Secretariat of the Pacific Community

FIELD REPORT No. 9

on

TECHNICAL ASSISTANCE AND TRAINING IN SMALL-SCALE TUNA LONGLINING, TARAWA, KIRIBATI

2–17 December 1998
18 April – 24 May 1999;
10 February – 23 March 2000; and
31 October – 14 December 2000

by

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Units used

°C—degrees Centigrade
HP—horsepower
kHz—kilohertz (cycles per second)
km—kilometre
kW—kilowatt
m—metre
mm—millimetre
nm—nautical mile
VDC—volts direct current

SUMMARY

The Kiribati Government requested technical assistance from the Fisheries Development Section in 1998. The main aims of the assistance were to: work with the staff of the Fisheries Division on their new tuna longline vessel F/V *Tekokona II*, to assist with longline fishing gear construction and installation of the monofilament longline system and vessel electronics, and to conduct fishing trials; train Fisheries Division counterpart staff and interested local fishermen in the different aspects of tuna longlining; make an assessment of the vessel as to it's suitability as a longline vessel; train crew and other local fishermen on the correct on-board handling and processing practices for tuna and other pelagic species; keep records of the fishing effort and catch, revenue from fish sales, and all operating expenses; collect any additional data required by the Fisheries Division; assist with trial export shipments of fish; and provide a written report of all activities.

Many delays were encountered during the project. As a result the work was divided into three phases. Phase I focused on gear construction and fitting out of the project vessel during December 1998, and April–May 1999. Phase II of the project (10 February to 23 March 2000) focused on the fishing trials, training of the crew in fishing activities and an initial assessment of the vessel. Phase III of the project (31 October to 14 December 2000) focused on fish quality and exporting trials.

Thirteen fishing trips were undertaken during 2000, with the first trip undertaken by the Fisheries Division before the commencement of Phase II of SPC's technical assistance. During Phase II, 4185 hooks were deployed in 10 sets over the four trips. Weather conditions confining the fishing operations to the lee side of the island. The total saleable fish catch for the ten sets amounted to 1791 kg for 68 fish. The catch per unit of effort (CPUE) for this phase was 42.8 kg/100 hooks. After fishing trials and training, the Fisheries Division conducted another five fishing trips. The six trips conducted by the Kiribati Fisheries Division resulted in a total saleable catch of 2738 kg from 75 fish, with 3400 hooks deployed over nine sets. The CPUE for these trips was 80.5 kg/100 hooks.

The three trips (5 sets) in Phase III resulted in a catch of 19 saleable fish weighing 701 kg, with 1934 hooks deployed. The CPUE for Phase III was 36.2 kg/100 hooks. If all fishing activity is combined, 9519 hooks were deployed over 24 sets resulting in a total catch of 162 saleable fish weighing 5229 kg. The overall CPUE was 54.9 kg/100 hooks.

One trial export shipment was made with two bigeye tuna. The fish were first sent to Fiji, where the person receiving the fish gave a report on fish quality. On arrival, the fish had core temperatures of 4° C before they were placed in a chiller. After a close inspection the following morning, only one fish was deemed suitable for export to Hawaii, with the other loined in Fiji. This was a reasonable outcome for the first trial, as there was very little infrastructure in place for processing and packing export tuna in Tarawa at the time this was undertaken.

When comparing the direct operating costs for the fishing trials (AUD 10,138) to the estimated value of the total saleable catch (AUD 7786), a loss of AUD 2351 was realised. This loss partly reflects the adverse weather conditions encountered during the project, the training of the skipper and crew, and the low value of the landed catch in Kiribati. More importantly though, part of the loss is attributed to the vessel's limiting factors, such as: the vessel being underpowered which restricts the weather conditions that can be fished and the hauling operation, especially when trying to fish deep; the small fuel carrying capacity that restricts the fishing range and duration of trips; the limited fish hold space and ice carrying capacity, which restricts the amount of catch that can be carried per trip; and the lack of space below deck to greatly increase fuel and fish hold capacity.

Recommendations are made in the report on ways to try and improve the fishing operation and make improvements to the vessel itself, and the infrastructure requirements to process, pack and export high quality fish from Tarawa.

RÉSUMÉ

En 1998, les autorités de Kiribati ont sollicité l'aide technique de la section Développement de la pêche. Les principaux objectifs de cette mission d'assistance étaient les suivants : travailler avec les agents du Service des pêches à bord de leur nouveau palangrier thonier, le Tekokona II, aider à la fabrication de l'engin de pêche et à l'installation du système de palangre à monofilament et de l'électronique de bord et entreprendre des essais de pêche; former les homologues du Service des pêches et les pêcheurs locaux intéressés par les différents aspects de la pêche du thon à la palangre; évaluer les infrastructures et les moyens techniques du navire et déterminer s'ils permettent de l'utiliser comme palangrier; former les membres d'équipage et autres pêcheurs locaux aux bonnes pratiques de manipulation et de transformation à bord du thon et des autres espèces pélagiques, (faire) consigner dans le journal de bord l'effort de pêche et les prises, les recettes tirées de la vente du poisson et tous les coûts d'exploitation; recueillir toutes les données supplémentaires exigées par le Service des pêches; collaborer à l'exportation, à titre expérimental, de poisson; et présenter un rapport écrit de toutes les activités.

Des retards se sont accumulés au cours de la mise en œuvre du projet dont les activités se sont décomposées en trois phases. La phase I (2-17 décembre 1998 et 18 avril-24 mai 1999) a porté sur la fabrication de l'engin et l'armement du navire. La phase II (10 février-23 mars 2000) a été axée sur les essais de pêche, sur la formation des marins-pêcheurs aux opérations de pêche et sur une première évaluation des caractéristiques techniques du bateau. La phase III (31 octobre-14 décembre 2000) a été centrée sur la qualité du poisson et sur des opérations d'exportations réalisées à titre expérimental.

En l'an 2000, treize sorties ont été effectuées, la première par le Service des pêches avant le début de la phase II de la mission d'assistance technique de la CPS. Au cours de cette même phase, 4 185 hameçons ont été mouillés lors de dix calées réparties sur quatre sorties réalisées dans la zone sous le vent de l'île, en raison de mauvaises conditions climatiques. Le poids total des prises commercialisables pour les dix calées s'est élevé à 1 798,5 kg pour 68 spécimens. La prise par unité d'effort (PUE) pour cette phase a été de 42,8 kg/100 hameçons. Après avoir participé à ces essais de pêche et avoir reçu la formation voulue, les agents du Service des pêches sont encore sortis à cinq reprises. Les six sorties effectuées par ces agents ont permis de capturer en tout 75 poissons commercialisables d'un poids total de 2 737,9 kg pour 3 400 hameçons mouillés lors de neuf calées. La PUE sur l'ensemble de ces sorties a été de 80,5 kg/100 hameçons.

Les trois sorties (cinq calées) réalisées au cours de la phase III ont permis de capturer 19 poissons commercialisables d'un poids de 700,5 kg, pour 1 934 hameçons mouillés. Pour la phase III, la PUE a été de 36,2 kg/100 hameçons. Si l'on regroupe toutes les activités de pêche, on peut dire que 9 519 hameçons ont été mis à l'eau au cours de 24 calées, ce qui a permis de capturer en tout 162 poissons commercialisables d'un poids de 5 228,9 kg. La PUE globale a été de 54,9 kg/100 hameçons.

Deux thons obèses ont été exportés, à titre expérimental. Le premier à Fidji où la personne qui l'a reçu a rédigé un rapport sur la qualité du poisson. À l'arrivée, la température interne du poisson était de 4°C avant qu'il ne soit placé dans un réfrigérateur. Après une inspection rigoureuse le lendemain matin, un seul poisson a été jugé apte à être exporté à Hawaii et l'autre a été découpé en longes à Fidji. Ce résultat est honorable pour un premier essai car, au moment où cette opération a eu lieu, les infrastructures nécessaires à la transformation et au conditionnement de thon destiné à l'exportation était quasi-inexistante à Tarawa.

Lorsque l'on compare les coûts d'exploitation directs des essais de pêche (10 138,40 AUD) au prix estimé de toutes les prises commercialisables (7 786,47 AUD), il en résulte une perte de 2 351,93 AUD. Ce déficit ne signifie pas que le navire ne se prête pas à une utilisation en tant que palangrier thonier mais il s'explique plutôt par une faible quantité

de prises, certaines réalisées dans des conditions climatiques défavorables et par le prix de vente insuffisant du poisson débarqué à Kiribati. Ce rapport comporte des recommandations sur la manière d'améliorer les opérations de pêche, le bateau lui-même et les infrastructures nécessaires au traitement, au conditionnement et à l'exportation de poisson de qualité depuis Tarawa.

CONTENTS

1. INTRODUCTION AND BACKGROUND

1.1 General

Kiribati straddles the equator in three different places in the central and western Pacific Ocean (Figure 1). The island group is made up of 33 low lying coral atolls that are sub-divided into three main groups. These are the 16 Gilbert Islands to the west, where the capital, Tarawa, is located; the eight uninhabited Phoenix Islands in the middle, and the eight Line Islands, including Kiritimati, to the east. Banaban (Ocean Island) lies alone between Tarawa and Nauru. Total land area is only 817 km^2, while the exclusive economic zone (EEZ) of Kiribati is very large at 3,550,000 km^2 (Stanley 1992).

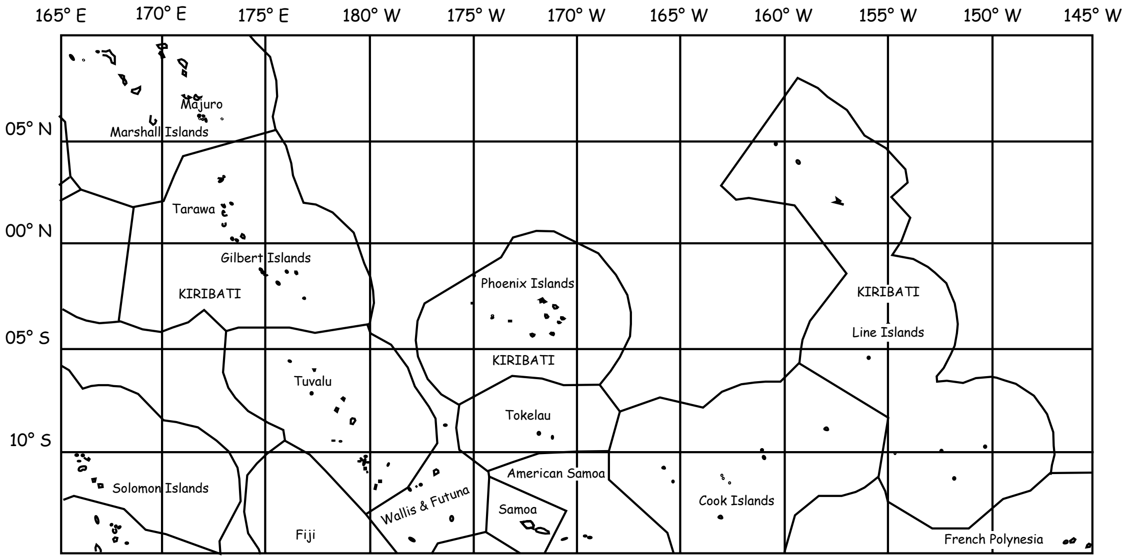

Figure 1: : The three island groups, Gilbert, Phoenix and Line Islands, that make up Kiribati

The Gilbert Group (Figure 2) extends from approximately 5° S to 5° N latitude, and 168° E to 180° E longitude. Tarawa (Figure 2) lies at the centre of the Gilbert archipelago and is located between 1° and 2° N latitude and 173° E longitude. The most heavily populated island in Kiribati is Betio, the southwestern most of the islets making up Tarawa atoll. Betio is also the main port for shipping and fishing in Kiribati. Fisheries Division is located on Tanaea Islet, which is connected by causeways and roads to all of the other islets of south Tarawa. On North Tarawa, however, transport between islets is by boat or by walking at low tide only. Betiraoi Boatbuilding is located on the southernmost islet of North Tarawa, Abatao.

The population of Kiribati was estimated to be 90,700 in mid-2000, with an estimated annual population growth of 2.5 per cent (SPC 2000).

1.1.1 Climate and weather

Kiribati has an 'equatorial maritime' type of climate, with temperatures that vary throughout the year between 25° and 33° C. The islands are located in the dry belt of the equatorial oceanic climate zone. The wet season extends from December to May and rainfall variation is high in most of the islands. Rainfall can be very irregular and at times long periods of drought can be experienced. The northeasterly and southeasterly winds are predominant throughout the year and provide a welcome cooling effect from the hot sun (Anon 2000). The drier months are from June to November. During the dry periods, winds are generally from the southeast while in the wetter months winds are predominantly from the north and east. Within 5° on either side of the equator, tropical cyclones rarely form, but, when these systems do develop in latitudes greater than 5° north and south, gale force winds can be experienced throughout the islands with damaging winds coming from the north and southwest.

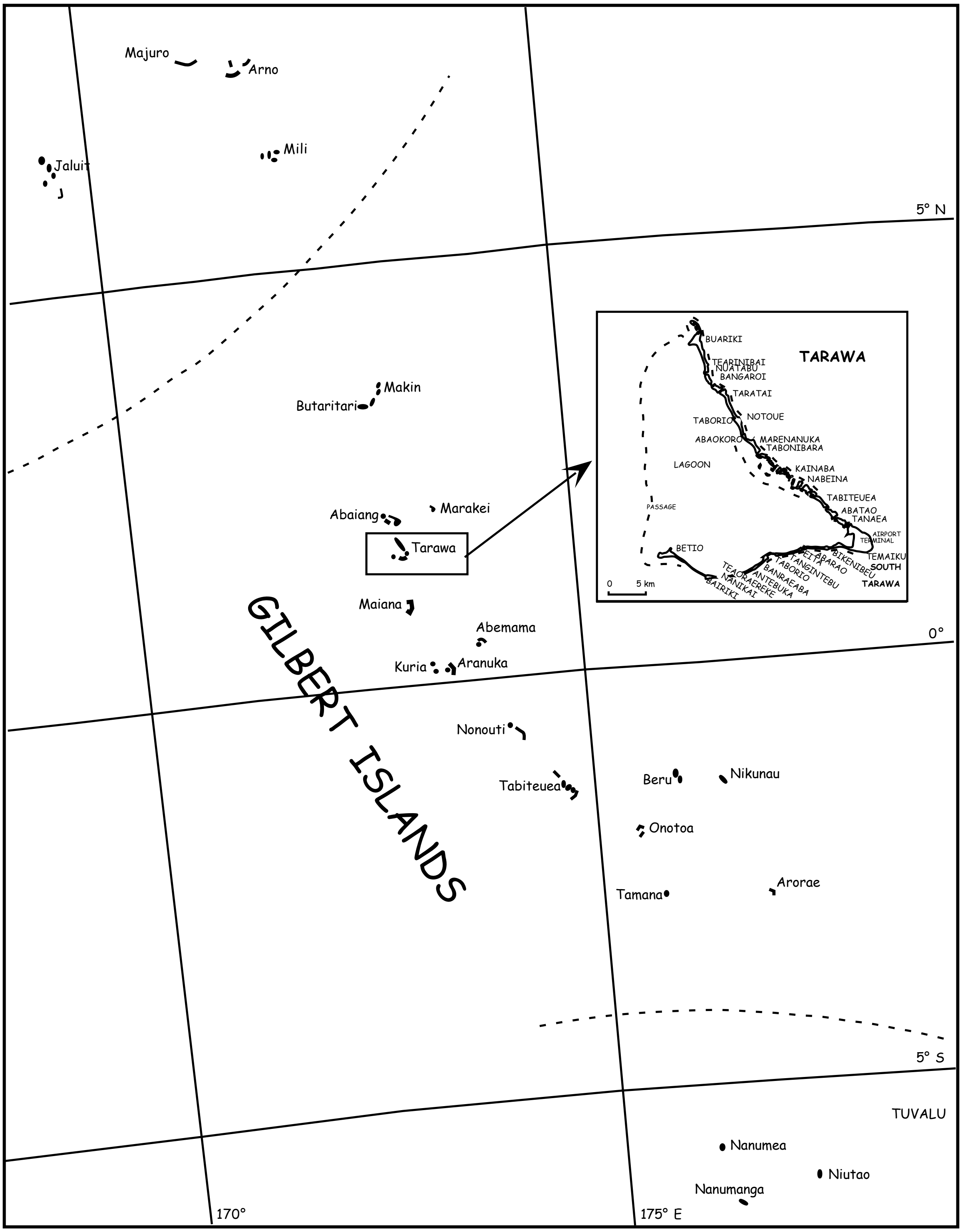

Figure 1: : The three island groups, Gilbert, Phoenix and Line Islands, that make up Kiribati

1.1.2 Oceanography

There are some significant ocean currents that run through the Kiribati EEZ that influence the tuna fishery. The Gilbert and Phoenix Groups of Kiribati are oriented in more or less an east-west direction along the equator, and so are predominantly influenced by the westward flowing 'Equatorial Current'. This current runs roughly between 5° N and 10° S (SPC 1993). There is also a counter-current that runs easterly. This 'Equatorial Under Current' is strongest during mid-year, when it rises to the surface and separates the westward current into two currents. The two westward currents straddle the equator and are also deflected towards the poles on either side by Coriolis Effect. This divergence of currents causes a strong upwelling, which brings nutrient rich sub-surface water up from the depths. The best fishing areas, however, are to the north and south of these divergences, where currents come together (convergences) and water sinks again. The convergence zone along 5° N often concentrates tuna (Grandperrin 1978). Therefore, during the months of June, July, and August, fishing may be good in the Gilbert Group along the border with Marshall Islands.

The other oceanographic features of the sea that affect tuna fishing are thermal in nature. Yellowfin tuna are often associated with the mixed layer while bigeye tuna are associated with the thermocline. The mixed layer is the depth between where the temperature is relatively constant (about 27° C) down to the upper boundary of the thermocline (about 15° C). The thermocline is the region in the water column where the temperature changes rapidly over a small depth range (SPC 1993). In waters around the Gilbert Group, the top of the mixed layer varies between 50 to 100 m depth depending on time of year, while the thermocline is normally found at about 200 m all year round. This information would have implications on fishing strategies, particularly on depth of set and target species.

1.1.3 Economy

Copra, seaweed and other fisheries products are the main source of foreign exchange earnings available to Kiribati. Licensing of foreign fishing vessels (distant water fishing nations, or DWFN) to fish in the Kiribati EEZ contributes around AUD 2–3 million per annum. Unfortunately for Kiribati, the abundant commercially viable phosphate deposits that were on Banaba have run out. Economic development in Kiribati is further constrained by the islands' lack of natural resources, remoteness from international markets, and weak infrastructure to support international trade with the available resources. Having previously depended on foreign aid to supplement GDP, mainly from the United Kingdom, Australia and Japan, Kiribati is steadily trying to effectively utilise the few resources that they do have. Remittances from workers abroad, mainly sailors, account for more than AUD 5 million each year (Anon 1999).

Instead of depending on licensing fees from DWFNs, the Kiribati Fisheries Division is showing an interest in initiating domestic tuna longlining for the overseas fresh fish markets in the hope that this will be taken up by the private sector. Focus is now being placed on establishing the infrastructure to support this industry.

1.1.4 Infrastructure

The jetty at Betio provides suitable access for vessels up to 35 metres. This jetty was undergoing renovations at the time of the project, however. There is good lagoon access and safe anchorages within 500 m of the jetty (Kaneko and Savins 1995). There are mobile crane-trucks, forklifts, and trucks for moving cargo. International shipping services are available in general and refrigerated containers. Most freight is inbound so out going rates are very competitive. There is direct access to Japan, Australia, New Zealand, and Fiji.

Vessel repair facilities are very limited in Kiribati. Betio Shipyard can handle boats up to only 20 t. Anything larger has to go to Majuro, Marshall Islands or Suva, Fiji. Basic repairs are available in Kiribati but are very expensive. Commercial fishing gear and bait supplies are not available, although there is some milkfish (*Chanos chanos*) bait available from the milkfish farm on Tarawa, either fresh or frozen. Ships stores, such as groceries, are limited to tinned and frozen goods imported from Australia. Fresh meat, dairy products, and produce are generally not available. Although there is a shipment once every six weeks from Australia, it is readily consumed by local residents. DWFN vessels are usually supplied everything from fuel to cigarettes and groceries by company motherships (pers. comm. from Mr. Sung Hoon Han of Green World Corp).

Fresh potable water is often in short supply on Tarawa. Also, there is no regular ice supply, although at the start of the project there was a plan for a Japanese grant-in-aid (OFCF) ice machine to be installed at Fisheries Division.

There is an international airport on Tarawa at Bonriki that is serviced by Air Nauru's 737, and can handle aircraft as large as 727s. Air Nauru has links to Nadi, Fiji and Brisbane. In the past, there was a link to Honolulu through Majuro on Air Marshall Islands.

1.2 The tuna fishery in Kiribati

Marine resources are very important in Kiribati, as they provide the main source of protein for the population. The tuna resource is fished domestically by the artisanal fleet and commercially by the DWFN fleet.

1.2.1 Domestic tuna fishery

Fishing for tuna in Kiribati is a well-developed traditional activity that is mostly carried out on a subsistence level. As in other Pacific island countries and territories, realisation of the value of this commodity has brought about legislation and implementation of fishing boundaries so that Kiribati can fully utilise the stock of these migratory fish when they pass through the nation's waters.

There is a high demands for tuna by the world market, especially the sashimi market in Japan and the US, and canneries world-wide, while most island nations are not equipped to fish for tuna on a large scale whereas developed fishing nations are. This has led to revenue generating schemes by the island governments in the form of fishing licenses and access agreements.

Over the years the abundance of tuna congregating in or migrating through the Kiribati EEZ has attracted many foreign fishing fleets, mainly to fish for skipjack, yellowfin and bigeye tuna. Fleets from the USA, Japan, South Korea, Taiwan and the USSR have fished in Kiribati waters.

In the early 1980s, several Japanese pole-and-line vessels were based in Kiribati, targeting skipjack tuna (*Katsuwonus pelamis*). With backing from the Japanese government in the form of aid, the Kiribati Fisheries Division eventually set up a domestic fleet of their own to carry out pole-and-line fishing.

A state owned fishing company, Te Mautari Ltd, was established in 1981 with the services of two Japanese-type pole-and-line vessels, which eventually increased to six pole-and-line vessels by 1989. Skipjack pole-and-line fishing was carried out successfully around the Kiribati group and when the skipjack season slowed the Te Mautari vessels did excursion trips to Fiji, and later to the Solomon islands (SPC 1993). The company performed well until the early 1990s when vessel maintenance, operations costs, and the company's overall performance failed, resulting in heavy losses that forced the company to look at other avenues of generating funds. More recently, Te Mautari has been focusing on tuna longlining. This switch has been bolstered by a grant-in-aid from Japan to develop tuna longline fishing.

In 1995 Teikabuti Fishing Co Ltd of Tarawa equipped an FAO designed 9.5 m outrigger canoe with a four-mile hand-hauled longline (Kaneko and Savins 1995). Some bigeye and yellowfin tuna were exported to the Sydney Fish Market where they fetched prices averaging AUD 12.00/kg.

Tuna longline fishing mainly targets yellowfin (*Thunnus albacares*) and bigeye tuna (*T. obesus*) although albacore tuna (*T. alalunga*) is caught in higher latitudes. In earlier years large Japanese, Korean and Taiwanese longliners (DWFN) have fished the Pacific for tuna using vessels that were equipped with large freezers, that could carry anywhere between 100–400 t of fish. A considerable number of these vessels still fish in Kiribati waters under bilateral arrangements.

The current trend is to get into small to medium-scale domestic tuna longline operations that would target the overseas sashimi markets. These operations are easier to manage and can be lucrative if quality fish can be landed and exported.

1.2.2 DWFN tuna longline effort and catch

Kiribati waters have produced longline catch rates for the three major tuna species that show the fishery to be economically viable. SPC's Occasional Paper No. 10 (Klawe 1978) reports estimates of longline catches of tuna and billfish by Japanese, Korean, and Taiwanese longliners from within the EEZs of SPC member countries and territories. The data is summarised in 5º squares (5º latitude by 5º longitude) so does not correspond exactly with EEZ boundaries. The years covered by the report are 1972 to 1976 (data for Korea covers only 1975 and 1976). Kiribati is listed as Gilbert Islands in the report. Weight is given in kg and effort in number of hooks. Catch per unit effort (CPUE) estimates are fairly simple to estimate, using Klawe's data.

For 1972, for example, the combined Japanese and Taiwanese effort in the Gilbert Islands EEZ (Kiribati) was 16,274,635 hooks, and catch of all species of tuna and billfish was 14,309,992 kg. CPUE for 1972 was, therefore, 88 kg/100 hooks. A breakdown by the three main target species (bigeye, yellowfin, and albacore) gives the following CPUEs: bigeye—29.9 kg/100 hooks, yellowfin—42.9 kg/100 hooks, and albacore—7.6 kg/100 hooks. Interestingly, over eight tons of northern bluefin tuna (*T. thynnus*) were also caught that year by the combined fleets in the Gilbert Islands EEZ.

CPUEs in kg/100 hooks from other years, based on Klawe, are as follows:

- 1973: bigeye—26.9, yellowfin—25.6, albacore—11.5,
- 1974: bigeye—30.5, yellowfin—17.3, albacore—2.4,
- 1975: bigeye—38.7, yellowfin—16.2, albacore—4.3, and
- 1976: bigeye—33.6, yellowfin—28.7, albacore—4.2.

The combined CPUE for all tuna and billfish for the five year period of Klawe's data is 70.8 kg/100 hooks (46,161,111 kg caught on 65,181,492 hooks).

CPUEs were extracted from SPC's database (Lawson pers. comm.) for the Gilbert Group only for the years 1978 to 2000. During that 23 year period the combined Japanese, Taiwanese, and Korean fleets fished a total of 39,390 days, setting 95,025,633 hooks. This amounted to an average daily effort of 2,412 hooks for each boat. CPUEs for the three main target species were: bigeye—19.7 kg/100 hooks, yellowfin—32.8 kg/100 hooks, and albacore—0.58 kg/100 hooks. The CPUE for all fish was 56.9 kg/100 hooks.

1.2.3 SPC fisheries projects in Kiribati

Three SPC Masterfisherman projects were conducted from Tarawa in the last two decades. In 1980, Masterfisherman Pale Taumaia conducted deep-bottom fishing trials as part of SPC's Deep Sea Fisheries Development Project (Taumaia and Gentle 1983). A total of 18 fishing trips were made in three different areas using three Fisheries Division boats equipped with Samoan-style wooden handreels. Fishing was conducted around Tarawa, Maiana, and Kuria. A total of 998 reel-hours resulted in a catch of 7176 kg of saleable fish for a CPUE of 7.2 kg/reel-hour. One of the identified constraints to development of a commercial deep-bottom fishery based in Tarawa was the problem with marketing the catch. Local markets could easily become saturated and export opportunities were limited. The problem was further compounded by the fact that the largest percentage of the catch consisted of the unmarketable red snapper (red bass—*Lutjanus bohar*), which has been implicated in cases of ciguatoxicity, and the relative scarcity of the high value *Eteline* snappers.

Masterfisherman Pale Taumaia visited Kiribati again in 1984 on two occasions to conduct further deep-bottom fishing trials and training (Taumaia and Cusack 1997). This time fishing trials were conducted around Tarawa, Abiang, Abemama, Arorae, and Tamana atolls using an aluminium *alia* catamaran, a KIR-1 sailing canoe, a KIR-2 sailing canoe, and a KIR-3 canoe with outboard motor. All of the boats were equipped with handreels and trolling gear.

A different fishery was looked at during 1989 and 1990. SPC Masterfisherman, Paxton Wellington (Wellington in press), conducted a small-scale tuna longlining project from a fibreglass outboard skiff using basket longline gear. Wellington made 30 sets totalling 3789 hooks. The total catch of all species was 139 marketable fish weighing 3035 kg. The CPUE for all species was, therefore, 3.6 fish per 100 hooks or 80 kg/100 hooks. Almost half of the catch by weight and numbers was yellowfin tuna (*T. albacares*). The average size of the yellowfin tuna was 20.3 kg. Sharks accounted for almost 50 per cent of the catch by weight. Wellington tried a variety of baits including fresh and frozen milkfish (*Chanos chanos*) and saury (*Cololabis sauri*). It was concluded that the fresh milkfish outfished the frozen milkfish but that the saury outfished the milkfish by a factor of two to one. He concluded that the project vessel was too small for any kind of commercial operation and that a 10–12 m boat would have a better chance. He also warned that anyone starting up a longline venture in Kiribati would have to look carefully at market opportunities and infrastructure before committing funds.

1.3 Initiation of the project and the objectives

The growing interest within the Pacific region by island governments to develop their own small to medium-scale tuna longline fisheries prompted the Kiribati Fisheries Division to look at alternatives other than issuing fishing licences to foreign tuna vessels. The focus settled mainly on the development of small-scale tuna vessels that would encourage local fishermen to become involved in the tuna longline industry. The industry would be directed at supplying fresh tuna to overseas markets.

The initial concept for an outrigger canoe design was introduced in an Asian Development Bank (ADB) technical assistance report (Kaneko and Savins 1995). Two designs were proposed for the development of small-scale longline fishing: an 11 m catamaran, the KIR 11, and a 12 m outrigger, the KIR 12. Kaneko and Savins provided a financial analysis of a small-scale commercial export longline fishery based on assumed operating parameters of the KIR 12. They projected that the original loan for purchase of boat and equipment (totalling AUD 63,470) would be paid off in eight years at 12 per cent interest. This would be accomplished by making two trips per month of two to four days duration, catching 6531 lbs (2968 kg) of fish valued at AUD 8060. Each longline set would be 500 hooks. Trip operating expenses would be AUD 5100, leaving a net of AUD 2960 after each trip. The catch would be comprised of 1500 lbs (681 kg) of bigeye tuna, 2800 lbs (1273 kg) of yellowfin tuna, and 2231 lbs (1014 kg) of bycatch. Per trip operating expenses included AUD 900 for ice, AUD 1600 for bait, AUD 130 for fuel, AUD 400 for provisions, AUD 500 for shore support, and AUD 1070 for transshipping costs. (CPUE based on their assumptions, would be 198 kg/100 hooks for a two to four day trip—three days fishing.)

Based on the findings of Kaneko and Savins, and the desire of the Fisheries Division to develop small-scale tuna longlining in Kiribati, the construction of an 11.8 m twin-hull vessel was undertaken. While the vessel was under construction, the Kiribati Fisheries Division requested technical assistance from SPC's Fisheries Development Section to assist with the layout of fishing equipment on the vessel, and the fishing side of the operation. Preparations for the project were initiated in Kiribati in November 1998, with the main objectives for the project being:

- to work with the staff of the Fisheries Division on their new tuna longline vessel F/V *Tekokona II*, to assist with longline fishing gear construction and installation of the monofilament longline system and vessel electronics, and to conduct fishing trials;
- to train Fisheries Division counterpart staff and interested local fishermen in the different aspects of tuna longlining;
- to make an assessment of the vessel as to it's suitability as a longline vessel;
- to train crew and other local fishermen on the correct on-board handling and processing practices for tuna and other pelagic species;
- to keep records of the fishing effort and catch, revenue from fish sales, and all operating expenses;
- to collect any additional data required by the Fisheries Division;
- to assist with trial export shipments of fish; and
- to provide a written report of all activities.

In all, four visits were made by SPC Fisheries Development Officers. FDO Steve Beverly spent two weeks in December 1998 and six weeks in April — May 1999, and FDO William Sokimi spent six weeks in February — March 2000 and six weeks in November — December 2000. A total of 4.6 man-months were invested in the small-scale tuna longline project, to meet the above objectives.

2. PROJECT OPERATIONS

Many problems were encountered with this project, so it was decided to split the project into three phases. Phase I focused on the gear construction and the fitting out of the project vessel, with this work conducted from 2–17 December 1998, and 18 April to 24 May 1999. Phase II of the project (10 February to 23 March 2000) focused on the fishing trials, training of the crew in fishing activities and an initial assessment of the vessel. Phase III of the project (31 October to 14 December 2000) focused on fish quality and exporting trials. The report of the project was compiled in early 2001.

2.1 The project vessel, F/V *Tekokona II*

The design for the outrigger longline vessel was modelled on the Kiribati outrigger canoe, although it is much larger, is decked, and has a wheelhouse. The outrigger hull is shorter and shallower in draft than the main hull (Figure 3). This would allow the main hull to be loaded down before it levelled off with the outrigger. A continuous deck similar to that of catamarans joins the two hulls. The vessel was designed by Oyvind Gulbrandsen and built at the Betiraoi Boatbuilding yard in Abatao, North Tarawa by master boat builder, Mike Savins. Mr Savins has had a long association building Mr Gulbrandsen designed artisanal fishing boats, which includes several models that were specifically designed for Kiribati — the KIR 6 (6.5 m) two man canoe, the KIR 7 (7.1 m) sailing canoe, and the KIR 4 (7.2 m) motor/sailing canoe (Gulbrandsen and Savins 1987).

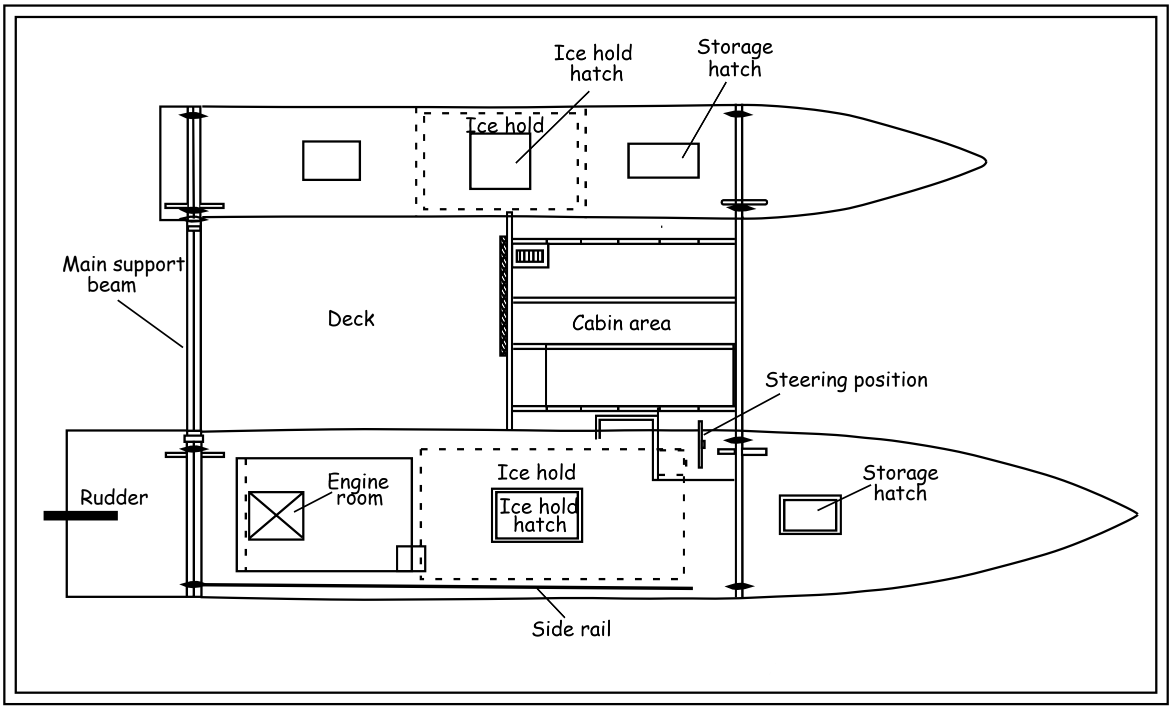

Figure 3: Plan view of F/V Tekokona II *showing hull configurations*

This new design is called the KIR 12 (11.8 m — F/V *Tekokona II* — Figures 4 and 5), and was powered by a three-cylinder, 39 HP, hand-crank Yanmar diesel engine. Appendix A provides the specifications for the KIR 12 and engine. Besides being the vessel's propulsion system, the engine also drove the hydraulic pump, alternator, and general service pump. The vessel was also equipped with an aluminium monofilament longline reel. Wheelhouse electronics and safety equipment included radar, GPS, echo-sounder, SSB radio, VHF radio, compass, EPIRB, lifejackets, liferings, fire extinguishers, and liferaft. There were two fish holds, one in each hull. The main hull fish hold had an approximate capacity of 0.9 t, while the outrigger held around 0.6 t. Crew complement was three to four, including the captain.

Figure 4: F/V Tekokona II *viewed from the front*

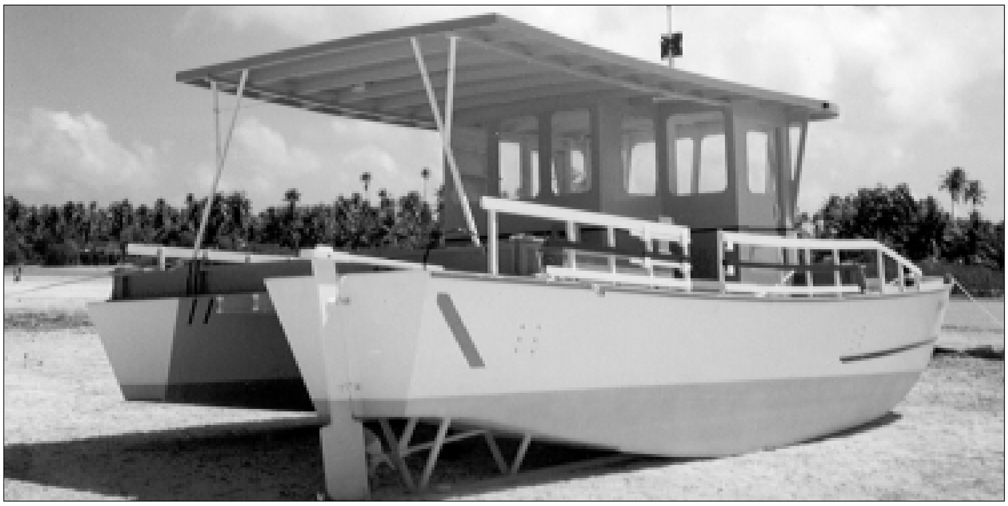

Figure 5: F/V* Tekokona II *viewed from the stern

2.1.1 Monofilament longline system

A hydraulically-powered aluminium longline reel was fitted to the project vessel during the latter stages of Phase I, including the installation of the hydraulic system. The reel was manufactured by SeaMech Limited in Fiji, and could hold 15 nm of 3.0 mm monofilament. The reel was mounted directly behind the cabin facing aft, with blocks positioned to guide the mainline over the stern for setting, with different block positions to guide the line back onto the reel during the hauling operation.

2.1.2 Fishing gear

During the Phase I period, the fishing gear was constructed and kept in readiness for future fishing trials. This consisted of all the deck gear with the exception of the reel and mainline.

Forty floatlines were made from 6.4 mm tarred mainline. These were 30 m in length with an eye splice and swivel snap on opposite ends of each line. Forty floats were rigged with a short length of tarred line (40 cm) with a snap attached to each line.

Five flagpoles with Polyform buoys were constructed (Figure 6) to be used as high flyers in intermediate marking positions. Four hundred and eighty branchlines were made from 2.0 mm clear monofilament line and 60 gram leaded swivels. No trace wires were used. The branchlines were 12 m long with the leaded swivel attached 1 m from the hook. The hooks were all No. 3.6 Japan tuna hooks. Branchline bins were constructed from galvanised wire mesh (Figure 7) and held 240 branchlines each — 120 hooks in a row with two rows.

Figure 6: Making up five flagpoles with Polyform buoys

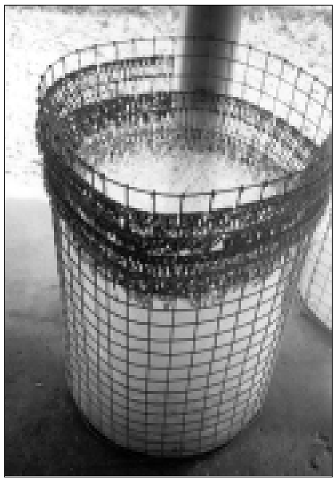

Figure 7: Branchline bin constructed from wire mesh, with branchlines

2.2 Trip preparations

Preparing a vessel for a fishing trip is as important as carrying out the fishing operations itself. Careful consideration was given to the details of each trip so that once the vessel had left port, fishing operations were carried out without hindrance. Appendix B provides several checklists for the engine room, deck gear and fishing gear, which should be worked through before departing on each trip, with some of the main factors considered in preparing the F/V *Tekokona II* for sea being:

- careful planning of the trip, taking into consideration the number of fishing days, number of steaming days, and the choice of fishing ground;
- ensuring that sufficient crew were taken on the trip so that a consistent operation could be carried out without over-crowding or under-manning;
- ensuring that all electronics and machinery were in good working order;
- checking the tool box for all the necessary tools to deal with mechanical problems;
- checking all life saving and sea survival gear;
- ensuring that victuals were sufficient for the full voyage;
- topping up the fresh water tank;
- checking cooking appliances and cooking gas;
- checking bait, ice, fishing gear, fuel, filters, main engine lubricating oil and hydraulic oil; and
- checking the weather bulletin.

2.3 Choice of fishing area

Within the Kiribati EEZ there are many rich fishing grounds to choose from. There are many reasons for choosing fishing grounds, although with the project vessel being a prototype design and these were the initial trials, it was decided to be prudent and remain within a reasonable distance of the islands. Adverse weather conditions prevented the vessel from venturing far from the islands. The western side of the islands was the leeward and protected area, and also had a more direct route to and from port. The choice of fishing grounds was therefore limited to the western side of Tarawa and Abaiang Islands, except for trip four during Phase II when fishing was attempted 40 nm to the east of Tarawa.

Oceanographic conditions were also considered. Eddies, formed around 15 nm west of Buariki. Tarawa almost always lies under the influence of the South Equatorial Current, with westerly sets and currents of 1.5–2.0 knots. Persistent westerly winds, which can occur between December and April, may cause easterly sets (Anon 1964). In choosing fishing grounds to the east of the islands, the ‘current’ factor had to be carefully considered. With a rate of up to 2 knots, the gear can travel 24 nm in the 12 hours soak time that it is in the water. A vessel will need to travel well to the east of the islands to avoid the line getting washed up on the reef. During one trip at the commencement of the trials, the line was caught on the bottom and had to be abandoned.

2.4 Bait

The project vessel was supplied with milkfish from the Fisheries Division’s ‘Teimaiku Intergrated Fish Farm’ for all fishing trials. The bait sizes taken each trip ranged from 80–100 grams. Bait that was heavier than 100 grams was angle cut around the centre of the fish and both pieces attached to hooks. Whole pieces of bait were hooked through the head (Figure 8). The head cut pieces were hooked the same way as for whole bait fish, while the cut tail piece were hooked on the extreme end of the bait, opposite the tail end (Figure 9).

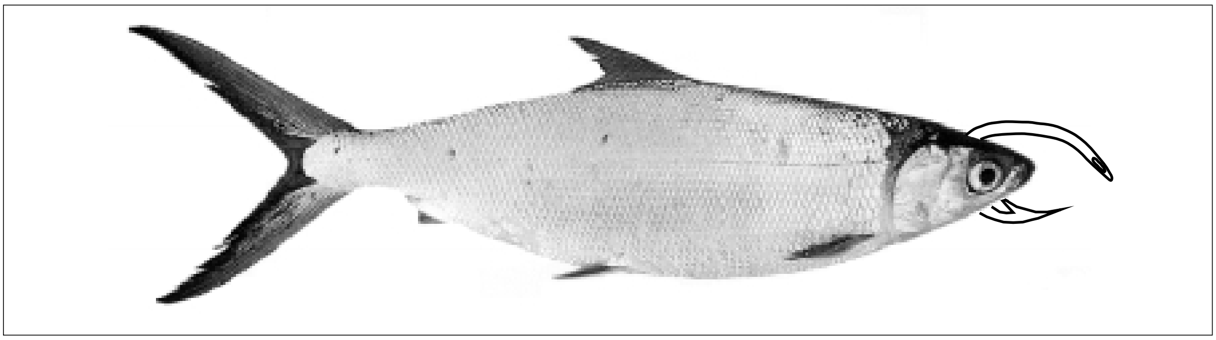

Figure 8: Placement of the hook in the head of a milkfish bait

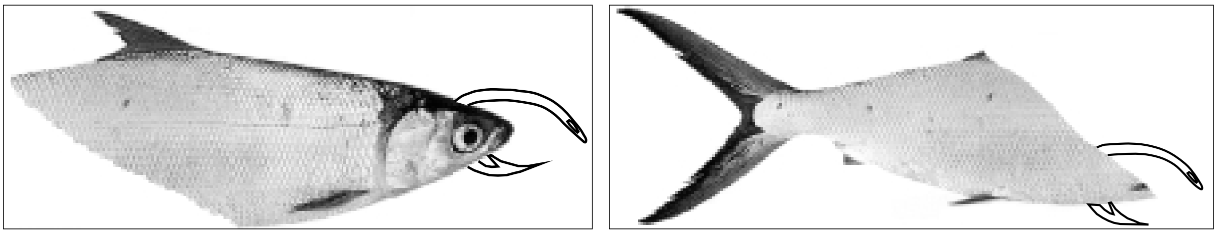

Figure 9: Placement of the hook in angle cut milkfish baits

Milkfish bait proved to be effective for tuna longline fishing. Average soaking time at the beginning of the trials was around 8 hours. This was reduced to 5.5 hours in later sets. During this soak and hauling period, more than 90 per cent of the bait remained on the hook. Upon retrieving the branchlines and discarding the bait, most of the milkfish still maintained its firmness and shiny colour. The majority of fish catches were done during 'trolling while hauling' and resulted in live fish being landed. This is an indication that the bait was still effective after 5–8 hours of soaking time.

2.5 Longlining method

During the ten sets carried out in Phase II, four variations of hooks per basket were used at different times. These were 18, 21, 23 and 30 hooks per basket. Vessel speed was maintained throughout the 10 sets at 6–7 knots, with the wind on the port quarter. Hook spacing was set at 40–50 m between hooks. Wind direction varied from southeast to northeast throughout the ten sets.

The variation in the number of hooks per basket was implemented, not only to locate a suitable fishing depth, but also to test the durability of the 39 HP Yanmar diesel engine with various loads, to find its optimum performance level.

Setting took from 1.5–1.75 hours, and hauling took between 5 and 7 hours. In all the sets carried out, the sections with 30 hooks between floats proved to be the most successful in fish catches, compared to the other hook spacings.

F/V *Tekokona II* does not have a line shooter to assist in setting the mainline deep. During Phase III, bigeye tuna were targeted for export trial purposes. Without a line shooter, the line settling depth depended mainly on the weight of the leaded swivel on the branchlines, length of branchlines, length of floatlines and the collapse of the line due to the effect of the current. The curved (or zigzag) track of the vessel during line setting also assists in getting the line to a deeper depth.

2.6 On-board handling of the catch

One crew member was fully assigned to deal with fish preparation and preservation on ice. Once the fish was gaffed and lifted aboard, it was clubbed then carefully lifted to the area designated for gilling and gutting. Here the fish was spiked and bled. The *taniguchi* method was then applied by running a monofilament line through the soft spot area behind the eyes, and down the spinal cord of the fish. When the fishes' nerves had been neutralised, gilling and gutting was carried out.

Gilling and gutting of all tuna was done by cutting around the anus and severing the intestine connection at this end. No longitudinal cuts were made. The gill attachments were then severed and gills and guts were removed through the gill cover. Thorough cleaning of the gill cavity area and fish body was then undertaken in preparation for icing.

When fishing was slow, all fish landed were quickly gilled and gutted and iced properly. When several fish were landed in a short time, any fish gilled and gutted were placed in the ice hold until a slack period. Then the hauling operation was postponed while the processed fish were thoroughly iced. Once that was done the hauling operation continued. Because of the congested layout of the fish hold, transfer of fish to the fish holds for thorough icing could not be carried out when fish were continuously coming aboard. To do this would result in several hauling operation hold-ups and continuous loss of cold air due to longer periods of having the hatch open.

3. PROJECT RESULTS

Many problems were encountered during the different phases of this project. Many of the problems were associated with purchasing materials and equipment for the project vessel from overseas, the remoteness of Kiribati, and the limited air cargo space available on incoming flights. These problems were mainly encountered during Phase I of the project.

3.1 Modifications made to the project vessel

Extremely poor weather conditions were experienced throughout the Phase II trial fishing period with very rough seas and winds between 20 to 25 knots blowing consistently. Although the weather during the Phase III period was moderate, unforeseen mechanical problems developed that prevented the Fisheries Development Officer from completing any of the three trips attempted.

3.1.1 Hydraulic system

The vessel's hydraulic system is powered by a Permco, P–3000 pump with a 12-volt electric clutch. The pump is mounted on a bracket connected to a strengthening rib on the vessel's shipside bulkhead, and is belt driven off the main engine. Initially, a 20 litre tank was mounted in the engine room to hold the hydraulic fluid for running the system. The hydraulic oil passed through stainless steel keel cooling pipes to cool the hydraulic oil in the system. This enabled the hydraulic oil to leave the tank direct to the pump and return through the keel cooling pipes.

The hydraulic keel cooling pipes have constantly been exposed to salt water and air from being submerged at high tide and sitting dry at low tide (Figure 10). This has led to a rapid deterioration of the keel cooling pipes requiring the pipes to be changed after only two years. In addition, it was noticed that the hydraulic system tended to heat up to 90–100° C before the hauling operation was completed.

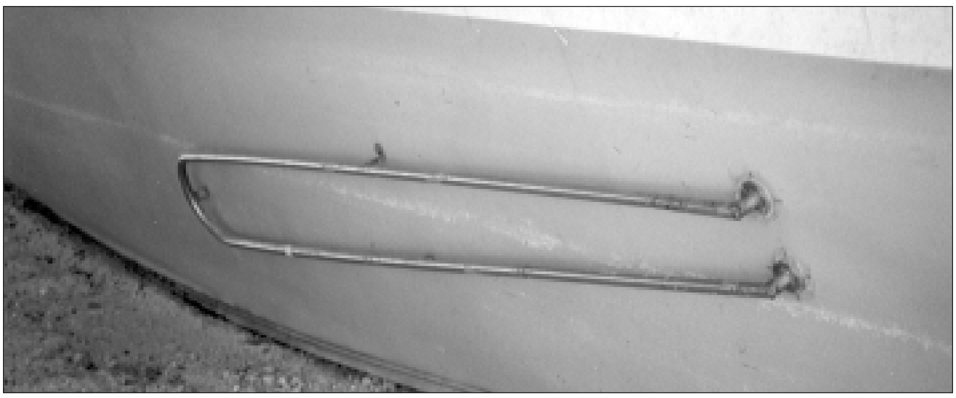

Figure 10: Keel cooling pipes on F/V **Tekokona II**

During the installation of the repaired system, it was decided by the OFCF engineer consultant to change the pipes from 2 mm gauged stainless steel pipes to 5 mm gauged galvanised pipes, and the hydraulic oil holding tank was increased to a 100 litre capacity. This showed a marked difference in the trials after the repairs. The system temperature remained at 40–60° C throughout the entire hauling operation. The new system can also be operated without the keel cooling. A valve was installed in the engine room to permit the keel cooling line to be shut off, directing the flow of hydraulic oil through the pump, to the reel and back to the tank. The bigger tank is sufficient to ensure that the operation can be operated without overheating. This is especially important if the keel cooling line develops a leak.

3.1.2 Engine room, mounting bracket and V-belt pulley

The installation of the hydraulic pump in the engine room was difficult, as there was limited space available in which to mount the bracket so that the pump would be in line with the engine drive pulley. The only reasonable solution was to have the bracket mounted on the longitudinal rib on the shipside bulkhead. The bracket itself had four bolts for adjusting the tension of the V-belt. Tightening the V-belt put a lot of pressure on the shipside longitudinal strengthening rib. This constant tensioning and slacking effect on the vessel's shipside bulkhead may lead to cracks or leaks in the engine room joints around the immediate area.

The confined engine room space also prevents easy access to the hydraulic pump and pulley area, should work be required. The exhaust pipes and heated engine restricts a person from working until all has cooled. This was done several times during the trials.

The vessel's engine room was not designed to accommodate an engine the size of the Yanmar 39 HP engine, and to contain accessories such as a hydraulic pump. The present situation has the drive pulley on the main engine barely clearing the forward bulkhead. This poses a lot of difficulty when trying to change the V-belt out at sea, during operations. The clearance is not enough to allow the belt to slide easily through. It has to be knocked and manoeuvred between the pulley and the bulkhead to have it sitting in position for adjustment. The pulley on the hydraulic pump and engine requires a V-belt of size B25.

3.1.3 Engine bed

The third and last trip of Phase III almost resulted in disaster. The starboard aft holding-down bolt of the engine bed had worked itself loose, and slipped through the hull allowing water to rapidly fill the engine room. The problem was quickly eased by screwing in a bolt half the length and slightly wider in diameter, as this was all that was available. This enabled the intake flow of water to be reduced but did nothing for securing the bed from moving, causing the engine to wobble during passage back to port. The danger in this is the wear and tear on the shaft 'boss' area, and the danger of having the engine breaking off its remaining securing bolts on the return trip.

After the first trip of Phase III, it was noticed that the engine room was shipping more water than usual. This was attributed to the gland packing being loose. It was then tightened so that sufficient water was dripping through to cool the shaft. While out at sea during the second trip the problem persisted but not to an alarming level. A full check of the engine room was conducted but no visible sign was detected. The bolts holding the engine in place were still doing so rigidly. Problems persisted through out the trip in trying to keep the hydraulic drive belt in proper tension so the vessel returned to port and engineers were called to rectify the problem. The engine was re-aligned with the hydraulic pump and the consequent tests were perfect.

When the engine was re-aligned only the bolts holding the engine to the engine bed were adjusted to get the engine in line. At this time the adjustment was sufficient to show positive results on the test. However, because the vessel was in port, the vessel was not subjected to swell action. Had this been so, it would have been noticed that the engine had gone out of line again due to the engine bed itself shifting. While all thought was given to checking that the engine bolts were secured to the engine bed, less was given to ensuring that the bed was secured to the ship's bottom.

The current design has the engine secured to an engine bed, and the engine bed bolted down to the ship's bottom using full thread 20 mm bolts with nuts and washers on both ends. The top ends of the aft bolts are hidden under the engine room deck flooring and the nuts on both ends do not have a locking mechanism in place. Since the bolts are full thread and not the type with a flat head on the top end, there will exist a strong possibility of the top or bottom nut working itself loose during operations and thus a reoccurrence of the same problem could occur. Therefore, regular checks should be made to ensure any loosening of these bolts is detected, with them tightened as needed.

3.1.4 Engine power

Using the 30 hook spacing between floats during rough seas with heavy swells and strong head winds (about 25 knots), the vessel's engine could not increase engine revolutions to meet the load. At times, the engine showed signs of stalling. When this happened, hauling had to be stopped to allow the engine to pick up revs and move forward to ease the tension on the line. The hydraulic pump itself was more than sufficient to deal with the workload.

In slight to moderate seas with 10 to 15 knot head winds, the 30 hooks between floats did not result in too much of a problem until extra load was put on the line by fish being caught (three fish weighing a total of 60 kg was enough to effect the engine power). This again caused the engine to show signs of being overloaded.

The 18 to 23 hook spacing between floats did not cause the engine to overload and was faster to haul up. Observations during the four trips showed that these hook spacings did not produce good catches though. The only real solution to this problem is to either stick to shallower sets (less than 23 hooks between floats) or to re-power the vessel with a more powerful engine that will allow deeper sets to be made in moderate and heavy weather conditions.

3.1.5 Work deck

The after deck of the F/V *Tekokona II* is spacious and provides a good working platform for line setting as well as for the line hauling operation. The current arrangement for line setting is adequate in that only two people are required to set the line, while a third can tend to steering the vessel. During the hauling operation there is more than sufficient room to work the line retrieving duties as well as the fish processing duties.

3.1.6 Fuel capacity

F/V *Tekokona II* has a maximum fuel capacity of 300 litres. This is contained in a single tank situated aft of the engine room. The tank dimensions are: top length, 97 x 52 cm; height 68 cm; and bottom length 71 cm. (Figure 11). No form of fuel calibration was supplied with the tank. Using the above measurements, a fuel calibration table was configured (Appendix C) and a sounding rod with one centimetre graduations made and used to check the fuel level.

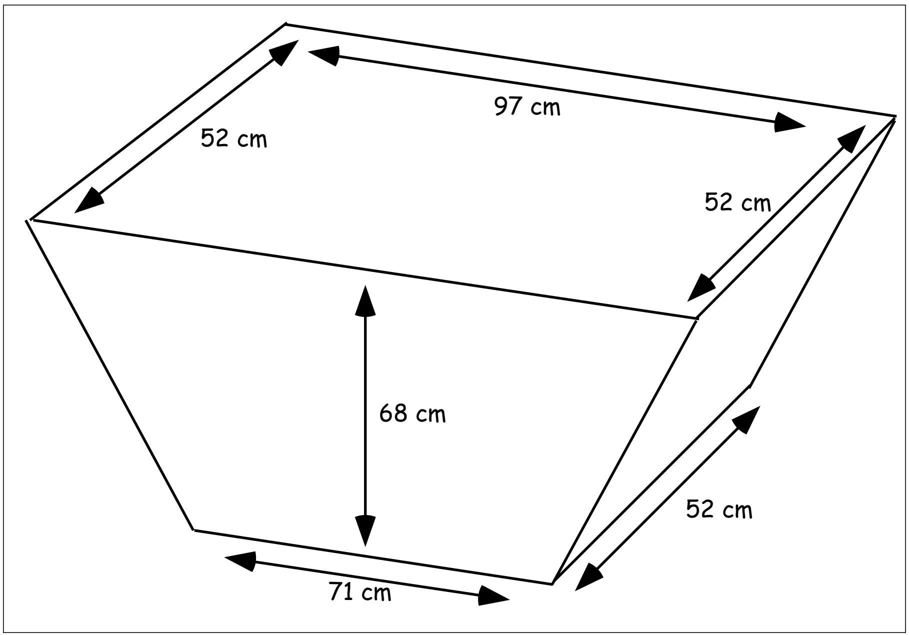

Figure 11: Fuel tank on F/V Tekokona II *showing dimensions*

The fuel capacity is not sufficient to allow the vessel to work too far away from port. To overcome this during the last two trips, extra fuel was carried on board in a 200 litre drum in the hope that the vessel would be able to venture farther, weather permitting.

3.1.7 Relocation of the galley

F/V *Tekokona II* was originally fitted with a kerosene stove, which was mounted in the cabin area. The kerosene stove posed a threat to the vessel's safety requirements and emitted unbearable carbon fumes. During bad weather, the crew would prefer to go without a hot meal in exchange for cooler living quarters and no fumes. Therefore, the kerosene stove was replaced with a two-burner gas stove.

The location of the new gas stove and the whole galley was also moved out of the cabin and accommodation area, to increase crew comfort. A cupboard-like structure was constructed in the port-aft section of the wheelhouse superstructure to contain several shelves and a storage area for the gas cylinder. One of the shelves was designed to hold the gas stove and allow the cooking pot to sit, while the other shelves held the cooking utensils and other galley items (Figure 12). The walls around the stove area were lined with stainless steel to reduce the chance of fire and for ease of cleaning. This arrangement suited the crew and worked perfectly in all weather conditions.

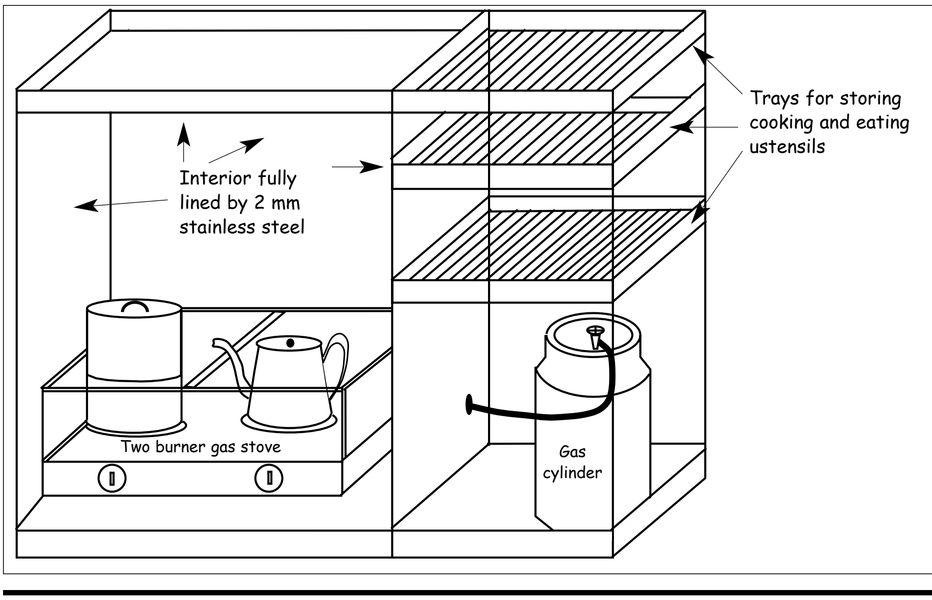

Figure 12: New galley design on the project vessel

3.1.8 Extra Bunk

An extra bunk was constructed in the accommodation/wheelhouse area. Previously only two bunks were constructed on the aft bulkhead of the superstructure and the forward bench was designed as a folding bed. The bottom half of the lower aft bunk was extended to form an extra bunk thus allowing four bunks for the crew to rest in.

With the galley section relocated, the accommodation area was utilised explicitly for navigation, steering, storing food and equipment, and resting.

3.1.9 Hauling block davit

The original position for the hauling block davit was unsuitable for prolonged hauling operations. In this position, the block was behind the hauler, thus requiring this person to constantly look backwards or to swivel round in the seat and operate the vessel in an unnatural sitting position. The vessel's steering wheel is in a forward facing position, the line leading up to the block leads from forward to aft, therefore the natural sitting position should be facing forward.

The hauling block davit was moved one metre forward from its original position, to allow the person steering the vessel to glance sideways at the line being hauled in. It would have been preferable to have positioned the block another 0.5 m forward, but the arrangement on the vessel did not provide enough space to do this.

3.2 Results of fishing activities

The SPC Fisheries Development Officer conducted four fishing trips (10 sets) during Phase II and three trips (5 sets) during Phase III, to assess the performance of F/V *Tekokona II* as a potential small-scale tuna longline vessel. The Kiribati Fisheries Division also conducted six trips of their own as a follow through on the trials. One trip was done before Phase II and five trips between Phases II and III in the absence of the SPC Fisheries Development Officer. Appendix D summarises all tuna longlining activities on F/V *Tekokona II* by set and trip.

During Phase II, 4185 hooks were deployed in 10 sets over four trips. The total catch of saleable fish was 68 fish weighing 1790.5 kg. CPUE for this phase was 42.8 kg/100 hooks. The three trips (5 sets) in Phase III resulted in a catch of 19 saleable fish weighing 700.5 kg, with 1934 hooks deployed. The CPUE for Phase III was 36.2 kg/100 hooks. Combined, 6119 hooks were deployed over 15 sets resulting in a catch of 87 saleable fish weighing 2491 kg. The combined CPUE was 40.7 kg/100 hooks.

The six trips conducted by the Kiribati Fisheries Division resulted in a total saleable catch of 2737.9 kg from 75 fish, with 3400 hooks deployed over nine sets. The CPUE for these trips was 80.5 kg/100 hooks. If all fishing activity is combined, 9519 hooks were deployed over 24 sets resulting in a total saleable catch of 5228.9 kg from 162 fish. The overall CPUE was 54.9 kg/100 hooks.

Yellowfin tuna was the most predominant species in the total saleable catch, with 90 fish (55.5% by number) weighing 2658.2 kg (50.8% by weight). Unfortunately, only 11 bigeye tuna (6.8% by number) weighing 508.1 kg (9.7% by weight) were taken during the fishing trials. The low catch of bigeye was attributed to the problems encountered when trying to do deep sets, resulting in mainly shallower sets being undertaken. Appendix E provides a breakdown of the species caught during the project by number and weight, while Appendix F provides the percentage make up of each species in the catch by number and weight.

3.3 Marketing of the catch

All of the catch during Phase II of this project were sold on the local market. During Phase III, one trial export shipment was made, with the balance of the catch sold on the local market.

3.3.1 Local fish sales

All saleable fish were recorded as gilled and gutted weights, while whole weights were used for the unsaleable catch. All fish were sold on the local market at AUD 1.50/kg except for the last trip when fish sales worked out to AUD 1.32/kg. Two large bigeye tuna were exported from the catch of the last trip, and this is discussed more in the next section. Saleable species included bigeye tuna, yellowfin tuna, albacore tuna, mahi mahi, skipjack tuna, blue shark, bigeye thresher shark, oceanic white tip shark, black tip shark, wahoo, swordfish and barracuda.

The procedures for offloading and shore processing undertaken during the project were done under rudimentary conditions. Upon anchoring the project vessel offshore, the fish were transferred to an open skiff (Figure 13) and transported 20 m ashore to a tarpaulin-covered long-back truck (Figure 14). Here, the fish were again transported another 100 m to the Teimaiku fish farm facility where the fish were weighed, measured, processed (cut unto chunks) and sold. The facility itself was not designed as a shore processing facility, and the full operation was done under direct sunlight in an exposed area (Figure 15). The Fisheries staff were fully aware of the requirements for onshore processing, but because of the unavailability of a proper complex on the island, fish processing had to be done in this way during the project, targeting the local market only. Because fish is one of the major foods in the I-Kiribati diet, the sale of fish at Teimaiku would be over within an hour or two.

Figure 13: Unloading the catch to a skiff to run ashore

Figure 14: Unloading the catch from the skiff to a truck to transport to Teimaiku fish farm

Figure 15: Processing the catch in open conditions for local sale

3.3.2 Export marketing trial

Construction was underway to establish a better fish processing and storage facility at the wharf area in Betio, which was scheduled to be operational by mid 2001. For this reason it was decided that this project be used to demonstrate and guide the appointed fisheries staff through the processes leading up to exporting fresh tuna, possibly to Hawaii in the first instance. It was also decided that Japan not be used as a destination just yet, while the training process was underway, because of the lack of proper facilities. Only when the proper facilities are in place and the staff are fully confident of producing high grade, quality tuna, will the Japanese market be tried. This is to reserve a place in the future for Kiribati to build a reputation for providing high grade fresh tuna. The Japanese market can be very touchy in this aspect. Once tuna from a country is found to be suspect the Japanese buyers tend to be cautious in dealing with operators from that country for long periods.

One shipment was attempted towards the end of the project in which two bigeye tuna weighing a total of 112 kg (54 and 58 kg) were exported to Great Pacific Seafood Limited in Fiji. The company was appointed to market the fish from Fiji to its Hawaii market and to provide the Kiribati Fisheries Division with a report on the fish status at its destination. Meanwhile, selected fisheries staff were to familiarise themselves with the activities and paperwork involved. The shipment of the two tuna was meant as a non-profit practice exercise.

Much care was taken by the crew in keeping the fish iced all the way to the processing area. This was difficult under the current conditions in Kiribati, and most fish would only be good for local consumption, as the fish most likely would not stand up to the temperature/time period it takes to get to an overseas market. The preferable conditions and requirements for fish processing would be to have the fish in a chilled medium throughout its transition from the fish hold to the packing box.

When fish is required to be carted a distance it should be done in a slurry box. Offloading of fish in Kiribati should preferably be carried out at night when the temperature is cooler. At the processing table, clean, chilled water should be used to hose the fish down during cleaning. This can be achieved by rigging up a slurry box next to the main water outlet and have the hose running through the ice slurry. In this way, warm tap water enters the slurry box through copper pipes and chilled water exits (Figure 16).

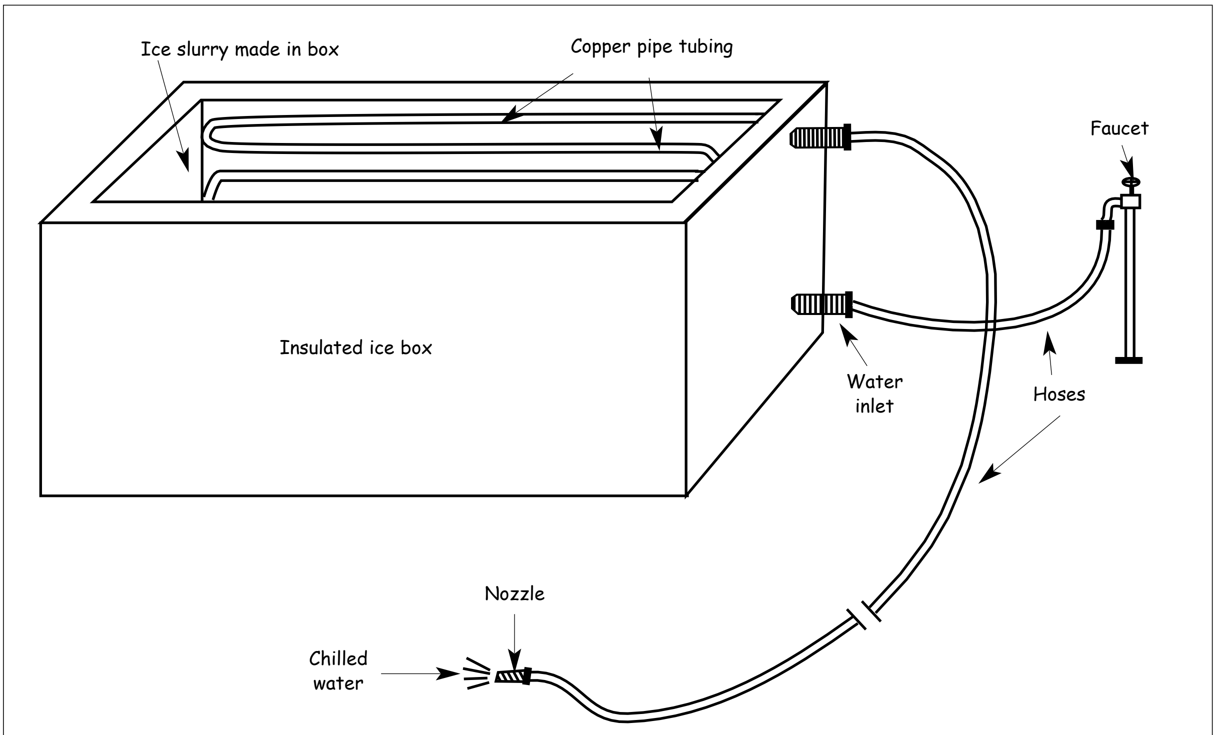

Figure 16: Slurry box arrangement to chill water for processing and washing-down export tuna

From the processing table, the fish should be packed with gel-ice packs (0.7 kg of gel-ice to 10 kg of fish) in fish boxes that are insulated and waxed on the inside. These boxes are securely taped up and labelled according to their contents, weight, and destination. Normally around four to five gel-ice packs are used in a box, depending on the size of the fish and the distance to its destination.

The fish boxes and insulation used during the Phase III export trial were obtained from Te Mautari Fishing Corporation. The boxes were leftover from an earlier tuna longline project attempted by a Hawaii-based company. The project was cancelled and several pieces of equipment were given to Te Mautari. The labelling stencils on the boxes were blanked off for use during the trial shipment.

Project staff were shown how to construct boxes out of the cardboard sheets and the method of inserting the air bubble and plastic insulation linings (Figure 17). The ice used for transporting the fish in the cartons was made from fresh water ice blocks. Fresh tap water was put in thick plastic bags, then sealed and stored in deep freezers. Most airlines insist on the use of gel-ice in fish export boxes as these do not drip during the melting stages. Gel-ice could not be used during this project, as there was none available on the island.

Figure 17: Assembled carton with insulation and plastic liners

The only airline connecting Kiribati to major overseas destinations is Air Nauru which has one Boeing 737–400 series jet that is serviced and maintained in Australia. The airline connects Tarawa to Nauru, Fiji (Suva, Nadi), Australia (Brisbane, Sydney and Melbourne), FSM (Pohnpei), Guam, and Manila in the Philippines (http://www.airnauru.com.au).

After packing (Figure 18) the next step was to transport the boxes to the Air Nauru cargo booking office. Here the boxes were weighed and an Airway Bill made out. The packed fish were then returned to the cooler at Teimaiku where it was stored until one hour before the flight departed. (The cooler temperature should be at 0° or –1° C so that the fish box is kept at an ambient temperature that prevents the ice from melting away while maintaining the fish quality.) A copy of the Airway Bill was faxed to the operations manager of Great Pacific Seafood and details of the flight arrangement were listed.

Figure 18: Bigeye tuna being packed into carton for export

One hour before the flight departure the fish was delivered to the cargo terminal and checked in. A sticker indicating the fragile nature and type of cargo was stuck onto the boxes. Care was taken at this stage to ensure that the fish was kept in a cool or shaded area (Figure 19) and that no other cargo was stacked on top of the fish boxes. The airport at Bonriki, Tarawa, does not have a cool storage area so a fisheries staff was always present beside the boxes to watch over them.

Figure 19: Two cartons of fish ready for export from Tarawa to Fiji

As soon as the flight departed, the operations manager of Great Pacific Seafood was faxed and informed of the arrival time of the flight in Fiji. From this stage onwards the care of the fish was left to the appointed agents.

The initial report from Fiji indicated the temperature of the fish was at 4° C when the cartons were opened and placed in a chiller. The next day the fish were assessed, with only one of the fish deemed suitable for export to Hawaii. The second fish was loined in Fiji, with the loins trimmed and vacuum packed for presentation. The prices received for these two fish were not available at the time of writing this report.

3.4 Economics of the fishing operation

One of the objectives of this project was to make an assessment of the vessel as to its suitability as a tuna longliner, through the collection of records on fishing effort and catch, revenue from fish sales, and operating expenses.

3.4.1 Income from fish sales

The average price to buy fish in Kiribati is AUD 1.50/kg, including shark meat. Table 1 summarises the estimated value of the total catch taken on F/V *Tekokona II*, during the fishing trials from January to December 2000. Not all fish was sold, and two fish were exported as a trial, so the average sale price has been used to calculate a total value of the catch. Based on these calculations, the total catch of 5263.5 kg of saleable fish over the 13 fishing trips had an estimated value of AUD 7786.47.

Table 1: Estimated income from fish sales, with AUD 1.50/kg applied to the unsold catch to calculate a total value for the saleable catch

Trip	Landed	Catch sold		Saleable catch unsold		Estimated value of
No.	Weight (kg)	Weight (kg)	Value (AUD)	Weight (kg)	Value (AUD)	total catch (AUD)
1	860.0	0.0	0.00	860.0	1290.00	1290.00
2	324.0	59.0	88.50	265.0	397.50	486.00
3	180.0	59.0	88.50	120.0	180.00	268.50
4	486.1	360.0	540.00	110.5	165.75	705.75
5	822.0	359.0	538.50	458.0	687.00	1225.50
6	635.1	553.0	829.50	82.1	123.15	952.65
7	0.0	0.0	0.00	0.0	0.00	0.00
8	172.8	132.0	198.00	39.8	59.70	257.70
9	678.0	606.0	909.00	67.5	101.25	1010.25
10	397.5	328.0	492.00	69.5	104.25	596.25
11	195.5	58.0	87.00	137.5	206.25	293.25
12	189.0	113.0	169.50	76.0	114.00	283.50
13	323.5	72.0	95.04	244.0	322.08	417.12
TOTAL	**5263.5**	**2699.0**	**4035.54**	**2529.9**	**3750.93**	**7786.47**

3.4.2 Operating expenses for the project vessel

The operating expenses for a fishing vessel in Kiribati are high. Diesel fuel costs AUD 0.70/litre and ice costs AUD 0.30/kg. Bait costs were reasonable at AUD 2.50/kg, as the milkfish bait was supplied fresh from the Teimaiku fish farm facility, which is operated by the Fisheries Division. Table 2 summarises the operating expenses for the project vessel, with a more detailed breakdown of these expenses provided in Appendix G.

Table 2: Summary of operating expenses for F/V *Tekokona II* for all 13 fishing trips

Item	Amount	Value (AUD)
Diesel fuel @ AUD 0.70/litre	2169	1517
Lube and engine oils (litres)	80	230.4
Bait @ AUD 2.50/kg	1124	2810
Ice @ AUD 0.30/kg	11,451	3435
Victuals		1726
Replacement gear		320
Other expenses		100
TOTAL		**10,138.40**

F/V *Tekokona II* was a very economical vessel fuel-wise, although the vessel was deemed to be under-powered when working deep sets. When travelling, the engine can push the vessel at up to 8 knots in slight to moderate conditions at 1100 RPM. Because of the adverse weather conditions experienced during the trials, the engine revolutions were reduced mostly to around 900 RPM when steaming to and from fishing grounds. Total steaming time (engine running hours) for the four trips in Phase II of the project amounted to 231 hours. Total fuel consumption amounted to 797 litres during these trips. Average fuel consumption over the four trips came to 3.45 litres per hour, which is quite economical for a vessel of this type.

3.4.3 Profit/loss of the fishing trials

When comparing the direct operating costs for the fishing trials (AUD 10,138.40) to the estimated value of the total saleable catch (AUD 7786.47), a loss of AUD 2351.93 was realised. This loss partly reflects the adverse weather conditions encountered during the project, the training of the skipper and crew, and the low value of the landed catch in Kiribati. The economics for this vessel could be very different if the vessel was based in Kiritimati, where there is a direct flight to Hawaii for marketing the catch.

More importantly though, part of the loss is attributed to the vessel's limiting factors, such as: the vessel being underpowered which restricts the weather conditions that can be fished and the hauling operation, especially when trying to fish deep; the small fuel carrying capacity that restricts the fishing range and duration of trips; the limited fish hold space and ice carrying capacity, which restricts the amount of catch that can be carried per trip; and the lack of space below deck to greatly increase fuel and fish hold capacity. These limiting factors can be addressed, at least in part, through modifications to the design for future vessels, although making the necessary changes to F/V *Tekokona II* will be more difficult.

It should be noted that the costs presented in Section 3.4.2 are all variable costs. Fixed costs have not been considered at this stage as the project was based on trial fishing and training of crew, rather than trying to operate the vessel under commercial fishing conditions. It is estimated that the wages alone for crew would have been an additional AUD 4644.00 to the project expenses. Therefore care needs to be taken when interpreting these figures, as the vessel itself is a suitable vessel for tuna longlining, although the logistics of operating out of Tarawa are a major constraint, and the vessel has some limiting factors, such as ice hold and fuel capacities.

3.5 Training activities

The Kiribati Fisheries Division provided three full time fisheries staff to be trained in the operation of the vessel and to learn all aspects of a fresh fish tuna longline operation. The Fisheries Division's fishing master was selected as the skipper and head of the team. On all trips, two fishermen from companies in the private sector were invited to observe and participate in the fishing trip. Two different fishermen would be taken on each trip.

The training stages were broken down into five areas: preparing a fishing vessel for a fishing trip, navigation, fishing operation, processing the catch, and marketing. In the first stage, preparing the vessel for a fishing trip, the crew was instructed on the construction and maintenance of all the required fishing gear. Next, they had to carry out tests on all navigation equipment, conduct maintenance on the vessel's engine and hydraulic system, check spare parts, tools, check on all the sea survival and fire fighting equipment, and stock the vessel with fuel, victuals, water, ice and bait.

For navigation purposes, the skipper and crew were required to obtain an advanced knowledge of the use of the vessel's GPS equipment, and to learn chartwork. This enabled them to take full advantage of the equipment. Knowledge of the use of radar was required as a backup to the use of the GPS, especially for lookout reasons and night travel within the lagoon and along the coast. Equally important was a complete understanding of the functions of the vessel's direction finder. This enabled the crew to locate the radio beacons attached to the ends of the mainline.

Fishing operations involved choice of fishing grounds, the methods of setting the line, suitable times to set the line, target species, time to haul the line back in, on board processing, and icing of the fish. The skipper and crew were briefed on the importance of maintaining a schedule so that the fishing trip will result in a successful deployment and retrieval of the appropriate number of hooks.

The vessel's return to port should be based on the flight timetable to market destinations. Here the skipper and crew were briefed on the importance of knowing the exact timing of flights to coincide with their fishing operations and processing plans. The progression of fish processing and marketing dealt mainly with meeting the requirements of the markets and packing accordingly, for example, gilled and gutted fish, fillet, headed or left whole.

On-shore fish processing focussed mainly on having the fish processed according to the buyer's preference, then weighed and packed into proper insulated fish boxes with gel-ice packs to maintain the cool temperature. The skipper, crew, and an appointed Fisheries Officer were led through the functions of processing and packing, checking in the fish at the airline cargo office, storing in a cool room for the night, then transporting the fish boxes to the cargo bay at the airport.

The fisheries personnel were briefed on the necessity of keeping good communications with the marketing agent until the fish is sold and the money transfer arrangements have been met.

4. DISCUSSION AND CONCLUSIONS

Assessing a new prototype vessel is difficult, especially in a remote location like Tarawa in Kiribati, where logistics play such an important part. Therefore, the assessment will be split into two areas, the vessel and fishing operation, and the viability, processing and marketing of catch.

4.1 F/V *Tekokona II* and its fishing operation

The seagoing trials of F/V *Tekokona II* revealed that the vessel could be effective in the Kiribati tuna fishery as a potential small-scale tuna longliner. The vessel is a suitable fishing platform and excellent workspace for conducting tuna longline operations, although the economic viability of this vessel working out of Tarawa is questionable. In view of the fact that the vessel is meant to be an ocean going fishing vessel, several adjustments could be made to the present design that will make it a better fishing vessel in terms of practical on board working arrangements and added safety measures for the vessel's crew.

The construction of the F/V *Tekokona II* is sound and the vessel can be utilised as it is, should an operator wish to do so, but for future designs, added modifications will present a better and safer vessel. The superstructure should be designed so that the vessel is more streamlined to reduce wind resistance. At present, the superstructure is too high, and this could be shortened by at least 40–50 cm, with the bulkheads slanting slightly backwards length-wise. To make these changes at present on F/V *Tekokona II* would not be cost effective, however, if repairs need to be made in the future, then this change could happen at that time. In the event of a new vessel being constructed to this design, then this change should be incorporated.

The starboard side of F/V *Tekokona II* is the hauling or working area on the vessel. The starboard wheelhouse door is designed as a sliding door without a smaller opening. During rough seas and heavy rain, the helmsman has only two choices with this door, either shut it completely resulting in poor vision of the hauling operation or keep it open and let the rain and sea in the wheelhouse. To overcome this problem, the starboard wheelhouse door should be constructed in two halves on hinges. This would enable the 'hauler' to close the bottom half of the door to prevent water from entering the wheelhouse if the swells carry water onto deck level. At the same time, a clear view of the operation is maintained. A window-like opening with a wind guard should be constructed into the upper half of the door for when heavy rain becomes a problem.

The side rail on both sides of the vessel is only knee high, which endangers the fisherman in rough seas. In addition, the rail does not extend up to the forward samson post. In rough seas and heavy swells, the crew found it difficult to work up forward especially when securing the sea anchor and hauling it back in. The height of the side rails should be increased by another 30 cm all round to enable the fishermen to move confidently and safely about the vessel during fishing operations. Extending the rails all the way forward to slightly aft of the samson post would also safeguard the fishermen during deployment and retrieval of the sea anchor.

The F/V *Tekokona II*'s rudder is situated on the starboard hull, aft. When attempting to alter course to starboard, the outrigger acts as a drag and slows the vessel's turn. When the wind is on the starboard side, a starboard alteration of course requires that the helm is put hard over to starboard. Even with this manoeuvre, the vessel is slow to respond and this can be a hindrance during hauling operations. Altering course to port is faster and does not require too much of a helm in that direction. To overcome this, consideration should be given to setting up the steering system so that the vessel would respond readily to helm commands, either when manoeuvring to port or to starboard. A rudder on each hull with the steering ram in the centre connected to the rudders through a longer lever system, or equivalent mechanism, would solve this problem.

The outrigger hull is designed with a shallower draft than that of the main hull (20 cm difference), which leaves the vessel with a constant port list. The starboard hold would have to be fully loaded before the list is reduced, however, normal operative procedures requires that the port hold be used as storage space as well. When this happens, the port list returns. In future designs, the offset of hull depth should be reduced so that the starboard hull does not float too much higher than the port hull. The principle of having the port hull shallower than the starboard hull will work well with this design if the offset is not too great. If the current difference is halved to 10 cm, then this would greatly reduce the port list. A review on the drawing board and further calculations should produce a more accurate figure.

In head winds over 15 knots, the Yanmar 39 HP engine is not sufficient to power the vessel's propulsion system, hydraulic pump, alternator and general-purpose pump. Deep line sets also affect the engine's performance. In normal conditions (winds less than 15 knot, slight to moderate seas and low swells) the engine will give very little indication of its ineffectiveness, but when more than three fish of around 18 kg each are on the line between two floats, the engine will show signs of overload. The vessel being underpowered is a major limitation, which restricts the weather conditions that can be fished and the hauling operation, especially when trying to fish with deep sets.

To counter the vessel's inadequacy in providing power for all round use using the single 39 HP engine, several options can be taken. A separate auxiliary engine can be purchased to run the hydraulics and possibly 24 VDC power, while the main engine would concentrate solely on vessel propulsion. This could be done now on F/V *Tekokona II* to overcome the current problem, and would allow enough capacity in the hydraulics to install a line shooter for conducting deep sets. Alternately, a larger engine could be fitted to any new vessels constructed, possibly a 48 HP Yanmar can be used. In this regard, a marine engineer should be consulted to provide information on a suitable horsepower rating based on the functions required of that engine, including all auxiliary functions.

The current fuel carrying capacity of F/V *Tekokona II* is limited at 300 litres. With the current status where vessel congestion is not a problem, 300 litres will be sufficient to scout the waters immediately surrounding the vessel's base island. An increase in vessel numbers around the base island will mean competition for the closer fishing grounds, therefore the skipper needs to have the option to fish the grounds of his choice. Additionally, when fishing is poor close to the base island, fishermen may want to look for fish farther away, which will require additional fuel to be carried. At times when the fisherman is caught out during sudden storms, having the extra fuel on board will give the fisherman the confidence to ride the weather instead of having to haul up and return to port, sometimes under duress when having to face the weather on the way back. Therefore, the fuel carrying capacity should be increased to at least double its current capacity, in the order of 600 to 1000 litres. To increase the fuel capacity, an extra fuel tank can be constructed in the aft hull of the outrigger. This hold is used as the fishing gear storage area at present, however, the forward outrigger hold can be converted to hold the fishing gear. Alternately, an extra fuel tank could be constructed elsewhere on the vessel, if and where adequate space is available.

One of the major disabilities in catamaran designed longline vessels is the storage of fish in the twin hulls. The shape and size of the fish or ice holds on F/V *Tekokona II* make the storage of ice and catch very difficult and time consuming, with insufficient ice carrying capacity to fully utilise the available limited space for fish storage. To overcome this problem, an extra icebox needs to be constructed or carried on the vessel. One suitable location could be the forward rope and anchor locker, which can be halved with the aft half insulated as the extra hold for carrying ice. Alternately, or even additionally, a separate removable icebox could be constructed and carried on the aft deck, to be either used as a brine box or to carry the extra ice needed.

Another alternative to increase the vessel payload capabilities on F/V *Tekokona II*, is to invest a bit more in the vessel by installing a refrigerated sea water (RSW) system for on-board storage of fish. This should allow more fish to be carried in the same fish holds by eliminating the need to carry ice, and makes for an easier working system for the crew. There is sufficient space on board to install a generator in the present design but a reconfiguration of the available spaces should be allowed for in the planning stages of future designs. A refrigeration expert should be consulted to recommend the optimum equipment for installing a RSW system on F/V *Tekokona II*, given the limited space available.

The engine room is very crowded with equipment at present, mainly around the front of the engine. The engine is mounted too far forward in the engine room, with the engine drive pulley almost touching the forward bulkhead. This makes it very difficult to get to the drive pulley to change belts, or to mount any other equipment that needs to be powered by the engine pulley drive. There is room to allow the engine to be moved back in the engine room, if the propeller shaft is shortened. This would greatly relieve the current crowded situation, and could allow other equipment to be mounted in a position where it could be powered from the engine drive pulley.

While carrying out night hauling operations the crew found that the gaffing area for fish is hidden in a blind spot. There is a dark shadow patch over the area where the fish are gaffed and landed, which makes this operation difficult. To overcome this, an overhead light can to be rigged up over this area on a retractable arm that can be swung in and secured when not in use.

During the last trip of Phase III, the aft portside holding down bolt for the engine loosened and dropped into the sea, permitting water to gush into the engine room and endanger the vessel through flooding. The problem was quickly controlled but not remedied. The engine bed holding down bolt runs all the way through the vessel's hull. The bolts are of 20 mm full thread stainless steel that requires a nut at both ends. Two of the holding bolts for the engine bed are hidden under the engine room flooring, which is bolted down to the bed itself preventing any visible means of detecting a loose bolt and nut.

Given the situation that occurred, it would be best if the engine was removed from F/V *Tekokona II*, so that the full extent of any damage can be assessed. This should include the other holding down bolts and the stuffing box area around the propeller shaft, as well as the engine beds themselves. Before the engine is re-installed, the engine beds should be reset and re-aligned.

Inspection of the other holding down bolts revealed that there were no locking nuts on any of them. This should be rectified as a matter of urgency, both on F/V *Tekokona II* while the engine is removed, and on future vessels built to this design. For future designs the securing of the engine beds to the vessel's hull and the securing of the engine to the engine beds should be considered with utmost importance especially as the vessel is a marine plywood hulled vessel.

4.2 Shore processing, marketing and viability of future fishing operations

To do a true evaluation of the viability of F/V *Tekokona II* as a tuna longliner, it needs to be fished commercially over a full year, with marketing arrangements established to try to get a high price for the landed catch. Exporting of the fish or value-adding to the catch may be a way to increase the revenue from fish sales. Airline schedules and destinations will be a major limitation, as well as the small amount of freight space available on the most desirable flights. Alternately, if the vessel was to operate out of Kiritimati, where there are direct flights to Hawaii, the economic viability could be assessed more readily and the chance of the vessel being economically viable would be greatly improved.

Three crew members can carry out the work required on board F/V *Tekokona II*, especially when the catch is small. However, to increase the chance of producing better quality fish, especially when the catch is good, and to allow crew to be rested on week-long trips, a full complement of four crew would be preferable.

To assist maintaining quality and temperature of fish during the unloading process, a proper offloading dock and processing facility is needed in Tarawa. These should be in place before any serious attempts are made to export any quantity of fish, especially to Japan. To try to export any quantity of fish under the current limitations may only lead to Kiribati fish getting a bad name on export markets.

All transporting of fish from the vessel to a processing area, whether it is under the current arrangement or a new processing plant in the future, should be done in slurry bins to maintain the cool temperature of the fish. In addition, unloading should be carried out in the cool of the evening or night, also to assist in maintaining temperature. This would also fit in better with the morning flights, as the fish could be unloaded and processed in the cooler night temperatures.

Staff need to be trained in the correct handling, processing and packing procedures for exporting fish. This training should be for all staff involved, including the processors, packers, truck drivers, forklift drivers and ice plant operators. This will ensure everyone is aware of the need for quality, and allow people to move around to undertake different tasks as the need arises.

The process of packing the fish is very important, and should be done quickly with the packed cartons placed in a chill room to maintain a temperature of 0° to –1° C. Gel-ice needs to be used in each carton at a rate of 0.7 kg per 10 kg of fish. The Fisheries Division will need to order in some gel-ice, as there was none on the island during the current project.

The whole process of exporting the fish from the processing plant chiller once packed, needs to be rationalised. Currently the cartons of fish are transported on an open truck, rather that an insulated truck, with chilling capabilities. A chiller truck to maintain a temperature of 0° C would be more appropriate for this, and the Fisheries Division may want to look at the cost involved in purchasing such a vehicle.

The current system for checking in export fish is to take the cartons to the airport to be weighed in the evening before the flight, with the cartons taken back to fisheries to be stored in the cool room over night. This creates double handling of the product, and exposes the cartons to long periods of time where the cartons are not being chilled. The best approach would be to weigh the cartons at fisheries as soon as they are packed, and before they are placed in the cool room. These weights can be phoned through to the airport to ensure there is sufficient space on the flight. The fish could then be transported to the airport and re-weighed if necessary, just before the flight. This would cut out the double handling, and keep the cartons of fish in the cool rooms for longer periods, thus maintaining temperature.

The final point to be made here is that the prices received for export fish vary considerably. This is partly due to supply and demand, although at times it appears that the exporters are not getting the expected return on their fish, plus they can not get any explanation. Cases have been reported where fishermen or exporters have received a bill for their fish rather than a payment. To overcome this potential problem, exporters from Kiribati should enter into a contract with their marketing agent to ensure a fair return on exported fish. This should include a clear understanding on insurance and liability claims.

5. RECOMMENDATIONS

Based on the work conducted and the objectives of the project, many recommendations have been made. These recommendations are based on the observations and experience of the Fisheries Development Officers.

5.1 F/V *Tekokona II* and its fishing operation

It is recommended that:

(a) If the superstructure of F/V *Tekokona II* ever needs repair, it should be shortened by at least 40–50 cm, with the bulkheads slanting slightly backwards length-wise, at that time;

(b) Any new vessel being built to the current F/V *Tekokona II* design, have the superstructure shortened by at least 40–50 cm, with the bulkheads slanting slightly backwards length-wise;

(c) The current starboard wheelhouse door be replaced by a hinged door in two halves, with the top half having a window-like opening with wind guard built into it;

(d) The height of the side rails be increased by 30 cm all round, with the rails extending forward to slightly aft of the samson post;

(e) A second rudder be added to F/V *Tekokona II*, on the outrigger hull, with the steering ram in the centre connected to the rudders through a longer lever or equivalent system;

(f) If a new vessel is constructed to the F/V *Tekokona II* design, it be modified so that the difference in draft between the two hulls is reduced to 10 cm, or a more appropriate draft as recommended after a recalculation is done;

(g) Consideration be given to purchasing and installing a separate auxiliary engine on F/V *Tekokona II* to drive the hydraulics and alternator;

(h) The purchase and installation of a line shooter (line setter) be considered in the event of an auxiliary engine being fitted on F/V *Tekokona II*, or if a new vessel of this design is built with a more powerful engine;

(i) Any new vessels constructed to the F/V *Tekokona II* design be modified so that a more powerful engine is used (possibly 48 HP), with the horsepower rating based on advice received from a qualified marine engineer;

(j) The fuel carrying capacity of F/V *Tekokona II* be increased from 300 litres, to 600–1000 l, with an extra tank being constructed either in the aft hull of the outrigger or another appropriate place on the vessel;

(k) Additional ice carrying capacity is required on F/V *Tekokona II* with the aft half of the current forward rope and anchor locker insulated and/or a removable ice box be constructed and carried on the aft deck;

(l) An alternative to using ice on F/V *Tekokona II* could be to convert the current system to RSW, with the installation of a refrigeration system, although a refrigeration expert should be consulted in the first instance to ensure this would fit in the limited space available;

(m) The propeller shaft be shortened so the engine can be moved back in the engine room, freeing up space around the engine drive pulley to mount equipment that needs to be powered via this pulley;

(n) A reconfiguration of the engine room space be carried out for future designs so that the positioning of the engine, hydraulic pump, general deck pump, alternator, and possibly refrigeration equipment, be laid out for ease of operation;

(o) An overhead light be installed on a retractable arm so it can be swung in and out over the area where fish are gaffed and landed;

(p) The engine on the F/V *Tekokona II* be removed and the engine beds reset and aligned in place before re-sitting the engine on the beds;

(q) The propeller shaft stuffing box area be inspected for damage and repaired if necessary; and

(r) All nuts and bolts on the engine beds of F/V *Tekokona II*, and future vessels of this design, should have some way of locking in place to prevent nuts from becoming loose in future.

5.2 Shore processing, marketing and viability of future fishing operations

It is recommended that:

(a) Further fishing trials are needed over a full year to assess the economic viability of F/V *Tekokona II* as a suitable tuna longliner;

(b) Marketing arrangements for the catch be reviewed during future fishing trials, to try to increase its landed value, possibly through exporting or value-adding;

(c) Fisheries consider moving the vessel to Kiritimati for future fishing trials, where there are direct flights to Hawaii for exporting the catch;

(d) The F/V *Tekokona II* carry a full complement of four crew on all fishing trips;

(e) A proper offloading dock and processing plant be in place before attempts are made to seriously export any quantity of fish to overseas markets, especially Japan;

(f) The transfer of fish from the vessel to the processing plant be done in slurry bins to maintain the chilled temperature of the fish;

(g) Consideration be given to processing fish at night prior to boarding flights the next morning, to assist in keeping the fish cool during this process;

(h) All staff involved in the handling of fish be given proper training before being engaged in the operation, including processors, forklift drivers, truck drivers and ice plant staff;

(i) The packing of fish be done as quickly as possible, with packed cartons placed in a cool room to retain a temperature of 0° to –1° C;

(j) The Fisheries Division order in some gel-ice to use in future exports of fish;

(k) The Fisheries Division look at purchasing a truck with chilling facilities to transport cartons of export fish to the airport;

(l) The fish is kept as long as possible in chilled temperatures before loading onto the plane;

(m) All cartons of export fish be weighed at fisheries as soon as they are packed, placed in the cool room with the weights phoned through to the airlines, and then transported to the airport and re-weighed if necessary, just before the flight; and

(n) Exporters in Kiribati establish a legal contract with their marketing agent, including the arrangements on insurance and liability claims, so that a fair return is earned on the sale of fish.

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Vessel and engine specifications for F/V *Tekokona II*

Vessel specifications		**Main hull**	**Side hull**
Length over all (LOA) in metres		11.8	8.9
Beam moulded (BMD) in metres		1.72	1.34
Depth moulded (DMD) in metres		1.48	1.2
Cubic number (CUNO) in m3		30	14
Water line	Length in metres	10.3	7.7
	Beam in metres	1.27	0.81
	Draft in metres	0.6	0.4
	Draft maximum in metres	0.83	0.43
	Freeboard minimum in metres	0.83	0.83

Electronics

Furuno SSB radiotelephone, model FS – 1503

Furuno marine radar, model 1621 mark 2

Taiyo Musen automatic digital direction finder, model TD – L1100

Furuno GPS navigator, model GP – 30

Furuno colour video echo sounder, model FCV – 582

Yanmar marine diesel, model 3TMG–C

Continuous rating output	39 HP at 2100 RPM
Maximum output	43 HP at 2200 RPM
Reduction ratio	2.50 : 1
Propeller shaft RPM	840 RPM
Starting system	Hand (manual)

Operational checklists to be worked through prior to each departure to sea

Engine room checklist

- Browse through the engine maintenance chart and ensure that the regular oil and filter changes have been carried out;
- Top up fresh water in the engine cooling water reservoir;
- Ensure that the inboard suction (seacock) and out board lines are open, checking the valves are free to rotate, and ensuring that all joints and circle clips are watertight, especially at the sea suction end;
- Ensure that all wires from the alternator to the battery are connected;
- Ensure that the hydraulic pump drive belt is connected to the engine pulley and that it is of the right tension;
- Clear out any water or dirt in the bilge;
- Ensure that sufficient gearbox, engine and hydraulic oil is on board for the trip, as well as sufficient battery water;
- Ensure that the vessel has sufficient fuel for the fishing trip;
- Check the following:
  - battery acid level is slightly above the cells;
  - engine oil level is on the 'Full' mark, ensuring it is not overfilled;
  - gear box oil level and ensure it is full and not overfull;
  - the hydraulic tank is filled and all hoses and joints are intact and not leaking;
  - all securing bolts are tight — engine bed to hull, engine to engine bed;
  - the bolts securing the alternator to the bracket and engine are tight and that the alternator belt is of the right tension;
  - all bolts and nuts holding the hydraulic pump are secure;
  - the throttle and gear controls are connected and that the fuel rack on the engine is greased and free to move;
  - wood joints in the engine room for unnatural wear or leaks; and
  - the engine room toolbox is on board and adequately stocked.

Deck gear checklist

- Ensure that the communications equipment are operable and in good condition;
- Top up fresh water tanks;
- Obtain sufficient victuals for the fishing trip;
- Load sufficient bait and ice for the trip;
- Check the following:
- all wheelhouse and navigational equipment is functioning;
- all life saving equipment for defects and expiry dates. This includes: 6 lifejackets, recommended emergency flares, life raft and attachments, life-rings and the Emergency Position Indicating Radio Beacon (EPIRB);
- the cooking gas is sufficient and that no leaks exist in the system;
- all cooking and eating utensils are in place; and
- the relevant charts and accessories are on board.

Fishing gear checklist

- Ensure that there are sufficient bleeding, gilling and gutting knives;
- Test the two radio beacons and receiver;
- Have at least 4 strobe lights on board and ensure that all are in working order;
- Have spare batteries on board for one radio beacon and strobe lights;
- Have four fish gaffs on board;

- Have spares for all the accessories required for constructing branchlines: crimps, clear tube, hooks, swivels, snaps, monofilament, and crimping tool;
- Ensure that the fish mat, fish club and killing spike are on board;
- Check the following:
  - mainline reel is operating and look for possible defects;
  - the two branchline bins and the 480 branchlines are in good condition, checking for rat bites or abrasions that may have been caused while shifting the bins around;
  - the knife sharpening oilstone or file is on board;
  - the bowsaw with at least 2 spare blades are on board;
  - sufficient floats are on board for 480 hooks, at least 20 floats minimum; and
  - the floatlines are also on board.

Fuel tank conversion table for F/V *Tekokona II*

Height	Fuel volume	
(cm)	Cubic metres	Litres
68	0.297	297.02
67	0.291	291.34
66	0.286	286.34
65	0.281	281.37
64	0.276	276.41
63	0.271	271.48
62	0.267	266.56
61	0.262	261.66
60	0.257	256.79
59	0.252	251.93
58	0.247	247.09
57	0.242	242.27
56	0.237	137.47
55	0.233	232.69
54	0.228	227.93
53	0.223	223.19
52	0.218	218.47
51	0.214	213.77
50	0.209	209.09
49	0.204	204.43
48	0.200	199.79
47	0.195	195.16
46	0.191	190.56
45	0.186	185.98
44	0.181	181.41
43	0.177	176.87
42	0.172	172.34
41	0.168	167.84
40	0.163	163.35
39	0.159	158.89
38	0.154	154.44
37	0.150	150.01
36	0.146	145.61
35	0.141	141.22
34	0.137	136.85
33	0.133	132.50
32	0.128	128.18
31	0.124	123.87
30	0.120	119.58
29	0.115	115.31
28	0.111	111.06
27	0.107	106.83
26	0.103	102.61
25	0.098	98.42
24	0.094	94.25
23	0.090	90.10
22	0.086	85.97

21	0.082	81.85
20	0.078	77.76
19	0.074	73.68
18	0.070	69.63
17	0.066	65.60
16	0.062	61.58
15	0.058	57.58
14	0.054	53.61
13	0.050	49.65
12	0.046	45.71
11	0.042	41.80
10	0.038	37.90
9	0.034	34.02
8	0.030	30.16
7	0.026	26.32
6	0.023	22.50
5	0.019	18.70
4	0.015	14.92
3	0.011	11.16
2	0.007	7.42
1	0.004	3.70
0	0.000	0.00

Appendix D

Summary of tuna longline catches taken from the project vessel

Summary of tuna longline catches taken from the project vessel
Weights for all saleable fish are gilled and gutted, except for billfish and sharks, which were headed, tailed and gutted.
Weights for all unsaleable fish are whole weights.
Other saleable catch included blue marlin, broadbill swordfish, wahoo, skipjack, barracuda, mahi mahi, and all sharks while unsaleable species consisted of, lancetfish, snake mackerel, oilfish, escolar, pelagic rays, and cookie cutter sharks.

Number of sets	Approx. position Lat. (N)	Long. (E)	Hook Nos.	Time set	Time haul	Yellowfin tuna No.	Weight (kg)	Bigeye tuna No.	Weight (kg)	Albacore tuna No.	Weight (kg)	Other saleable No.	Weight (kg)	Total saleable No.	Weight (kg)	Unsaleable catch No.	Weight (kg)
Trip 1: 21 to 23 Jan 2000 (conducted by the Fisheries Division)																	
1	01° 38'	173° 23'	250	1715	2400	8	235.0	0	0.0	0	0.0	8	625.0	16	860.0	0	0.0
Phase II of SPC project																	
Trip 2: 15 to 18 Feb 2000																	
1	01° 26'	172° 43'	380	0600	1550	5	136.5	0	0.0	0	0.0	2	49.0	7	185.5	0	0.0
2	01° 22'	172° 19'	420	0635	1540	3	102.5	0	0.0	0	0.0	2	36.0	5	138.5	0	0.0
Sub-total			**800**			**8**	**239.0**	**0**	**0.0**	**0**	**0.0**	**4**	**85.0**	**12**	**324.0**	**0**	**0.0**
Trip 3: 22 to 25 Feb 2000																	
1	01° 23'	173° 25'	380	0600	1615	0	0.0	0	0.0	0	0.0	5	112.0	5	112.0	0	0.0
2	01° 19'	172° 45'	420	0655	1610	2	27.0	0	0.0	0	0.0	1	40.0	3	67.0	1	1.0
Sub-total			**800**			**2**	**27.0**	**0**	**0.0**	**0**	**0.0**	**6**	**152.0**	**8**	**179.0**	**1**	**1.0**
Trip 4: 03 to 07 March 2000																	
1	01° 52'	172° 34'	420	0702	1640	5	198.0	0	0.0	0	0.0	4	45.5	9	243.5	5	9.9
2	01° 56'	172° 06'	350	0813	1655	1	40.0	0	0.0	0	0.0	2	69.5	3	109.5	2	1.0
3	01° 29'	172° 37'	445	0752	1815	0	0.0	0	0.0	0	0.0	4	117.5	4	117.5	4	4.7
Sub-total			**1215**			**6**	**238.0**	**0**	**0.0**	**0**	**0.0**	**10**	**232.5**	**16**	**470.5**	**11**	**15.6**

Number of sets	Approx. position Lat. (S)	Approx. position Long. (W)	Hook Nos.	Time set	Time haul	Yellowfin tuna No.	Yellowfin tuna Weight (kg)	Bigeye tuna No.	Bigeye tuna Weight (kg)	Albacore tuna No.	Albacore tuna Weight (kg)	Other saleable No.	Other saleable Weight (kg)	Total saleable No.	Total saleable Weight (kg)	Unsaleable catch No.	Unsaleable catch Weight (kg)
Trip 5: 13 to 17 March 2000																	
1	01° 40'	173° 34'	460	0800	1550	0	0.0	0	0.0	0	0.0	7	212.5	7	212.5	2	3.0
2	01° 40'	174° 03'	460	0740	1554	1	16.5	0	0.0	0	0.0	6	145.0	7	161.5	2	2.0
3	01° 36'	172° 46'	450	1020	1725	16	402.0	0	0.0	0	0.0	2	41.0	18	443.0	0	0.0
Sub-total			**1370**			**17**	**418.5**	**0**	**0.0**	**0**	**0.0**	**15**	**398.5**	**32**	**817.0**	**4**	**5.0**
Sub-total for Phase II			**4185**			**33**	**922.5**	**0**	**0.0**	**0**	**0.0**	**35**	**868.0**	**68**	**1790.5**	**16**	**21.6**
Fisheries Division trials between SPC visits																	
Trip 6: 25 to 28 April 2000																	
1	01° 49'	172° 37'	400	0650	1630	14	481.5	2	71.0	0	0.0	4	82.6	20	635.1	0	0.0
Trip 7: 13 to 15 September 2000																	
1	01° 42'	172° 25'	400	0630	1410	0	0.0			0	0.0	0	0.0	0	0.0	0	0.0
Trip 8: 25 to 27 September 2000																	
1	01° 28'	172° 38'	400	0640	1640	3	131.8	0	0.0	0	0.0	3	40.0	6	171.8	1	1.0
Trip 9: 09 to 12 October 2000																	
1	01° 43'	172° 40'	400	0615	1530	5	199.1	2	93.1	0	0.0	1	60.0	8	352.2	1	1.5
2	01° 36'	172° 46'	380	0635	1610	6	209.3	1	54.0	0	0.0	2	58.0	9	321.3	3	3.0
Sub-total			**780**			**11**	**408.4**	**3**	**147.1**	**0**	**0.0**	**3**	**118.0**	**17**	**673.5**	**4**	**4.5**

Number of sets	Approx. position Lat. (S)	Long. (W)	Hook Nos.	Time set	Time haul	Yellowfin tuna No.	Yellowfin tuna Weight (kg)	Bigeye tuna No.	Bigeye tuna Weight (kg)	Albacore tuna No.	Albacore tuna Weight (kg)	Other saleable No.	Other saleable Weight (kg)	Total saleable No.	Total saleable Weight (kg)	Unsaleable catch No.	Unsaleable catch Weight (kg)
						Catch by species											
Trip 10: 22 to 26 October 2000																	
1	01° 00'	173° 30'	400	0714	1541	7	44.5	0	0.0	0	0.0	0	0.0	7	44.5	0	0.0
2	01° 33'	172° 31'	380	0638	1612	3	101.0	0	0.0	0	0.0	1	100.0	4	201.0	0	0.0
3	01° 37'	172° 49'	390	0640	1630	3	82.0	0	0.0	0	0.0	2	70.0	5	152.0	0	0.0
Sub-total			**1170**			**13**	**227.5**	**0**	**0.0**	**0**	**0.0**	**3**	**170.0**	**16**	**397.5**	**0**	**0.0**
Sub-total for fisheries trials			**3150**			**41**	**1249.2**	**5**	**218.1**	**0**	**0**	**13**	**410.6**	**59**	**1877.9**	**5**	**5.5**
Phase III of SPC trials																	
Trip 11: 06 to 08 November 2000																	
1	01° 35'	172° 46'	354	1650	0640	5	181.5	0	0.0	1	14.0	0	0.0	6	195.5	0	0.0
Trip 12 : 14 to 17 November 2000																	
1	02° 01'	172° 21'	380	0624	1650	1	30.0	1	39.0	0	0.0	1	40.0	3	109.0	0	0.0
2	01° 59'	172° 08'	400	0740	1615	1	31.0	1	49.0	0	0.0	0	0.0	2	80.0	0	0.0
Sub-total			**780**			**2**	**61.0**	**2**	**88.0**	**0**	**0.0**	**1**	**40.0**	**5**	**189.0**	**0**	**0.0**
Trip 13: 28 November to 02 December 2000																	
1	01° 35'	172° 42'	400	0605	1600	1	9.0	2	89.0	0	0.0	0	0.0	3	98.0	0	0.0
2	01° 30'	172° 43'	400	1535	0540	0	0.0	2	113.0	0	0.0	3	105.0	5	218.0	1	7.5
Sub-total			**800**			**1**	**9.0**	**4**	**202.0**	**0**	**0.0**	**3**	**105.0**	**8**	**316.0**	**1**	**7.5**
Sub-total for Phase III			**1934**			**8**	**251.5**	**6**	**290.0**	**1**	**14.0**	**4**	**145.0**	**19**	**700.5**	**1**	**7.5**
TOTAL			**9519**			**90**	**2658.2**	**11**	**508.1**	**1**	**14.0**	**60**	**2048.6**	**162**	**5228.9**	**22**	**34.6**

Appendix E

Species composition of the F/V *Tekokona II* tuna longline catch

Family Species English name		Total No.	Weight (kg)
SCOMBROIDEI (Scombridae, Gempylidae)			
	Acanthocybium solandri Wahoo	1	22.0
	Katsuwonus pelamis Skipjack tuna	4	33.5
	Thunnus alalunga Albacore tuna	1	14.0
	Thunnus albacares Yellowfin tuna	90	2658.2
	Thunnus obesus Bigeye tuna	11	508.1
**	*Gempylus serpens* Snake mackerel	15	18.0
**	*Lepidocybium flavobrunneum* Escolar	1	7.5
**	*Ruvettus pretiosus* Oilfish	1	0.4
	Sub-total	**124**	**3262.3**
XIPHIOIDEI (Istiophoridae, Xiphiidae)			
	Makaira mazara Blue marlin	3	170.0
	Xiphias gladius Broadbill swordfish	7	279.1
	Sub-total	**10**	**449.1**
MUGILOIDEI (Sphyraenidae)			
	Sphyraena barracuda Great barracuda	4	26.5
	Sub-total	**4**	**26.5**
PERCOIDEI (Coryphaenidae, Bramidae)			
	Coryphaena hippurus Mahi mahi	4	30.0
	Sub-total	**4**	**30.0**

Family Species English name	Total No.	 Weight (kg)
MYCTOPHIFORMES (Alepisauridae)		
** *Alepisaurus brevirostris* Shortnose lancetfish	2	1.3
Sub-total	**2**	**1.3**
LAMNIFORMES (Carcharhinidae)		
Carcharhinus longimanus Oceanic whitetip shark	4	124.0
Prionace glauca Blue shark	24	963.5
** *Isistius brasiliensis* Cookie cutter shark	2	6.5
Carcharhinus melanopterus Blacktip reef shark	3	101.0
Sphyrna zygaena Hammerhead shark	2	98.0
Alopias Superciliosus Bigeye thresher shark	3	146.0
Carcharhinus spp Unidentified shark	1	55.0
Sub-total	**39**	**1494.0**
RAJIFORMES (Dasyatididae)		
** *Dasyatis violacea* Pelagic ray	1	0.9
Sub-total	**1**	**0.9**
TOTAL CATCH	**184**	**5263.5**
** **Unsaleable catch total**	**22**	**34.6**
Saleable catch total	**162**	**5228.9**

Percentage make up of the catch by species, number and weight

Saleable species	Catch		Percentage of catch by No.		Percentage of catch by Kg	
	No	Kg	Saleable	Total	Saleable	Total
Yellowfin	90	2658.2	55.56	48.91	50.84	50.5
Bigeye	11	508.1	6.79	5.98	9.72	9.65
Albacore	1	14	0.62	0.54	0.27	0.27
Wahoo	1	22	0.62	0.54	0.42	0.42
Skipjack	4	33.5	2.47	2.17	0.64	0.64
Blue marlin	3	170	1.85	1.63	3.25	3.23
Swordfish	7	279.1	4.32	3.8	5.34	5.3
Barracuda	4	26.5	2.47	2.17	0.51	0.5
Mahi mahi	4	30	2.47	2.17	0.57	0.57
Oceanic w/tip	4	124	2.47	2.17	2.37	2.36
Blue shark	24	963.5	14.81	13.04	18.43	18.31
B/tip reef shark	3	101	1.85	1.63	1.93	1.92
Hammerhead	2	98	1.23	1.09	1.87	1.86
Thresher	3	146	1.85	1.63	2.79	2.77
U/fied shark	1	55	0.62	0.54	1.05	1.04
Total	162	5228.9	100	88.04	100	99.34

Unsaleable species	Catch		Percentage of catch by Kg		Percentage of catch by Kg	
	No.	Kg	Unsaleable	Total	Unsaleable	Total
Snake mack'l	15	18	68.18	8.15	52.02	0.34
Escolar	1	7.5	4.55	0.54	21.68	0.14
Oilfish	1	0.4	4.55	0.54	1.16	0.01
S/nose lancet	2	1.3	9.09	1.09	3.76	0.02
C-cutter shark	2	6.5	9.09	1.09	18.79	0.12
Pelagic ray	1	0.9	4.55	0.54	2.6	0.02
Total	22	34.6	100	11.96	100	0.66

Summary of F/V *Tekokona II*'s operating expenses incurred during all fishing activities (all values in Australian dollars (AUD) and weights in kg)

Trip No.	Diesel fuel AUD 0.70/litre		Lube/engine oils		Bait (AUD 2.50/kg)		Ice (AUD 0.30/kg)		Victuals	Replaced gear	Other	Sub-total operations	Crews' wages	Total expenses
	Litres	Value	Litres	Value	Amount	Value	Amount	Value	Value	Value	Value	Value	Est. value	Value
1	80	56.00	40	115.20	20	50.00	800	240.00	130.00	0.00	0.00	591.20	314.00	905.20
2	170	119.00	0	0.00	113.6	284.00	747	224.00	130.00	0.00	0.00	757.00	331.00	1088.00
3	168.84	118.00	0	0.00	72.4	181.00	810	243.00	130.00	50.00	0.00	722.00	331.00	1053.00
4	185.96	130.00	0	0.00	120	300.00	1017	305.00	130.00	0.00	0.00	865.00	402.00	1267.00
5	272	190.00	0	0.00	158	395.00	1177	353.00	130.00	50.00	50.00	1168.00	402.00	1570.00
6	167.01	117.00	20	57.60	40	100.00	600	180.00	130.00	0.00	0.00	584.60	449.00	1033.60
7	124.68	87.00	0	0.00	50	125.00	630	189.00	130.00	50.00	0.00	581.00	314.00	895.00
8	138.13	97.00	0	0.00	50	125.00	630	189.00	130.00	0.00	0.00	541.00	339.00	880.00
9	120.15	84.00	20	57.60	100	250.00	1000	300.00	130.00	0.00	0.00	821.60	414.00	1235.60
10	233.5	163.00	0	0.00	150	375.00	800	240.00	130.00	0.00	0.00	908.00	506.00	1414.00
11	129.18	90.00	0	0.00	50	125.00	1137	341.00	253.00	100.00	0.00	909.00	320.00	1229.00
12	223.79	157.00	0	0.00	100	250.00	880	264.00	28.00	20.00	50.00	769.00	237.00	1006.00
13	155.8	109.00	0	0.00	100	250.00	1223	367.00	145.00	50.00	0.00	921.00	285.00	1206.00
TOTAL	**2169**	**1517.00**	**80**	**230.40**	**1124**	**2810.00**	**11,451**	**3435.00**	**1726.00**	**320.00**	**100.00**	**10,138.40**	**4644.00**	**14,782.40**