with a boom for off-loading fish or cargo. Kabakaul Wharf also did not have a dock-side boom. It was necessary to lift each fish from the hold and onto the bed of a truck (or into a brine box in the case of exports) by hand (Figure 42). Foam pads were laid in strategic positions so that no damage would occur if a fish was set down for a moment. The bed of the truck was iced before any fish were off-loaded. This was more to cool the truck bed down than to cool the fish. Fish were then transported to Kokopo Fisheries and removed from the truck or the brine box, using the same care, again by hand. At Kokopo the fish were removed from the plastic bags, weighed and processed.

If the fish were to be sold on the domestic market, the heads were removed and the fish were packed in crushed ice in Dynoplast insulated plastic fish boxes. They were then either sold as headed and gutted fish or further processed into fillets or fish burgers.

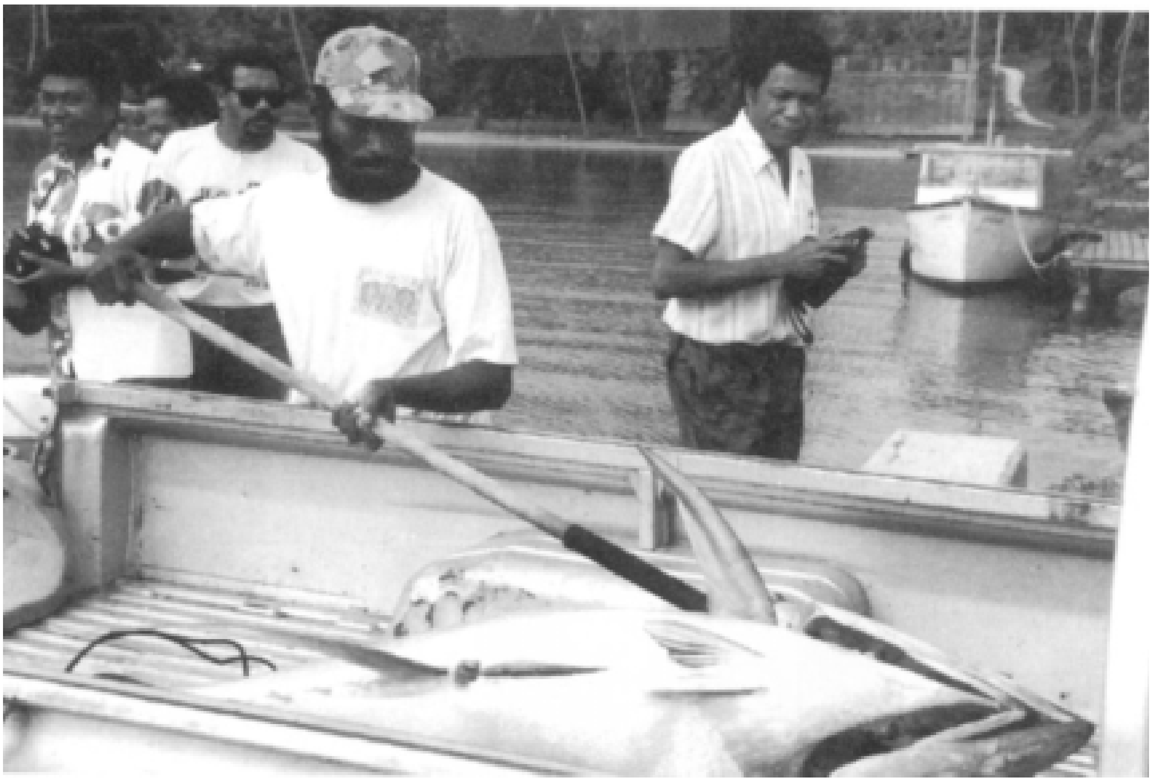


Figure 42: Fish being loaded onto the bed of a truck for transporting to Kokopo Fisheries

4.6.4 Export handling

Fish selected for export were rinsed, placed in a new plastic body bag, and put into a plastic-lined, corrugated cardboard shipping box, along with four or five 0.5 kg bags of gel ice. At this stage, random samples were taken of body-cavity temperature, using a digital probe thermometer. The boxes were then sealed with staples and tape, marked properly, and temporarily stored in a freezer container to await trucking to the airport (Figure 43). Care was taken when transporting the fish boxes, so that no damage could occur to the fish. Boxes were never thrown or slammed around and they were always kept in the shade or covered with a plastic tarpaulin.

From the airport on, however, their fate was in the hands of someone else. Rabaul Airport has no cold storage, or even covered storage on the tarmac. Port Moresby's Jackson Airport has a 10 t freezer container, but it is used primarily for transshipping medical supplies. (Remarkably, when the project sent the second shipment of fish to Cairns, via Port Moresby, Air Niugini had made no preparations for handling the fish, even though the manager of Kokopo Fisheries Project had been in almost daily contact with the cargo manager. One box of fish was seen riding out to the plane on the hot engine cover of a cargo-trolley tractor.)

4.6.5 Export packaging

With the exception of gel ice, all necessary packing materials were available from distributors or manufacturers in PNG. Rather than sourcing the different items needed for packing fish itself, ENBPTLP found it easier to use an agent in Port Moresby. The Net Shop was able to handle all imports and orders for gel ice crystals, boxes, plastic liners, plastic body bags, staples and staple gun. This practice was a little more costly in terms of initial cost of the individual items, but less costly in terms of time spent locating all the proper materials. For instance, a problem was encountered with the manufacturer of cardboard boxes in Port Moresby when the dimensions of the final product were not in accordance with specifications on the order. In such a case, an agent who can deal directly with the manufacturer is invaluable. As the longline fishery grows in PNG, the Net Shop, or a similar agency, will be able to stockpile all required packing materials. This will not only ensure a ready supply to fish exporters but will also guarantee product uniformity and acceptance by carriers, and lower costs.

Figure 43: Export cartons were labelled correctly and then stored in a freezer container awaiting transport to the airport.

Airlines have stringent requirements for air freighting of fresh chilled fish and other marine products. Their main concern is that corrosive liquid not be allowed to escape packaging and enter the body of the aircraft. Costly clean-up and maintenance procedures have to be followed, including taking aircraft out of service, in the event of liquid leaking from fish boxes. Therefore, waterproof, or ‘wetlock’ boxes are necessary (Philipson, 1989). Cardboard boxes with plastic liners are recommended by Philipson for the following reasons: they can be shipped collapsed for on-site erection, they can be shipped easily and economically, and there are already a number of manufacturers in the region.

Requirements vary from carrier to carrier, but minimum standards according to Airport Handling Agents (Cairns) Pty, Ltd. are the following: outside container of double corrugated cardboard walls, 7 mm (0.25 in) thick and double-lidded; 3 cm (1.2 in) thick foam insulating material; polyethylene film liner 0.2 mm (0.008 in) thick; polyethylene bag for gel ice, over 0.07 mm (0.028 in) thick; and ends of box and polyethylene liners to be taped with 4 cm (1.5 in) wide gummed tape.

Gel ice was chosen as it is the preferred coolant for air freighting fresh seafood (Lee, 1990). Gel ice packs were made from crystals imported in bulk. Gel ice is non-toxic and will not leak if the bag is punctured. One kilogram of crystal will make approximately 200 x 0.5 kg gel packs. Packs were made in 0.15 mm (0.006 in) polyethylene bags by adding water, heat sealing the bag, and freezing. The purpose of the coolant was to keep the air within the fish box at 0° C. Four or five 0.5 kg bags were used in each fish box.

After consulting the Great Barrier Reef Tuna Company of Cairns and manufacturers in PNG, ENBPTLP settled on a 1395 mm x 410 mm x 355 mm (55 in x 16 in x 14 in) double-corrugated, double-waxed, regular slotted case with fully overlapping flaps. In addition, a wetlock liner of waxed corrugated cardboard was adapted by the PNG manufacturer to fit into the cases. These liners had 'manufacturer's joints' designed so that when the flat sheet was folded, a wetlock box was formed, with no way for water to escape from the bottom or sides. This liner also served as added insulation, eliminating the need for foam liners. At the conclusion of the project, however, the manufacturer in PNG was still working the bugs out of the final product (box and liner).

Polyethylene (Visqueen) liners and polyethylene body bags were also used with these cardboard cartons. Polyethylene liners came in continuous rolls 0.10 mm x 2 m x 100 m (0.004 in x 79 in x 330 ft). Body bags came in continuous rolls of 0.10 mm x 600 mm tubes x 100 m (0.004 x 24 in x 330 ft). The body bags were tied around the fish at each end with plastic wire ties. The liners were folded over the fish and then twisted and taped at the ends. The ends were then tucked back into the box. This arrangement differed somewhat from requirements specified by Airport Handling Agents (above), but the boxes were deemed acceptable by the Great Barrier Reef Tuna Company's marketing manager. For a list of sources of packing materials and other gear see Appendix D.

The size of the fish carton was important for two reasons. Firstly, it was designed so that it would hold approximately 100 kg of fish. This would usually be two fish, but the box could also accommodate one exceptionally large fish. Secondly, the box dimensions allowed for maximum utilisation of an LD3 (LED) air-cargo container. Thirteen of these boxes fit into an LD3, thus using the entire capacity of the container which is 1.5 t (3500 lb). Boxes plus liners and gel ice add about 10 kg to the net weight of fish, so a full box would weigh about 110 kg. Thirteen boxes would have a gross weight of 1430 kg.

5. Catch and Effort[2]

5.1 PROJECT OPERATIONS

Longline fishing operations commenced in August 1993 and continued until the end of Phase II in September 1994. During the first 12 months of fishing (August 1993 – July 1994) 36 trips were taken and 40 sets made (see Appendix E). Limited ice availability resulted in most trips being restricted to one set only. However, on most trips of one set, enough fish were caught to saturate the local market in Rabaul.

Table 1 summarises the catch and effort for the 12-month period 1 August 1993 to 31 July 1994 to show a full year of fishing activity only. A total of 17,275 hooks were set in one year's effort of 40 sets. The average set was 430 hooks, although on most trips 450 hooks were thrown. The bait used in all cases was the Japanese saury or sanma (*Cololabis saira*). A total of 550 fish of all species were caught, with a total dressed weight of 20,350 kg (Table 1). Yellowfin tuna dominated the catch and totaled 363 pieces weighing 15,826 kg. All tunas were gilled and gutted, whilst all other retained species were headed and gutted, on board prior to weighing. All weights given in this report are dressed weights.

---

[2] Project data are given here as CPUE in kg/100 hooks, as in SPC's PNG Country Report 1987 and in Goodrick & Brown (1987), as this was felt to be more practical for commercial purposes.

Table 1: Summary of catch data for all species and yellowfin tuna, 1 August 1993–31 July 1994

Month (Aug.1993 – July 1994)	No. sets	No. hooks	No. fish (all species)	Weight (kg) (all species)	No. yellowfin	Weight(kg) (YF)
August	5	1,660	94	3,707	67	3,089
September	4	1,750	47	1,567	32	1,277
October	3	1,600	39	1,331	30	1,113
November	4	1,700	55	1,994	35	1,499
December	1	450	26	860	18	650
January	2	900	15	348	2	95
February	4	1,800	54	1,893	29	1,475
March	4	1,680	49	1,947	40	1,587
April	3	1,350	37	1,671	26	1,155
May	4	1,805	60	1,999	37	1,492
June	3	1,290	42	1,557	22	1,109
July	3	1,290	32	1,476	25	1,285
Year	40	17,275	550	20,350	363	15,826

Table 2 summarises the catch per unit of effort (CPUE) per 100 hooks and highlights the high percentage of yellowfin tuna caught (77% overall). Yellowfin tuna averaged 43 kg each (Table 2). The largest yellowfin caught was 74 kg. Only three bigeye tuna were caught during the first year's effort, weighing a total of 105 kg and averaging 35 kg (one fish was 55 kg). However, during August 1994 two additional trips were made and on the trip of 17 August five small bigeye weighing a total of 81 kg were caught (Appendix E). On this particular trip half of the line was set deep.

Table 2: CPUE for all fish and for yellowfin tuna

Month Aug.-1993 – July 1994	CPUE all fish (kg/100 hooks)	CPUE YF (kg/100 hooks)	% YF in catch by weight	Average YF weight (kg)
August	223	186	83	46
September	89	73	82	40
October	83	70	84	37
November	117	88	75	43
December	191	144	75	36
January	39	11	28	48
February	105	82	78	51
March	116	94	81	40
April	124	86	69	44
May	111	83	75	40
June	121	86	71	50
July	114	100	88	44
Year	119	92	77	43

1. YF: yellowfin
2. Weights are processed, gilled and gutted for yellowfin tuna and headed and gutted for other species.

By-catch species included black marlin (*Makaira indica*); blue marlin (*M. nigricans*); sailfish (*Istiophorus platypterus*); skipjack tuna (*Katsuwonus pelamis*); mahi mahi (*Coryphaena hippurus*), often called golden dolphin or dolphinfish in PNG; moonfish, or opah (*Lampris guttatus*); barracuda

(*Sphyraena barracuda*); and numerous sharks, mostly *Carcharhinus* spp., but also including white tips, hammerheads, and threshers. Sharks were not retained due to limited fish-hold space (with the exception of the one thresher shark caught). Live sharks were cut free, whilst dead sharks had their fins removed before discarding. Table 3 summarises the by-catch of marlin during the project's fishing activities. It should be noted that on Trip 35 (20–21 July 1994) a tagged black marlin was caught. The Masterfisherman wrote to the International Game Fishing Association in the US to notify it of the recovered tag (Appendix F), but no response had been received when this report was finalised.

Table 3: By-catch of blue marlin, black marlin and sailfish

Month	**BM**		**BL**		**SF**	
	No.	**Weight(kg)**	**No.**	**Weight(kg)**	**No.**	**Weight(kg)**
August	2	86	2	153	11	274
September	0	0	1	31	9	231
October	0	0	0	0	2	59
November	2	155	0	0	11	269
December	1	110	0	0	4	90
January	2	100	0	0	5	115
February	3	207	0	0	2	41
March	3	277	0	0	2	54
April	3	296	0	0	8	220
May	2	67	0	0	17	410
June	0	0	0	0	20	448
July	1	47	1	61	3	66
Year	19	1,345	4	245	94	2,277

1. BM= blue marlin, BL= black marlin, SF= sailfish
2. Weights are headed and gutted
3. One striped marlin was caught in August 1993.

Notably absent from the catch, or scarce, were numerous other species usually associated with longline catches in the Pacific, including: striped marlin (*Tetrapterus audax*), one caught in August 1993; albacore tuna (*Thunnus alalunga*), none caught; broadbill swordfish (*Xiphias gladius*), one caught in August 1994; shortbill spearfish (*Tetrapterus angustirostris*), none caught; and the usual discards–oilfish, snake mackerel, and black pomfret.

In some ways the catch composition was ideal from a commercial fisherman's point of view: over 70 per cent of the catch by weight was exportable yellowfin tuna, and almost all of the balance comprised billfish and other marketable species. Small numbers of sharks were caught and they caused a few problems by taking bait or damaging gear and other catches. On one occasion porpoises, or small whales, took all of the bait on a set, and whales disrupted fishing during one trip (their presence appeared to have frightened off any tunas).

CPUE for yellowfin tuna exceeded not only historical CPUEs for the SPC region but also past CPUEs for PNG. CPUE for yellowfin tuna for the first year's effort was 92 kg/100 hooks (Table 2). SPC's PNG Country Report 1987 (Anon., 1988, p. 21, Figure 20) gives CPUEs for PNG and for the SPC region for yellowfin for 1979-1987. The highest CPUE given is 70 kg/100 hooks for PNG for 1979. The lowest CPUE for PNG is about 30 kg/100 hooks for 1987. The highest given for the SPC statistical area is about 49 kg/100 hooks for 1980, and the lowest is about 25 kg/100 hooks for 1984.

Average weight of yellowfin caught during the project also exceeded historical average weights for the SPC statistical area. Figure 24, p. 23, of SPC's PNG Country Report gives average weight of yellowfin for the SPC statistical area for 1979–1987, categorised by set type (deep or conventional). The biggest average weight is about 32 kg for 1987, and for the nine-year period the overall average weight of yellowfin is about 26 kg. Yellowfin caught during the project averaged 43 kg gilled and gutted.

5.2 COMPARISON WITH OTHER PACIFIC REGIONS

There is some difficulty in attempting to compare catch data between different areas, as some reports give CPUE for longliners in numbers of fish per 100 hooks (Lawson, 1993), others in numbers of fish per 1000 hooks (Russo, unpub.), and still others in pounds per 1000 hooks (Anon., 1994 [a]). Project data are given here as CPUE in kg/100 hooks, as in SPC's PNG Country Report 1987 and in Goodrick & Brown (1987), as this was felt to be more practical for commercial purposes. Most studies from America use pounds per 1000 hooks. This is easily converted to kg/ 100 hooks.

A comparison with catch data from other areas is more meaningful if some qualifications are made. For instance, data from Hawaii (Anon., 1994 [a]) give a high CPUE for yellowfin tuna for 1970 of 460 lb per 1000 hooks. This is equivalent to 21 kg/100 hooks. This seems low compared to project data, but is that year Hawaii had a CPUE for bigeye tuna of 18 kg/100 hooks, for a total tuna CPUE of 39 kg/100 hooks. For the same year, by-catch CPUE was 17 kg/100 hooks for a total CPUE for all species of 56 kg/100 hooks.

What is important is that in Hawaii during 1970, yellowfin tuna only amounted to 37.5 per cent of the longline catch, while bigeye tuna was the main target species (since 1988 broadbill swordfish and bigeye tuna have become the main target species). By contrast, in the PNG project, yellowfin tuna comprised 77 per cent of the catch. This must be taken into account when comparing the CPUEs of 21 kg/100 hooks for Hawaii and 92 kg/100 hooks for PNG.

Similarly, a recent SPC study in American Samoa (Russo, unpub.) gives a CPUE for yellowfin tuna of 4.04 fish per 1000 hooks, with fish averaging 18 kg (36 lb) each. This would be equivalent to a CPUE of 6.6 kg/100 hooks. However, yellowfin tuna only comprised 11 per cent of the total catch. Obviously some species are under-represented in PNG and some species (e.g. yellowfin tuna) are unusually abundant compared with other Pacific areas.

A comparison of project data with catch data from a study that was geographically closer to PNG than Hawaii or American Samoa (although at latitudes more like those of Hawaii) shows results that are somewhat similar to ENBPTLP results. A longline study conducted in Queensland, Australia (Goodrick & Brown, 1987) reported that two commercial vessels had an average CPUE for yellowfin tuna of 130 kg/100 hooks for 13 sets during a three-month period (averaged from data on Table 3 in that report). Average size of the fish was 35 kg gilled and gutted. In Goodrick and Brown's own project, their data were not as impressive as those reported from the commercial vessels. CPUE for yellowfin tuna ranged from zero to 329 kg/100 hooks for 34 sets, and averaged 28 kg/100 hooks. Composition of by-catch, however, was similar to that for East New Britain waters. The areas fished in the Queensland project ranged from about 25° to 28° S latitude offshore from Brisbane and Bundaberg, including the Queensland Seamount.

A study that investigated Japanese longline fishing (Wright, 1980) monitored one trip of a 59 t automatic basket-gear boat setting 200 x 10 hook baskets daily for 25 days for a total of 49,690 hooks. The area fished was just to the north of PNG's Bismark Sea, in an area bordered by 1° to 3° N latitude and 130° to 141° E longitude. Yellowfin tuna comprised 55.2 per cent of the total catch. No detailed weights were given, but 85 per cent of the yellowfin tuna were under 30 kg. No CPUE information was given, except that 4.5 per cent of the hooks caught fish.

5.3 OTHER DOMESTIC LONGLINE EFFORTS IN PNG

During the ENBPTLP, two other longline fishing ventures were attempted in PNG. One was in Port Moresby and involved fishing trials using an 18 m crayfish boat that had been engaged as a crayfish processor in the Papuan Gulf region of PNG for a prawn and crayfish company based in Port Moresby and Daru. The vessel, *F/V Favio II*, was fitted with a five-mile monofilament reel manufactured in Australia. The ancillary gear was similar to that used in the ENBPTLP. On the first trip out the crew were sorting out gear configuration and no sanma bait was available, so no yellowfin tuna were caught. The Masterfisherman was invited on the second of three trips in January 1994 for fishing trials. One set of 200 hooks baited with sanma yielded a catch of about 400 kg of yellowfin tuna (average weight about 40 kg). The line was set at 0430 h and hauled at

1400 h on the same day in an area about three miles west of the FAD that was placed by SPC and DFMR in 1992 off Fisherman's Island. All weights were estimates, as no scales were available when the fish were landed. Provex Pty. Ltd., the owners of *F/V Favio II*, reported similar results on a subsequent trip. Their initial trials, although minimal, indicated that the waters off Port Moresby may harbour a rich tuna resource, similar to that of the waters of East New Britain.

The other domestic longline venture was started up in Finschhafen, using a 20-year-old Australian boat. The company, Finschhafen Fishing Industries, was run by a father-and-son team. The son ran the boat, with a crew of nationals, and the father did the marketing. Their vessel, *F/V Langemak*, is a 15 m twin-screw steel boat that was formerly used as a deep-sea bottom-fishing boat. In 1993 they equipped it with a Japanese-made, electrically-powered modular longline system. The system employed several small reels that were interchangeable and could be moved from a hauling station to a setting stand, with each reel holding about 5 km of line. With this exception, setting and hauling techniques were similar to those used on *F/V Kuriap*. In early 1994 *F/V Langemak* shifted its operation to East New Britain from Finschhafen, at the invitation of Kokopo Fisheries Project. The CPUE and catch composition for *F/V Langemak* were similar to those of F/V Kuriap during the time that it fished. However, by the end of ENBPTLP in September 1994 *F/V Langemak* had stopped fishing for a variety of reasons: the vessel was old and in general need of extensive maintenance work; the type of fishing gear was not suitable for commercial longline fishing; and Finschhafen Fishing Industries was under-capitalised and suffering from severe cash-flow problems. It was depending entirely on unsecured credit and revenues from sales of fish on the local market to meet all operating and fixed expenses on a trip-to-trip basis.

6. Test Marketing

Fish caught during the project were marketed, for the most part, in Rabaul and Kokopo. A few yellowfin tuna were sent to Port Moresby to hotels and restaurants and two small shipments of yellowfin tuna were shipped to the auctions in Japan via an Australian fishing and seafood company in Cairns.

6.1 Domestic market

Rabaul has a limited market for sales of large tunas and by-catch. There are three hotels and numerous guest houses in Rabaul and one hotel just outside town. Near the main market is a retail fish shop and there are several take-aways ('kai bars') that sell fish and chips. However, until ENBPTLP began providing yellowfin tuna to the local market, most of the hotels only had reef fish on their menus and the kai bars only sold imported barracouta.

GENB expressed the wish early in the project that every effort should be made during fishing trials to make at least some money to offset its contribution in grants, operating expenses and equipment. Kokopo Fisheries Project handled all sales of fish and all monies received went into its general account (Kokopo Fisheries Project, although a GPNG project, was funded regularly by grants from GENB). In the beginning, however, many fish were given away to promote sashimi, especially in the hotel restaurants. Two hotels (Rabaul Travelodge and Hamamas Hotel) consequently put sashimi on their menus and served it on a regular basis. In addition to selling large tunas to the hotels, Kokopo Fisheries Project also sold whole tunas and by-catch fish to the Rabaul Fish Market; and fresh tuna chunks (1 to 2 kg), frozen tuna and marlin fillets, and frozen fish burgers from the project headquarters in Kokopo. Kokopo Fisheries Project headquarters was referred to by locals as 'Kokopo Fish Market'.

The cash receipts from domestic sales were anything but spectacular. A total of only K 15,045 was earned for the first year's effort, 1 August 1993 to 31 July 1994. The monthly average for retail fish sales from Kokopo Fisheries Project was K 1254; the monthly breakdown of sales is given in Table 4. It is difficult to relate fish sales to catch data, as many fish were given away, especially during the first half of the project. Typically, however, whole headed and gutted tunas were sold for only K 1.50/kg and frozen fillets went for K 2.50/kg. By-catch prices were similar.

Table 4: Monthly receipts for domestic sales of fish

Month	Sales in Kina
August	1,193
September	755
October	592
November	1,221
December	1,121
January	878
February	891
March	1,903
April	742
May	1,110
June	1,017
July	3,622
Year	15,045

1. Figures are for sales of yellowfin tuna and by-catch species, sold whole, in chunks, as frozen fillets and as fish burgers.

Despite the low prices, domestic sales were successful in two ways. Sashimi became a part of the restaurant fare in Rabaul and this helped to promote an awareness in the local population and business community not only of ENBPTLP, but of the prospects and potential that longline fishing has in the region. The other outcome had to do with by-catch sales. Kokopo Fisheries Project could never make enough fish burgers to satisfy the local market. Records, unfortunately, did not show the relative amounts of fish burgers and fillets, but fish burgers typically sold out very quickly and there were always requests for more. Fish burgers were made from a mixture of ground fresh tuna or billfish or both, chopped onions, salt and coriander, pressed into patties using a special hand-operated burger press (Figure 44). Burgers were then frozen, six burgers to a pack, for retail sales. The success of the fish burgers and the popularity of other by-catch products, such as fish chunks and frozen fish fillets, showed that a market could be developed for such products in PNG, notwithstanding the competition from imported barracouta fillets.

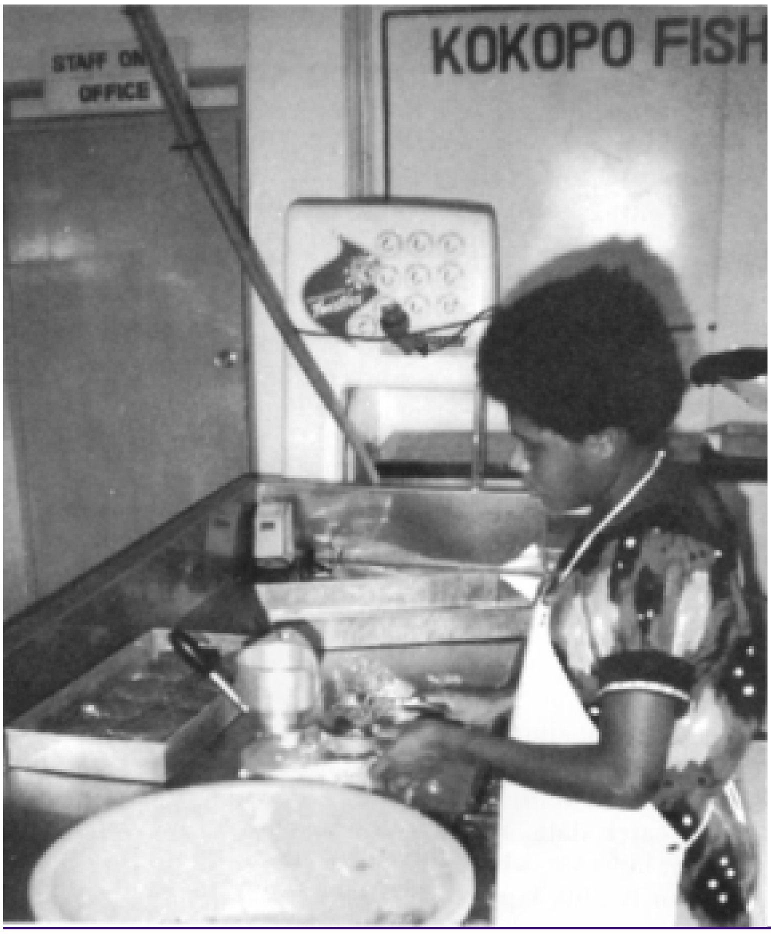


Figure 44: Fish burgers being made using a hand press

6.2 EXPORT MARKET

Two small shipments of yellowfin tuna were sent to Japan via an Australian company, Great Barrier Reef Tuna Company, in Cairns. In March 1994, 252 kg (6 fish) were sent and in April 1994, 594 kg (13 fish). The six fish sent in March all went to the auction at Nagoya Market and fetched an average price of 1,048 Yen/kg (approximately K 10.00/kg). Transport for this first shipment was a little unusual in that the fish were shipped from Rabaul to Cairns on a Kingair (with a one tonne maximum cargo capacity) that was travelling to Cairns for its regular maintenance servicing. Cost for this leg of the shipment was rather high, K 3.00/kg. Gross weight of the six boxes was 300 kg, so shipping cost for Rabaul-Cairns was K 900.00. Other marketing costs are given in Table 5. The net price received by PNG, not counting the K 3.00/kg air freight charged in Rabaul, was AUD$ 1,647.57 (about K 1,150). Thus, the final net price back to the vessel was about K 250. This was the first-ever foreign earning for domestically-caught sashimi tuna and was therefore something of a milestone in fisheries development in PNG.

The second shipment of 13 fish all went to the Tsukiji Market. The week that this shipment was sent happened to be a holiday in Japan (Golden Weekend). It was envisioned that the PNG-caught fish would do very well, considering the previous results and the fact that holiday prices for auction fish are usually high in Japan. As it turned out, the market was flooded with overseas fish during the Golden Weekend and prices bottomed out. All but two of the 13 fish received the reserve price of 700 Yen/kg. The other two fish got prices of 1700 Yen/kg and 1000 Yen/kg. The average price for the whole shipment was 800 Yen/kg. These fish were sent to Cairns via Port Moresby, first on an Air Niugini F28 from Rabaul, and then on an Air Niugini Airbus to Cairns. The company in Cairns never sent a final reconciliation of the transaction.

Table 5: Marketing costs for first tuna export to Japan

Sales No. GC42 to Nippon Kaisha, Tokyo, Japan. Three cartons, six yellowfin tuna for 252 kg net kg	264,100 Yen
Less Japanese costs:	
Market commission	14,525 Yen
Market handling charge	2,071 Yen
Trucking charge	8,397 Yen
Customs clearance fee	10,566 Yen
Importer's commission	13,205 Yen
Import duty	10,200 Yen
Total Japanese costs	58,964 Yen
Balance due from Japan	205,136 Yen
Converted to AUD @ 72.625	2824.60 AUD
Less Australian costs:	
AQIS (Customs)	30.00 AUD
Import agent fee	265.10 AUD
Great Barrier Reef Tuna Company fee: 252 kg @ AUD 3.50/kg	882.00 AUD
Net price per kg	6.54 AUD
Net income due	1647.57 AUD

7. Local Privatisation

GENB's interest in ENBPTLP revolved around the eventual privatisation of the operation, depending on catch records and trial marketing. Project results led GENB to initialise a privatisation scheme in early 1994. A company, Islands Fishing Company Pty Ltd, was formed with local investors and an incentive package offered by GENB that included a lease-purchase option on the vessels, fishing gear, and equipment. Model profit-loss, cash-flow estimates were drafted by the Masterfisherman at the request of GENB to assist a certified accountant in preparing an official statement for company officials to use in securing finance.

Islands Fishing Company was in the process of forming and is still in its infant stages. The company has been meeting regularly at the Ralum Club in Kokopo, East New Britain, but it does not yet have an address, post-office box, telephone or fax. So far the Company is made up of 8 or 9 shareholders, each with an allotted holding of 5000 shares or K 5000. Some holders will have more than 5,000 shares, but 5,000 is the minimum buy-in amount. Total paid-up shares for nominal capitalisation are intended to be 100,000 (K100,000). Once this money is in place in the Company's account, the Company intends to approach a local financial institution for additional funds of approximately K 250,000.

Initially, K 100,000 will be used for operating expenditures for *F/V Kuriap* and *F/V Kikori Tamate*, and the shore-side processing and marketing facility. (*F/V Kikori Tamate* is another Japanese aid vessel that was being under utilised in Port Moresby. GENB has made attempts to try to secure use of the vessel in conjunction with ENBPTLP.) The additional K 250,000 will be used to purchase another second-hand vessel from either Australia or Asia, once the company gets up and running. It is anticipated that the vessels and the shareholders' deposit will be used as collateral to secure this finance. The figure of K 250,000 is only an estimate and depends on availability of vessels at the time and on the willingness of institutions to participate.

8. Development Constraints

Some constraints were specific to the project; others were of the kind likely to affect any company or vessel attempting to set up a domestic tuna longline fishery in PNG.

8.1 East New Britain

Constraints specific to ENBPTLP included the inadequate ice supply, logistical problems, and difficulties in attempting to set up a commercial model fishery using public service staff and following specific Government procedures.

8.1.1 Ice supply

The major constraint, which limited fishing effort to one set per week, was the shortage of ice (1.5 t produced per week). GENB allocated funds for the purchase of a 5 t/day shell-ice machine before the start of the project in 1992. However, the machine was not ordered from the factory in Canada until well after the start of fishing trials in late 1993. By the end of the project in September 1994 the machine had arrived. However, it had not been installed or connected to power and water. Consequently, the only ice available for fishing during the entire course of the project was an existing supply of block ice (15 kg blocks) that was crushed as needed just prior to each trip. Kokopo Fisheries Project had previously used this ice to supply a small fish-buying scheme involving Duke of York Islands fishermen, using 6 m (20 ft) fibreglass Yamaha punts with outboard motors and small ice boxes. Approximately 1.5 t of ice was available each week and the process of crushing the ice, bagging it into 50 kg flour sacks and trucking it to the boat was a very labour-intensive exercise that used up half a day before each fishing trip. Furthermore, the type of crushed ice produced by the machinery available was not appropriate for icing sashimi-grade tuna, as the average size of ice chunks was too large and fish were often dented or scratched by the ice. On the first trip of 4 August 1993, only half of the fish landed could be iced; about 500 kg of fish were brought in on the deck and were in poor condition upon arrival.

If the ice supply had been adequate, the small size of *F/V Kuriap's* fish holds might have become a limiting factor. However, that situation did not occur.

8.1.2 Logistics

Other constraints to fishing effort, and operations in general, were logistical in nature. Project headquarters were at an existing office-plant complex in Kokopo, East New Britain, previously used as a fish-buying centre for the Kokopo-Duke of York Islands region. It was located about 30 km outside Rabaul town, away from most infrastructure, including the main harbour, slipways, engineering companies, government offices and the airport. Use of this facility was convenient to the chosen wharf site, Kabakaul, but inconvenient if services in Rabaul were needed.

The Kabakaul wharf site, however, presented the greatest logistical problem, as it was situated even further from Rabaul, about 45 km away (past Kokopo). The site was chosen for a number of reasons. The wharf at Kabakaul was built in the early 1980s after a volcano eruption scare in

Rabaul. It was built by GENB to be used in the event that Rabaul town would need to be evacuated. The wharf had been unused since that time and was available free of charge and without restrictions to the project. The other reason for locating the vessel at Kabakaul was that a planned international airport site was nearby (Tokua). However, the airport is years away from being available to cargo planes flying fish out of ENB. Furthermore, no power or water was available at the wharf site.

8.1.3 Government procedures

ENBPTLP was a joint effort involving SPC and two government bodies: GPNG and GENB. Government procedures therefore played a major role in the day-to-day activities of the project and at times conflicted with the goal of the project, i.e. setting up a model commercial tuna longline fishery. The main constraints to operating on a commercial model were those inherent to Government: namely the civil-service work procedures, and working within budgeted and allocated funding.

The crew assigned to the *F/V Kuriap* by ENB Fisheries Division learned quickly and performed every task given to them in a very conscientious and professional manner. However, the time that they were available to work, when not fishing, was limited to a public servant's work schedule (Monday to Friday from 0745 to 1606 h excluding holidays).

Most fishing trips revolved around the following schedule: icing, fuelling, and provisioning the boat on Tuesday morning; leaving for the fishing grounds Tuesday afternoon or night; fishing on Wednesday; returning to port by Thursday morning; off-loading and weighing-in the catch by noon Thursday; cleaning the boat by Thursday afternoon; and then disappearing until the next Monday. It was pleasing to see that while at sea the crew often put in long hours of hard work with little or no rest and acted as professional fishermen with no complaints. However, whether or not this could be sustained over time needs to be tested.

Constraints imposed by GPNG's and GENB's budgetary policies usually had to do with their system of distributing allocated funding. The Government in PNG uses a purchase-order system that has the acronym, 'ILPOC', which stands for Integrated Local Purchase Order Claim. During the project, ILPOCs were required for all operating expenditures for the project vessel that were a part of GENB's contribution according to the project Memorandum of Understanding (MOU). Unfortunately, the ILPOC procedure could be quite time-consuming and it was not uncommon for the processing of an ILPOC to take four to six weeks, which was very limiting to a development project .

8.2 NATIONAL

Since ENBPTLP was a semi-government operation, it was little affected by the type of constraint that might hinder the start-up of a domestic commercial tuna longline fishery (ENBPTLP was not required to have a licence, for instance). Because of this, ENBPTLP was fairly successful. However, development of a private tuna longline fishery in PNG would have a number of obstacles to deal with. Generally these constraints would be of two types: those relating to Government policy, and those inherent to developing Pacific Island countries. Some of these constraints were identified by the Masterfisherman during the course of the project and some were related to the Masterfisherman by the Fishing Industry Association (FIA–Maurice Brownjohn, personal communication). FIA is a group of businessmen involved in various aspects of commercial fishing and marketing in PNG who are attempting to lobby GPNG to change some of the current rules and regulations that are considered an obstacle to development of a fishery.

Constraints to longline fishing imposed by GPNG (DFMR, Department of Transport, Inland Revenue Service, Post and Telecommunication and Air Niugini) include survey and manning requirements, a complicated licensing policy, import and export duties on a developing domestic industry, the rules governing use of marine radios, and high air-freight rates for exporting fresh fish. Taken singly, these problems could probably be dealt with. However, taken as a whole, they could restrict the development prospects of any domestic longline fishery in PNG.

8.2.1 Survey and manning requirements

Survey and manning requirements that apply to any vessel over 10 m, including fishing vessels, are administered by the Department of Transport's Marine Department and are contained in The Merchant Shipping Act, otherwise known as Chapter No. 242 (Anon, undated [b]). Chapter No. 242 is some 270 pages long, not including appendices, and applies to all ships over 10 m (33 ft) operating in PNG. It contains regulations covering the following: coasting trade, crewmen, navigational aids, pilotage, registration, and safety. Although administration of rules and regulations pertaining to safety at sea is vitally important, some of the rules contained in Chapter No. 242 should be reviewed in relation to their application to fishing vessels or to vessels under 20 m (66 ft) in length, especially if the Government's mandate is to foster development of a domestic fishery. In particular, it is felt that the manning requirements and some of the safety requirements would be more appropriate if applied only to passenger and/or cargo vessels over 20 m (66 ft) in length.

Under Schedule 3, Crewmen Regulations, of Chapter No. 242, a vessel between 10 and 20 m (33 and 66 ft) long operating within PNG must have a Coxswain (Class 2) as captain, two Seamen (Class 1) as deckhands, and one Mechanic (Class 3) as engineer. Each of these men must carry PNG certificates. Aside from these basic manning requirements there is a myriad of other rules pertaining to their certificates, wages, accommodation, and discipline, most of which are felt to be inappropriate to a small fishing operation. The basic manning requirements present two problems to development of a tuna longline fishery: there are not enough qualified personnel in PNG to man a fleet of longliners, and PNG certificates of competency do not necessarily qualify their holder to be a tuna longline fisherman.

If a vessel is between 20 and 30 m (66 and 99 ft) the basic manning requirements increase. A Coxswain (Class 1) is needed as captain, a Coxswain (Class 3) as mate, four Seamen (Class 1) as deckhands, and a mechanic (Class 3) as engineer.

Survey requirements in Chapter No. 242 are generally reasonable and necessary, even though some are antiquated (e.g. the requirement for two hand leadlines). The main problem with the survey requirement, however, is that all emphasis is put on devices and appliances that are basically portable and expendable. The Marine Department surveyors check expiry dates on life rafts and rocket flares, count fire extinguishers and fire buckets (four on a 10 m (33 ft) vessel), and check for binoculars, horn, anchor ball dayshape, and hand-operated fire pump, etc. during the annual periodic surveys. However, critically-important hull and machinery components of a vessel are examined only on a four-year cycle, and then only in a cursory manner.

During three surveys of the *F/V Kuriap* (two periodic and one four-year) the seacocks were never examined. In fact the engine room and shaft tunnel were not inspected at all. After the four-year survey had been completed in July 1993 and the vessel had been passed as fit and ready to be unslipped, two corroded seacocks that supplied the ship's toilet were discovered by the crew. They had to be plugged or *F/V Kuriap* could have been in danger of sinking.

8.2.2 Licensing

Another potential constraint on domestic fisheries development is DFMR's licensing procedures. (It should be noted that DFMR is currently undergoing changes and licensing is likely to be completely different by the time this report is in print. This report refers to the policies in force at the time the project was conducted.)

Obtaining a domestic commercial fishing licence in PNG is a complex issue. The application form issued by DFMR is 14 pages long and requires a lot of information. DFMR also issues an instruction manual for filling out the licence application, which is 19 pages long. The whole process could overwhelm potential applicants. It is hoped that the licensing policy will be reviewed and modified as necessary, with the formation of the National Fisheries Authority.

8.2.3 Customs duty

Import and export duties levied by the Inland Revenue Commission that would affect a domestic longline fishery include the following: 11 per cent on hooks, lines, ropes, and buoys; 33 per cent on new vessels (unless the vessel is licensed to fish in PNG and has been financed in PNG, in which case there is no duty); 33 per cent on all other fishing gear, including longline fishing reels (unless the reel can be classified as a winch, in which case duty would be 11 per cent); 33 per cent on bait; and 5–15 per cent on fish exports (Anon., 1991). Some of the duty requirements are rather vague and obviously subject to interpretation. However, any duty charged on a pioneer industry such as domestic longline fishing could be considered to be restrictive.

ENBPTLP paid no duty on fishing gear or bait brought into the country during the course of the project, but was requested to pay the five per cent export duty when two trial shipments of tuna were sent to Japan. In calculating the five per cent duty, gross sales figures ex-Japan were used rather than the net back to the operation after deduction of airfreight, commissions, and Japanese duty (also 5 %). In order for a domestic tuna longline fishery to be able to develop, these duties should be reviewed in line with Government policies on developing domestic fisheries.

8.2.4 Radio communications

GPNG controls all marine radio licensing and use through the Ministry of Communications, which oversees the Post and Telecommunication Corporation (PTC). PTC, in turn, has delegated authority over radio-telephone ship-station operators to the Spectrum Management Department. Spectrum Management issues all radio licences in PNG and has put out a handbook (Anon., undated [a], Spectrum Management) laying out rules and regulations regarding use of marine radios, including ship-to-ship and ship-to-shore transmissions. Generally the rules laid out in the handbook are identical to those accepted and in use throughout the world. However, some of the rules appear restrictive and would only serve to stifle a smooth-flowing line of communications in a tuna longline fishing industry. Communications between vessels in a fleet of longliners are vital not only for safety but for sharing of catch results while at sea. One boat in a fleet may find the schools of tuna and need to share this information with other boats in the same company on a timely basis and in a fairly secretive manner. Also, catch information must be provided to a shore-based processing facility before vessels return to port. Freight forwarders and airlines typically require several days advance booking for overseas shipments and at least 48 hours notice for cancellation. It would be vital for catch data to be transmitted to a shore base regularly and consistently.

Fishing vessels in PNG, however, are allowed only one simplex ship-to-ship working frequency, 2112 MHz. The problem with this frequency is that the 2 MHz band has a limited range of around 75 km during the daytime. Clearly this frequency would be of little or no value to a fleet of longliners, as they would be operating more than 75 km from the shore base and from each other. The other frequency that may be used for ship-to-ship transmissions is 4146 MHz, but contact must first be made on 4125 MHz (with everybody listening). It is surprising that PNG does not have available to fishing vessels a simplex frequency in each of the frequency bands that can be used for ship-to-ship and ship-to-shore transmissions. Ship-to-shore transmissions, unless using the limited 2 MHz frequency assigned, must go through the Coastal Radio Station network.

Coastal Radio Stations operate in both Port Moresby and Rabaul. They monitor the international distress frequencies (2182, 4125 and 6215 MHz) and arrange ship-to-shore and shore-to-ship radiotelephone transmissions on a number of duplex frequencies. During the course of ENBPTLP, new SSB HF radios were installed on *F/V Kuriap* and at Kokopo Fisheries Project headquarters. Attempts were made to report catches before the vessel reached port in order to facilitate off-loading and marketing. Unfortunately, Spectrum Management intervened and informed the project that all ship-to-shore transmissions would have to take place in the prescribed way, through the Coastal Radio Station in Rabaul. Several attempts were subsequently made by *F/V Kuriap* to comply with this regulation, but on no occasion was a successful communication made. After repeated failures and frustration in communications, Kokopo Fisheries Project management applied for and received its own simplex working frequency, but it was a 2 MHz frequency which only had a range of around 75 kilometres. Eventually ENBPTLP had to rely on GENB’s Provincial VHF land-based radio network for communications.

8.2.5 Marketing constraints

Constraints to marketing, both domestic and export, are in part related to Government policy. Local fish consumption is dominated by imported tinned mackerel and by frozen barracouta fillets imported from New Zealand (up to 1,200 t annually at an FOB (free on board price of K 0.70/ kg). During the project the largest retailer in Rabaul (Anderson's Foodland) was offered product from the project, but was reluctant to pay more than K 1.25/kg for fresh-chilled headed and gutted yellowfin tuna as it was equating the value to the CIF (cost, insurance and freight paid) cost for barracouta. Prices for all by-catch species were similarly affected by the availability of this low-cost imported product. A higher import duty imposed by GPNG on any imported frozen finfish products would help a developing domestic industry.

Overseas marketing, however, is the main focus of most South Pacific tuna longline operations and it is also the weak link in the PNG picture. Marketing expenses for exporting fish from PNG are substantial and include the following: 5 per cent PNG export duty; 5 per cent Japan import duty; 15 per cent marketing costs in Japan (transport, commissions, etc.); 5 per cent processing costs in PNG; and K 3.00 to K 4.00 per kilogram airfreight charges. If the fish are transshipped through Cairns, there are additional fees and commissions to pay in Australia. The Japanese costs cannot be controlled, but it should be possible to negotiated a more competitive level for air freight. Air Niugini's initial quote to Kokopo Fisheries Project for air freighting fish from Port Moresby to Japan was K 3.75 to K 4.00/kg.

By comparison, freight rates for chilled tuna to Japan from Guam average about K 0.95/kg (Bartram et al., 1991); from FSM about K 1.35/kg (Hood, 1991); from Cairns, Australia about K 1.30/kg; and from Fiji about K 1.75/kg. (These rates were converted to Kina from other currencies based on the exchange rates during August 1994, before devaluation.) From Rabaul there is also the additional freight charge of getting the fish to Port Moresby. It costs more to ship a tuna from Rabaul to Port Moresby than it does to ship a tuna from Guam to Japan! This brings up another constraint; the availability of air cargo space.

Port Moresby's Jacksons Airport is currently the only international airport in PNG, although others are planned at Alotau, Milne Bay Province; Kavieng, New Ireland Province; and Tokua, East New Britain Province. Air Niugini is also the only major carrier servicing Jacksons Airport from the rest of the country. The domestic routes are serviced by a fleet of Fokker F28 jets. Export fish landed in Rabaul must first be shipped to Port Moresby for transshipping to Japan or elsewhere. The problem with the F28 aircraft, from a fish marketer's point of view, is that the cargo space is too small to handle fish export boxes in any quantity. Only 13 boxes will fit in the main cargo hold, and the shape of the hold is awkward and does not accommodate the size of the boxes very well. The boxes must be placed in the hold spanning the width of the hold, the bottom of which is not as great as the box length. The result is that the boxes end up with a 'dead' space underneath and other cargo on top of them. This could result in damage to the boxes and to the fish. In any event, the F28s can only take about one tonne of fish at a time.

Ideally, fish should be shipped in LD3 containers (1.3 t belly cargo containers for 747 aircraft) direct from an airport near the home port of the fishing fleet. Unfortunately, Rabaul's airport cannot accommodate larger aircraft and the airport cannot be expanded as the runway spans a peninsula and is bounded by water on both ends. Rabaul Airport will probably not become an international airport. A fish-exporting venture operating out of Port Moresby or near one of the planned international airports would not have the problems associated with F28 aircraft and could enjoy lower air-freight rates as well. Overall, however, there is not enough air cargo space leaving the country for Japan, or to possible transshipping points such as Cairns, to service a very large tuna export industry.

8.2.6 Infrastructure and miscellaneous constraints

Another problem with air-freighting fish out of PNG is the lack of cold storage space at airports in PNG. Air Niugini reportedly has plans for a cold store at Jacksons Airport, but currently only has one ten-tonne freezer container in place. There are no personnel or agencies in PNG with experience in air-freighting fresh-chilled tuna. These are basically infrastructure problems, not policy problems. The other identified constraints to developing a domestic tuna longline fishery in PNG are a result of the inherent inadequacies in goods, services and infrastructure that are found in most developing Pacific Island countries.

ENBPTLP was fortunate to be based in a location that has a surprisingly well-developed infrastructure to support the maritime industry. Rabaul has two 500 t slipways and several engineering and steel fabricating shops employing mechanics, fitters and turners. Simpson Harbour has one fuelling dock capable of fuelling vessels of several hundred tonnes. However, wharf space in Simpson Harbour is at a premium, and as a fishing fleet grows, there will be fierce competition for dock space. The situation is probably even more aggravated in Port Moresby's Harbour and elsewhere in PNG. Along with a shortage of wharf space, there are associated problems such as lack of shore-side water and power.

ENBPTLP experienced some minor problems when power outages became chronic in ENB in late 1993. At that time a 27 KVA auxiliary generator was installed at Kokopo Fisheries Project headquarters to maintain the bait supply and to ensure ice production capabilities. Aside from power, the only other shortcoming in infrastructure that hindered ENBPTLP was the lack of a well-staffed and equipped marine electronics facility in PNG. On two separate occasions the GPS unit on *F/V Kuriap* malfunctioned and had to be sent away to Australia for repairs. Each time it took about two months to receive the repaired unit back in ENB.

PNG has at least one outlet dealing in fishing gear, The Net Shop in Port Moresby (Appendix D), that deals in both retail sales and wholesale sales to commercial fishing companies. It carries a limited line of gear and equipment of the type used in monofilament tuna longline fishing, but as the industry grows in PNG it will probably expand its operation. Currently, however, there is no company in Rabaul engaged in a similar venture, and all gear must be brought from overseas or from Port Moresby. Monofilament fishing reels are available from USA, Australia and Fiji. Importing large capital-expenditure items such as fishing reels can be quite costly: freight and duty can add as much as 50 per cent or more to the FOB cost of such equipment. Generally, any electronics, machinery, replacement parts, or technical services of any kind are very costly in PNG. The comparative high cost of initial capital expenditure could be viewed as a constraint to development of a domestic fishery. This is further compounded by the lack of suitable expertise in the industry.

One problem faced by any start-up industry is acquisition of suitable equipment. A new tuna longline fishery will not only have to make decisions on what type of vessels to acquire, but will need to choose fishing gear from a wide variety of manufacturers. Every fisherman has his own preference, but some rigs have proved to be better than others over the years. At least one case is known to the Masterfisherman of someone bringing the wrong sort of fishing gear into the fishery in PNG (a small electric-driven modular system that has proved to be a failure in other places). As a new fishing industry grows in PNG, it is important that the right expertise be consulted to minimise the chance of failure.

PNG has a number of steelworks and shipyards that are capable of building boats suitable for tuna longline fishing. In Rabaul there is a company, Rabaul Metal Industries (RMI), that has manufactured several 10 m (33 ft) steel boats that are currently being used as coastal freighters in the New Guinea Islands region. RMI builds its boats at just under 10 m (33 ft) length overall to exempt them from survey requirements. Other shipyards in PNG have built small ships and barges suitable for coastal trading. However, at this time no one in PNG is building fishing boats in the 15 to 20 m (50 to 66 ft) range that would be suitable as tuna longliners. If a fishing fleet is to start up in the near future, boats would have to be imported at high cost, with the added risk of getting boats unsuitable to the fishery.

Under current circumstances it is likely that the wrong sort of boats could be brought into the country as there is a general lack of expertise in PNG in commercial fishing, particularly tuna longline fishing. A plan to import low-cost Russian boats has already been brought to the attention of the Masterfisherman. The entrepreneur in question had not given any thought to availability of spare parts or compatibility of components with those available in PNG or Australia. Another potential tuna longline fisherman wanted to bring a 50 m (165 ft) freezer boat into the fishery. The main problem with the vessel, other than its size and the crewing requirements, was that it had a direct reversing engine that takes about seven seconds to go from forward to reverse. Such a vessel is unsuited for monofilament tuna longline fishing, as its forward momentum would tend to tear fish off the line before the vessel could slow or stop.

Other possible problems or constraints associated with vessel and gear acquisition in PNG are the high cost of financing capital expenditure, especially in a new industry, and the relatively high cost of insurance.

Lack of skilled manpower is a present constraint to developing a tuna longline fishery, but only in the short term. PNG has an abundance of young, trainable, unemployed people. Many businesses in PNG keep signs on their premises that say, ‘No gat wok’ (No work available) to keep away job seekers. If a newly-formed domestic tuna longline fishing company anywhere in PNG were to put up a sign that read, ‘Mipela gat planti wok’ (plenty of work available), it would be inundated by applicants. For the time being, however, skilled Masterfishermen and experienced fish marketers and fish processing managers will have to be recruited from overseas to help start up the industry and to train local counterparts.

9. Conclusions and Recommendations (Phase II)

9.1 CONCLUSIONS

(a) PNG has a large unexploited tuna resource in its archipelagic waters, at least around East New Britain. CPUE for all species, and for yellowfin tuna in particular, was exceptionally high during ENBPTLP (119 kg/100 hooks for all species and 92 kg/100 hooks for yellowfin tuna alone).

(b) The resource differs from that in other South Pacific localities in that yellowfin tuna comprise over 75 per cent of longline catches; and by-catch species, although not insignificant, are less abundant than usual. Bigeye tuna and broadbill swordfish, two important commercial species, are present in PNG but were not found in significant numbers. Discard species are also noted for their lack of abundance.

(c) The yellowfin tuna resource is unusual, too, in that the average size of fish is well over the average caught in other South Pacific localities. Project yellowfin tuna averaged 43 kg gilled and gutted.

(d) The yellowfin tuna resource is present, at least in East New Britain waters, all year round, although it seems to be more abundant in the months of July, August and December.

(e) The waters around Port Moresby also harbour a large yellowfin tuna population; it is possibly that the resource is abundant throughout the country’s DFZ.

(f) PNG’s yellowfin tuna, although not prime export-market fish, would do well in Japan’s fresh sashimi market, and would probably do very well in other markets, such as the Sydney Fish Market or the Hawaii market. A PNG-based domestic tuna longline fishing operation could expect to realise prices of K 10 to K 15 per kg (gross) for export yellowfin tuna. A small domestic market for sashimi tuna could be developed in PNG’s hotels, and a domestic market exists for other species and products.

(g) With the exception of air-freight capabilities and adequate berthing for small (under 50 gross tonne) fishing vessels, PNG possesses most of the basic types of infrastructure required for a domestic longline operation. Slipways, engineering, engine repairs, electronics, fishing gear, and general materials and goods and services are available in certain localities, some of which are situated near good fishing grounds.

(h) PNG’s seagoing community is small by Pacific standards, but fisheries personnel, merchant seamen and artisanal fishermen in PNG are fully capable of adapting to modern tuna longline fishing techniques. Historically, PNG nationals crewed on the pole-and-line fleet in the 1970s and 1980s, and more recently the crew of *F/V Kuriap* showed that they were fully capable of catching yellowfin tuna by longlining on their own.

(i) GPNG, GENB, community leaders and business houses in PNG are supportive of the development of a domestic tuna longline fishery in PNG .

(j) Overseas interest in tuna longline fishing in PNG ranges from those who want to come in and exploit the resource by bringing in fleets of distant-water fishing boats, to those who want to work together with PNG interests in either joint ventures or client–agent arrangements. There are people and companies genuinely desiring involvement in the fishery who should be sought after by PNG interests for their experience and technical expertise.

(k) While GPNG supports the development of a domestic longline fishery, it is also the caretaker, if not the architect, of many laws, rules, regulation, and policies that may over-regulate the development of a domestic longline fishery.

(l) Based on historical longline catches in PNG (averaging over 6,500 t annually), ENBPTLP results, and developments in other regional countries (Fiji, for instance, exported about 2,500 t of tuna worth K 16,000,000 in 1993 [Anon., 1994 (b)]), a domestic tuna longline fishery in PNG could be worth as much as K 40,000,000, or more, annually once fully developed.

9.2 RECOMMENDATIONS

Following the recent project conducted in ENB, it is recommended that:

(a) Further research be directed at building export market links to expand marketing opportunities;

(b) Ways to expand the availability of air cargo space (internationally and domestically), such as allowing more airlines to operate on both PNG–foreign country and domestic routes, be explored;

(c) Ways to allow PNG-flagged and crewed vessels, fishing either in PNG's DFZ or on the high seas, to transship their catch out of foreign ports (such as Cairns, Australia, the Federated States of Micronesia or Guam) be investigated;

(d) The building of provincial international airports be encouraged as a high priority, to facilitate export opportunities for tuna fishing operations;

(e) A full review of the Chapter No. 242 Regulations take place, and appropriate amendments be made, to alleviate any unnecessary restrictions on domestic fishing vessels, especially those under 20 m in length;

(f) Import duties be dropped or minimised for a period of five years for any new or second-hand longline vessels, longline fishing reels, fishing gear, bait, freezers, cool rooms, ice plants, and fish processing equipment and supplies, to facilitate and encourage development in the tuna longline fishery;

(g) New domestic tuna longline ventures be granted a five-year tax holiday, as an incentive to foster development;

(h) All rules, regulations, and procedures regarding exporting of fresh seafood from PNG be reviewed and streamlined where possible;

(i) As domestic catches of fish, including tunas, increase GPNG may need to re-assess its import duty on imported fish products as a means of promoting the marketing of domestically caught fish;

(j) The Spectrum Management Department review all rules governing the use of SSB HF marine radios, to allow fishing vessels the use of several simplex radio frequencies in suitable bands (4, 6 and 8 MHz band) for ship-to-ship and ship-to-shore communication;

(k) Soft loans for new domestic longline fishing ventures, possibly through GPNG's Central Bank or the Agricultural Bank, be explored as a means of creating development in the tuna longline fishery;

(l) DFMR recruit a suitably experienced and qualified masterfisherman or fisheries consultant to advise GPNG, DFMR, provincial governments and private companies in PNG on all aspects of tuna longline fishing operations.

10. References

ANON. (1988). Papua New Guinea country report 1987. Tuna and Billfish Assessment Programme, South Pacific Commission, Noumea. 24 p.

ANON. 1991. Fishing export industry profile, Papua New Guinea. ADB/Infofish. 41 p.

ANON. (1992). Tuna resources of Papua New Guinea waters, with particular reference to the Morgado Square. Tuna and Billfish Assessment Programme. South Pacific Commission, Noumea. 17 p.

ANON. (1994 [a]). Amendment 7 to the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region. Western Pacific Regional Fishery Management Council, Hawaii.

ANON. (1994 [b]). Fiji Fish wins success with sashimi. Islands Business Pacific. Vol 20(1): 33.

ANON. (Undated [a]). Handbook for radiotelephone ship station operators. Spectrum Management Department, PNG.

ANON. (Undated [b]). Independent State of Papua New Guinea. Chapter No. 242. Merchant Shipping.

ANON. (Undated [c]). Survey report of the East New Britain coastal fishery development project. Overseas Fishery Cooperation Foundation, Japan. 80 p.

BARTRAM, P. et al. (1991). Guam fresh tuna longline transshipment Study: Phase 2, market and economic impacts; future development potential. Department of Commerce, Government of Guam.

BEVERLY, S. & P. CUSACK. (1993). Report of a pilot fish aggregation device (FAD) deployment off Port Moresby, Papua New Guinea, 27 June-8 August 1992. South Pacific Commission, Noumea. 29 p.

BOY, R. & B.R. SMITH. (1984). Design improvements to fish aggregation device (FAD) mooring systems in general use in Pacific Island countries. Handbook No. 24, South Pacific Commission, Noumea. 77 p.

DOUGLAS, N. & N. DOUGLAS. (1989). Pacific Islands Yearbook. Angus and Robertson, 434-481.

GATES, P., P. CUSACK & P. WATT. (1996) South Pacific Commission fish aggregating device (FAD) manual. Vol. II: Rigging deep-water FAD moorings. South Pacific Commission, Noumea. 43 p.

GIBSON, D. (1984). Southern bluefin tuna for the sashimi market. New Zealand Ministry of Agriculture and Fisheries. 42 p.

GOODRICK, B. & I. BROWN. (1987). Development of a longline fishery for export grade tuna in Southern Queensland Waters. Southern Fisheries Research Centre.

HOOD, R. (1991). Consultant’s final report, Government of the Federated States of Micronesia fisheries development. Asian Development Bank and the Government of the Federated States of Micronesia. 48 p.

LAWSON, T. (ed). (1993). South Pacific Commission Tuna Fishery Yearbook 1992. Tuna and Billfish Assessment Programme. South Pacific Commission, Noumea. 80 p.

LEE, W. (1990). Seafood shippers rise to the occasion. Seafood Leader. Vol. 10(5): 162–219.

LINDLEY, D. (1988). Early Cainozoic stratigraphy and structure of the Gazelle Peninsula, East New Britain: an example of extensional tectonics in the New Britain arc–trench complex. Australia Journal of Earth Sciences.

NAKAMURA, R.M., J.S. AKAMINE, D.E. COLEMAN & S.N TAKASHIMA. (1987). The management of yellowfin tuna in the handline fishing industry of Hawaii: a fish-handling handbook. Sea Grant Advisory Report No. 36. State of Hawaii. 32 p.

PHILIPSON, P. (1989). Air freight practices for chilled fish. **In**: The Marketing of Marine Products from the South Pacific. Institute of Pacific Studies, University of South Pacific, Suva, Fiji. 239–250.

RUSSO, G. (unpub.). American Samoa trial pelagic longline programme project assessment: feasibility of establishing a chilled tuna fishery and activities report. Report prepared for the South Pacific Commission, Noumea.

WILLIAMS, S. (1986). Marketing tuna in Japan. Queensland Fishing Industry Training Committee. 60 p.

WRIGHT, A. (1980). An investigation of Japanese longline tuna fishing operations in the region of Papua New Guinea. Research Bulletin No. 23. Department of Primary Industry, Port Moresby. 47 p.

Appendix A

SPECIFICATIONS OF *F/V KURIAP*

Length overall	14.8 m
Beam	3.4 m
Draft	1.9 m
Length on water	11.98 m
Gross tonnage	8.5 t
Speed	10.0 knots
Hull type	Fibreglass-reinforced plastic (FRP)
Engine	Yanmar 6 CHK 4 cycle, 130 hp at 2600 rpm
Fish holds No. 1	1.3 m^3
No. 2	2.0 m^3
No. 3	2.3 m^3
Fish-carryying capacity	2.5 t
Fuel-oil capacity	1600 l
Fresh-water capacity	450 l
Crew complement	4

Built by Yanmar Diesel Engine Co. Ltd, Japan, March 1984

Appendix B

LONGLINE GEAR ORDERED FOR *F/V KURIAP,* WITH COSTS*

Quantity	Description	Cost (USD)
1	27 inch x 30 inch LP longline reel	6,205.00
450 lb	3.0 mm monofilament on spool @5.65/lb	2,542.50
450 lb	3.0 mm monofilament @6.25/lb	2,812.50
10 spools	2.1 mm on 25 lb spools @173.75	1,737.50
1000	1/8 inch snap with 8/0 swivel @0.90	900.00
200	1/8 snap with 9/0 swivel @1.14	228.00
3	Small grey branchline bins @220.00	660.00
2000	Taiwan 3.6 hook with ring @48.18/100	963.60
2	Small Swedish fids @7.67	15.34
2	Wire cutters @9.06	18.12
2	Radio buoy, size medium @1,000.95	2,001.90
1	Taiyo RDF Model TD-L1100	2,995.00
10	OPI strobe @69.07	690.70
4	Mustad gaff head @9.17	36.68
3	LP 4 inch block @156.00	468.00
8	LP 4 inch block bearing @13.55	108.40
1	Brand valve	234.60
3	Helly Hansen pants, medium @55.45	166.35
3	Helly Hansen pants, long @55.45	166.35
3	Helly Hansen jackets, medium @57.27	171.81
3	Helly Hansen jackets, long @57.27	171.81
6 pairs	Bata boots @22.00	132.00
5 doz.	V-line gloves, medium @20.56/doz.	102.80
5 doz.	V-line gloves, long @20.56/doz.	102.80
5 coils	6.4 mm tarred mainline @155.63	778.15
6 ft	Red link belt @7.80/ft	46.80
1	Guide roller	152.00
2	LP pawls @49.95	99.90
48	300 mm plastic floats @20.00	960.00
	TOTAL	25,668.61

* Longline reel is FOB Florida, USA. All other items are FOB Honolulu, Hawaii, USA.

WORK CARRIED OUT ON *F/V KURIAP* DURING THE PROJECT

(Work completed on *F/V Kuriap* prior to 21 July 1993 Marine Department survey. Some of the work was routine maintenance; other tasks were directly related to installation of the monofilament longline system. This list was originally done at the request of the marine surveyor, thus it is divided into categories according to location on boat.)

1. Deck

- Installed foredeck floodlights.
- Installed new sea-water hose.
- Removed all old fishing gear (including one hauler and two bottom fish reels).
- Replaced all hydraulic hoses.
- Replaced hydraulic control valve.
- Installed new hydraulic longline reel.
- Installed radio direction finder antenna on main mast.
- Moved anchor capstan.

2. Safety gear

- Life raft—fully serviced.
- Installed new fire extinguishers.
- Installed new horn and horn button.

3. Wheelhouse

- Removed defective gyro-compass.
- Installed new GPS navigation system.
- Installed new colour video sounder.
- Installed new radio direction finder
- Checked all wiring and fuses.

4. Crew’s quarters

- Installed new stove, gas lines, and gas regulator.
- Removed toilet and toilet sea-cocks.
- Blocked off toilet sea-cocks with pipe caps.
- Installed shelves in toilet stall, making it a food locker.
- Re-covered all mattresses on bunks.

5. Hull

- Cleaned and painted hull with anti-fouling paint.
- Checked all zinc anodes.
- Changed all shaft bearings.
- Repacked shaft gland.
- Installed new shaft.
- Checked propeller.
- Inspected rudder bearing and rudder-post packing.
- Installed new transducer and transducer housing for colour video sounder.

6. Engine room

- Rebuilt, re-packed and greased all sea-cocks.
- Removed rotten bilge pump lines and replaced with hose.
- Rewired electric bilge pump.

- Installed new filter system on hydraulic tank.
- Installed new hand bilge pump.
- Installed new hose on hydraulic-system pressure gauge.
- Replaced all rotten deck boards.
- Cleaned bilge.
- Checked operation of sea-water pump.
- Checked operation of battery-charging systems.
- Checked all batteries.
- Cleaned parts locker and tool locker.

7. Main engine

- Replaced damaged cam followers (tappets)
- Replaced all push rods.
- Replaced all valves.
- Resurfaced heads.
- Replaced head gaskets.
- Replaced exhaust manifold.
- Installed new gaskets on intake and exhaust manifolds.
- Installed new zinc anodes in cooling system.
- Installed rebuilt injectors and new dust-cover seals.
- Installed new water hoses and clips as needed.
- Inspected all pumps, including sea-water pump and coolant-water pump.
- Inspected all heat exchangers.
- Changed oil and filters.
- Cleaned sea-water strainer and installed new O-ring seal.
- Installed new crankcase breather hose and new hose clips.
- Checked all V-belts.
- Checked engine alignment with new shaft and shaft coupling.
- Test-ran engine and working of new shaft.

AGENTS, MANUFACTURERS, AND SUPPLIERS OF MATERIALS USED OR CONTACTED DURING ENBPTLP

1. Longline gear

The Net Shop
Maurice Brownjohn
P.O. Box 5860
Boroko, NCD
Papua New Guinea
Telephone: (675) 258222
Facsimile: (675) 258994
(*Longline reels, line, buoys, hooks, bait*)

Pacific Ocean Producers—Ocean Producers International
Sean Martin, Jim Cook
965-B N. Nimitz Highway
Honolulu, Hawaii 96819
USA
Telephone: 1 (808) 5372905
Facsimile: 1 (808) 5363225
(*Total longline installations, bottom fishing gear, bait, electronics*)

Seamech (Smart Reels)
Ross Brodie
P.O. Box 3258
Lami
Fiji
Telephone: (679) 301882
Facsimile: (679) 309866
(*Longline reels and hydraulics*)

Ikko Co., Ltd.
Ichiro Usuda
P.O. Box 15
Minimishitaura 238
01 Japan
Telephone: 0468 (89) 1555
Facsimile: 0468 (89) 1505
(*Lines, hooks, etc.*)

2. Marketing and freighting

Airport Handling Agents (Cairns) Pty. Ltd.
Ray Mackie
Cairns Airport
Telephone: 61 (70) 527743
Facsimile: 61 (70) 359204
(*Freight forwarder*)

Air Niugini Cargo
(Air freight)
Emmanuel Balamus
P.O. Box 7186
Boroko, NCD
Papua New Guinea
Telephone: (675) 273670
Facsimile: (675) 273211

Great Barrier Reef Tuna
Bob Lamason
37-39 Aumiller St.
Cairns, Qld 4870
Australia
Telephone: 61 (70) 352633
Facsimile: 61 (70) 352644
(*Fish marketing in Japan*)

Islands Aviation
Tony Skelton
P.O. Box 217
Rabaul, ENBP
Papua New Guinea
Telephone: (675) 922900
Facsimile: (675) 922812
(*Air freighting from Rabaul*)

Customs Management Services
Geoff Stephenson
P.O. Box 920
Rabaul, ENBP
Papua New Guinea
Telephone: (675) 922574
Facsimile: (675) 922534
(*Customs agent*)

3. Electronics

C.H. Smith Marine Electronics
Rod Smith
P.O. Box 1020
Melbourne, Victoria 3066
Australia
Telephone: 61 (3) 4171077
Facsimile: 61 (3) 4161171
(*Agents for JRC, repairs*)

Rabaul Battery Service
Alan Jameson
P.O. Box 248
Rabaul, ENBP
Papua New Guinea
Telephone: (675) 922574
Facsimile: (675) 922534
(*Agents for Furuno, ICOM*)

Tecair Ltd
Graham Johnson
P.O. Box 631
Suva
Fiji
Telephone: (679) 385011
Facsimile: (679) 370238
(*Agents for Furuno*)

4. Refrigeration

Rabaul Refrigeration
Phil Tong
P.O. Box 520
Rabaul, ENBP
Papua New Guinea
Telephone: (675) 921569
(*Ice machine and freezer installations and repair*)

5. Packaging and processing materials

Bunzl Ltd
Mark Hume
CMC Box 6391
Cairns, Qld 4870
Australia
Telephone: 61 (70) 512388
Facsimile: 61 (70) 510867
(*Plastic liners and body bags*)

Golden Manufacturers Limited
P.O. Box 6518
Nasinu
Fiji
Telephone: (679) 391522
Facsimile: (679) 340129
(*Fish cartons*)

Pioneer Supplies
G.P.O. Box 14902
Suva
Fiji
Telephone: (679) 312737
Facsimile: (679) 400136
(*Mutton cloth*)

POM Packaging (PNG) Pty Ltd
Song Zhi Wong
P.O. Box 124
Gerehu, NCD
Papua New Guinea
Telephone: (675) 261600
Facsimile: (675) 261300
(*Fish cartons*)

Seafood Technologies Pty Ltd
Michael White
Suite 6 51-55 City Road
South Melbourne, Vic. 3205
Australia
Telephone: 61 (3) 6860222
Facsimile: 61 (3) 6860155
(*Gel ice and Dynoplast fish boxes*)

6. Seafood companies

Delta Seafoods
Lady Roslyn Morauta
P.O. Box 1267
Port Moresby
Papua New Guinea
Telephone: (675) 217986
Facsimile: (675) 214375
(*Prawn fishing, processing, and exporting*)

Mar Fishing Company, Inc.
Eugene Abao
P.O. Box 308
Zamboanga City
Philippines
Telephone: 63 (2) 8190760
Facsimile: 63 (2) 8170190
(*Purse seine fishing and canning*)

Provex Pty. Ltd.
Sam Chang
P.O. Box 1390
Boroko
Papua New Guinea
Telephone: (675) 254000
Facsimile: (675) 250993
(*Prawn and crayfish fishing, processing, and exporting*)

7. Boats and steelworks

Rabaul Metal Industries
P.O. Box 163
Rabaul, ENBP
Papua New Guinea
Telephone: (675) 921188
Facsimile: (675) 922619
(*Steel fabrication, 10 m steel boats*)

Appendix E: Summary of catches taken by *F/V Kuriap* during longline fishing activities off East New Britain.
Note that all weights for tuna are gilled and gutted, while for marlin they are headed and gutted weights. Other catch consisted of mahi mahi, barracuda, opah, skipjack tuna, black pomfret, oilfish, thresher shark, and small yellowfin tuna.
* During trip 17 the entire longline was lost in rough weather and not found. ** These trips were conducted without the SPC Masterfisherman present.

						Catch by species															
Trip	Position		Hook	Time	Time	Yellowfin tu		Bigeye tun		Striped mar		Blue marli		Black marli		Sailfish		Other		Total	
No.	Lat (S)	Long (E)	Nos.	set	haul	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)
August 1993																					
1	4°10'	151°12'	300	0630	1500	28	1260					1	50			4	100			33	1410
2-1	4°13'	151°13'	300	0630	1500	6	271			1	44			1	60					8	375
2-2	3°54'	151°35'	300	0630	1500	3	119											5	32	8	151
3	4°28'	151°15'	360	0615	1500	20	963							1	93	5	124	4	25	30	1205
4	4°18'	151°17'	400	0615	1500	10	476					1	36			2	50	2	4	15	566
Total for August			**1660**			**67**	**3089**			**1**	**44**	**2**	**86**	**2**	**153**	**11**	**274**	**11**	**61**	**94**	**3707**
September 1993																					
5	4°27'	151°24'	400	0615	1500	13	466									1	29			14	495
6	4°14'	151°20'	450	0600	1500	13	500							1	31	2	56	2	12	18	599
7	4°38'	151°19'	450	0600	1445	1	50													1	50
8	4°09'	151°13'	450	0600	1600	5	261									6	146	3	16	14	423
																				0	0
Total for September			**1750**			**32**	**1277**							**1**	**31**	**9**	**231**	**5**	**28**	**47**	**1567**
October 1993																					
9	4°15'	151°15'	450	0600	1500	6	271	1	55									2	54	9	380
10	4°18'	151°16'	550	0600	1500	19	727	1	33									1	3	21	763
11	3°24'	151°06'	600	0615	1500	5	115									2	59	2	14	9	188
Total for October			**1600**			**30**	**1113**	**2**	**88**							**2**	**59**	**5**	**71**	**39**	**1331**
November 1993																					
12-1	4°11'	151°13'	500	0545	1515											1	20			1	20
12-2	3°59'	151°39'	300	0230	830	13	511					1	76			2	51	1	30	17	668
13	3°52'	151°36'	450	0130	1200	14	694									2	50	4	27	20	771
14	3°57'	151°42'	450	0300	1200	8	294					1	79			6	148	2	14	17	535
Total for November			**1700**			**35**	**1499**					**2**	**155**			**11**	**269**	**7**	**71**	**55**	**1994**

Appendix E (cont'd.)

						Catch by species															
Trip	Position		Hook	Time	Time	Yellowfin tu		Bigeye tun		Striped mar		Blue marli		Black marli		Sailfish		Other		Total	
No.	Lat (S)	Long (E)	Nos.	set	haul	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)
December 1993																					
15	4°00'	151°35'	450	0330	1200	18	650					1	110			4	90	3	10	26	860
Total for December			**450**			**18**	**650**					**1**	**110**			**4**	**90**	**3**	**10**	**26**	**860**
January 1994																					
16	4°55'	152°47'	450	0315	1230	2	95					2	100			5	115	6	38	15	348
*17	5°29'	152°08'	450	0500	nil																
Total for January			**900**			**2**	**95**					**2**	**100**			**5**	**115**	**6**	**38**	**15**	**348**
February 1994																					
18-1	5°33'	152°03'	450	0600	1500	4	207					2	130			1	22	6	44	13	403
18-2	4°58'	152°19'	450	0600	1430	9	472	1	17			1	77					5	38	16	604
19	5°02'	152°12'	450	0600	1530	12	593											5	44	17	637
20	5°04'	152°15'	450	0600	1330	4	203									1	19	3	27	8	249
Total for February			**1800**			**29**	**1475**	**1**	**17**			**3**	**207**			**2**	**41**	**19**	**153**	**54**	**1893**
March 1994																					
21	4°20'	152°30'	350	0600	1500	8	403											1	8	9	411
**22	5°08'	152°40'	450	0400	?	7	351					2	184			1	24	1	7	11	566
**23	5°04'	152°10'	430	0400	?	6	251					1	93			1	30	2	14	10	388
24	4°01'	151°40'	450	0530	1530	19	582													19	582
Total for March			**1680**			**40**	**1587**					**3**	**277**			**2**	**54**	**4**	**29**	**49**	**1947**
April 1994																					
25	4°00'	151°30'	450	0530	1500	12	543					2	96			1	35			15	674
26-1	4°00'	151°40'	450	0530	1500	9	423									4	110			13	533
26-2	3°55'	151°25'	450	0330	1230	5	189					1	200			3	75			9	464
Total for April			**1350**			**26**	**1155**					**3**	**296**			**8**	**220**			**37**	**1671**

						Catch by species															
Trip	Position		Hook	Time	Time	Yellowfin tu		Bigeye tun		Striped mar		Blue marli		Black marli		Sailfish		Other		Total	
No.	Lat (S)	Long (E)	Nos.	set	haul	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)
May 1994																					
27	4°00'	151°30'	450	0530	1500	10	387					1	25			3	77			14	489
28	5°02'	151°11'	450	0530	1400	6	292					1	42			2	45			9	379
29	3°45'	152°05'	525	0530	1400	13	587									4	98	3	23	20	708
30	3°52'	151°56'	380	0530	1400	8	226									8	190	1	7	17	423
Total for May			**1805**			**37**	**1492**					**2**	**67**			**17**	**410**	**4**	**30**	**60**	**1999**
June 1994																					
31	3°45'	151°45'	450	0500	1430	8	400									7	151			15	551
**32	not recorded		420	0430	?	9	416									10	233			19	649
33	3°48'	151°49'	420	0530	1400	5	293									3	64			8	357
Total for June			**1290**			**22**	**1109**									**20**	**448**			**42**	**1557**
July 1994																					
34	3°55'	151°49'	450	0530	1430	16	843					1	47							17	890
35	3°59'	151°33'	360	0850	1600	5	217							1	61					6	278
36	3°51'	151°47'	480	0540	1400	4	225									3	66	2	17	9	308
Total for July			**1290**			**25**	**1285**					**1**	**47**	**1**	**61**	**3**	**66**	**2**	**17**	**32**	**1476**
Total catch for the 12-month period from 1 August 1993 to 31 July 1994																					
36			**17275**			**363**	**15826**	**3**	**105**	**1**	**44**	**19**	**1345**	**4**	**245**	**94**	**2277**	**66**	**508**	**550**	**20350**
August 1994																					
37	4°16'	151°13'	450	0530	1445	13	461	5	81							4	88	1	13	23	643
38	4°12'	151°14'	450	0215	1200	7	205											2	15	9	220
Total for August			**900**			**20**	**666**	**5**	**81**							**4**	**88**	**3**	**28**	**32**	**863**
Total catch for the full duration of the project fishing activities																					
38			**18175**			**383**	**16492**	**8**	**186**	**1**	**44**	**19**	**1345**	**4**	**245**	**98**	**2365**	**69**	**536**	**582**	**21213**

Appendix F

LETTER SENT TO IGFA IN FLORIDA, USA REGARDING BILLFISH TAG

Stephen Beverly
Consultant Masterfisherman
South Pacific Commission
C/- Kokopo Fisheries Project
P.O. Box 418 Kokopo
East New Britain
Papua New Guinea

Tel. (675) 92-8337, fax (675) 92-8455

30 July 1994

Billfish Tagging, IGFA
2419 E. Commercial Blvd
Ste 303
Fort Lauderdale, Florida 33308
USA

Dear Sirs,

On a recent longline fishing trip in East New Britain waters the East New Britain Fisheries Division Vessel *F/V Kuriap* landed a 61 kg (headed and gutted weight) black marlin bearing one of your tags. Unfortunately we did not take the fork length at the time, and as all fish are cleaned on board the weight is only H and G weight. The fish was dead on the line. The line was set at 0830 on 20 July 1994 and hauled at 1600. The position at the time the fish was landed was 03 degrees 57.63' S latitude and 151 degrees 38. 51' E longitude, close to the 1000 fathom curve. The number on the tag is as follows: Billfish FDN BF 49037. The number is a little fuzzy, it looks like there is another number underneath it. I have enclosed the tag, in any event. Also caught on that set of 450 hooks were 5 yellowfin tuna weighing a total of 217 kg and one sailfish and one yellowfin (both shark damaged). The bait used was Japanese sanma.

Kind regards,

Steve Beverly