FISHERIES DEVELOPMENT SECTION REPORT

OF

SEA AND FISHING TRIALS ON BOARD THE SAMOAN FISHERIES DIVISION'S NEW 12.2 M *SUPER ALIA*

26 April – 4 September 2000

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Original text: English

Secretariat of the Pacific Community cataloguing-in-publication data

Sokimi, William

Sea and fishing trials on board the Samoan Fisheries Division's new 12.2 m *super alia*, 26 April – 4 September 2000 / by William Sokimi and Lindsay Chapman

(Report / Fisheries Development Section)

1. Fisheries – Samoa. 2. Fishing – Samoa – Equipment and supplies. 3. Fishing boats.

1. Title 2. Secretariat of the Pacific Community 3. Series 4. Chapman, Lindsay

639.22 AACR2

ISSN 1605–446

ISBN 982–203–757–0

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Prepared for publication at
Secretariat of the Pacific Community headquarters
Noumea, New Caledonia, 2000

Printed by Graphoprint, Noumea, New Caledonia

ACKNOWLEDGEMENTS

The Secretariat of the Pacific Community (SPC) acknowledges with gratitude the co-operation provided by the administration and staff of the Samoa Fisheries Division and the tremendous support and assistance they have given the Fisheries Development Officers during the course of this project. Special appreciation and thanks are directed to Mr Ueta Fa'asili, Assistant Director (Fisheries); Mr Peter Watt, AusAID Commercial Fisheries Extension Advisor (during Stage II); Mr Savali Time, Senior Fisheries Officer (Development); Mr Toni Mulipola, Principal Fisheries Officer (Resource Assessment); Mr Kelvin Passfield, AusAID Fisheries Adviser; Mr Roy Peters, Boatbuilder; the crew of F/V *Ulimasao*, Mr Pesaleli Toatu (Skipper), Mr Fou Fuli, Mr Livi Faleau, Mr Michael Forsythe, and Mr Ielu Faleau; and fishing vessel operators, Mr Kim Levi, Mr Raymond Slate, Mr Peter Rasch and Mr Leau Chu Shing.

The authors are also grateful to those involved in the production of this report, in particular, Ms Marie-Ange Roberts for the format and layout as well as drawing many of the diagrams, Ms Sarah Langi for editing, and Ms Patricia Martin for the design of the cover. The authors also thank the SPC's translation staff for translating the summary.

The Fisheries Development Section gratefully acknowledges the financial support of AusAID, who fully funded the project and the production of this report.

SUMMARY

The Samoan tuna longline fishery has developed rapidly over the last five years, with the main vessel used being the *alia* catamaran. These vessels target albacore tuna, which is landed locally, frozen, and exported to the two canneries in neighbouring American Samoa. An increasing component of the catch from the Samoan longline fishery is the catch of higher-value species, such as larger yellowfin and bigeye tunas. These fish are landed to processors, who export them fresh to overseas markets.

In 1999, the SPC provided technical assistance to the Samoan Fisheries Division designed to increase the catch of higher-value tuna species for the fresh export market, and to provide training in several areas. The catch rates recorded for the higher-valued species were consistent with the catches obtained by local fishermen. The training component of the project was very successful, especially in the area of on-board fish handling, processing and preservation. The current report draws on the results and background information of the 1999 project (Sokimi et al., 2000).

The *alia* catamaran is limited with regard to the weight it can carry; the capacity of insulated areas to chill and store the catch; stability; size; navigation equipment; and crew comfort. To overcome these limitations, the Fisheries Division had a new *super alia* designed and constructed, and requested technical assistance from SPC's Fisheries Development Section to supervise the sea and fishing trials on this new vessel. The main objectives of the project were to assess the effectiveness of the new vessel as a suitable tuna longliner under Samoan conditions; make recommendations on any changes that could improve the fishing operation and vessel layout; and train the skipper and crew to operate the new vessel.

The results of the longline fishing and sea trials on board the new 12.2 m *super alia*, F/V *Ulimasao*, were very encouraging. The vessel is feasible for the fishing operations in Samoa and has proven itself over the eleven trips that were conducted. The present design is adequate to conduct full-scale longline fishing operations and is much better than that of the smaller *alias* in the fishery. The increased size and stability of the vessel, the insulated fish holds below deck, the added safety and efficiency of the twin diesel engines, and the cabin for accommodation and the latest navigational equipment, all make this a good small-scale tuna longliner that appears to work well under Samoan fishing conditions.

The twin Yanmar engines performed admirably and demonstrated that the horsepower produced by both engines was more than sufficient to power a boat of this size and take the load of the hydraulic fishing gear. Fuel consumption by these engines showed that the vessel could be run economically. While the original plans for the vessel indicate that it can carry up to four tonnes of ice, the trials showed that for practical purposes, 1.8 t is more realistic and comfortable to work with. This however, limits the amount of fish that can be correctly iced.

The trials on F/V *Ulimasao* were conducted under semi-commercial circumstances. However, despite this limitation, the economics of the operation based on the achieved saleable catch were profitable and encouraging. The overall catch of saleable fish at 16,838 kg with a wholesale value of WST 81,957 was good for the vessel under trial fishing conditions. If this vessel was fished commercially, it is projected that 40 to 60 trips could be undertaken per year, depending on fishing strategy, with three sets per trip. The anticipated catch would range from 80 to 121 t with an estimated wholesale value ranging from WST 392,717 to WST 589,075. After all fixed and variable costs (including wages for the skipper and crew) are taken into consideration, the anticipated profit would range from WST 77,474 to WST 184,560.

Several improvements can be made to the vessel, the fishing operation, and the ongoing maintenance of the vessel. These are detailed in this report.

RÉSUMÉ

La flottille de bateaux de pêche thonière à la palangre, composée essentiellement de catamarans Alia, s'est rapidement développée au cours de ces cinq dernières années. Ces unités ciblent le germon qui est débarqué localement, congelé et exporté vers deux conserveries des Samoa américaines voisines. Les espèces à valeur commerciale plus élevée, telles que les thons jaunes et les thons obèses de grande taille, deviennent une partie croissante des prises réalisées par la flottille de palangriers du Samoa. Ces poissons sont débarqués et pris en charge par des spécialistes de la transformation qui les exportent à l'état frais vers des marchés étrangers.

En 1999, la CPS a fourni une aide technique au Service des pêches du Samoa afin de lui permettre d'augmenter ses prises d'espèces de thonidés à plus forte valeur commerciale, destinées à l'exportation de produits frais, et elle a assuré une formation dans plusieurs domaines. Les taux de prise enregistrés pour ce type d'espèces ont correspondu à ceux réalisés par les pêcheurs locaux. Par contre, l'action de formation s'est soldée par un franc succès, en particulier pour ce qui est de la manipulation, de la transformation et de la conservation à bord du poisson. Le présent rapport a été établi d'après les résultats du projet mis en œuvre en 1999 et les informations générales fournies à cette occasion (Sokimi et al., 2000).

Le catamaran Alia a certains points faibles sous les aspects suivants : sa charge utile, la capacité des coffres isothermes où les prises sont réfrigérées et stockées, sa stabilité, sa taille, le matériel de navigation et le confort de l'équipage. Pour y remédier, le Service des pêches a commandé un super Alia de conception et de fabrication nouvelles et il a demandé à la section Développement de la pêche de la CPS de bien vouloir superviser, dans le cadre d'une mission d'assistance technique, des essais en mer et des essais de pêche de cette nouvelle unité. Les principaux objectifs de ce projet étaient d'évaluer si ce navire serait un bon bateau de pêche thonière à la palangre dans les conditions de navigation et de pêche dans les eaux du Samoa, de recommander éventuellement des changements de nature à améliorer la configuration du navire et ses performances dans le cadre d'opérations de pêche, et de former le patron de pêche et les membres d'équipage à l'exploitation de cette nouvelle unité.

Les résultats des essais de pêche à la palangre et des essais en mer réalisés à bord du nouveau super Alia de 12,20 mètres, l'Ulimasao, ont été très encourageants. Le bateau est bien adapté aux opérations de pêche au Samoa et il a fait la preuve de ses qualités au cours des onze sorties qui ont été réalisées. Le modèle actuel est adapté à des opérations de pêche à la palangre de grande envergure et il est bien supérieur aux Alias de plus petite taille qui font partie de la flottille. Les plus grandes dimensions et la stabilité accrue du bateau, les coffres à poissons isothermes placés sous le pont, la sécurité et le meilleur rendement des deux moteurs diesel jumelés, ainsi que les aménagements apportés à la cabine et la mise en place des instruments de navigation les plus modernes, tout cela fait du super Alia un bon bateau de pêche artisanale du thon à la palangre, qui semble bien répondre aux conditions de pêche du Samoa.

Les deux moteurs Yanmar ont fonctionné admirablement et démontré que la puissance de ces deux engins couplés était plus que suffisante pour propulser un bateau de cette taille et supporter la charge d'un engin de pêche hydraulique. La consommation de carburant a montré que le navire était d'une exploitation économique. Si, d'après les plans, le navire peut emporter jusqu'à quatre tonnes de glace, les essais ont démontré qu'à des fins pratiques, il est plus réaliste et plus commode de n'embarquer que 1,8 tonne. Néanmoins, cette limitation n'est pas sans incidence sur la quantité de poisson qui peut être correctement mise sous glace.

Les essais réalisés sur l'Ulimasao l'ont été dans des circonstances semi-commerciales. Cependant, malgré cette limitation, au vu des prises de poissons commercialisables, il s'est avéré que l'exploitation du navire était rentable et prometteuse. Le volume total des prises commercialisables (16 838 kg d'une valeur au prix de gros de 81 957 talas) a été bon, étant donné que le bateau a été utilisé dans des conditions de pêche expérimentale. S'il l'était dans une visée commerciale, il pourrait réaliser 40 à 60 sorties par an selon le type de pêche employé, avec trois calées par sortie. Le volume de prises anticipé se situerait entre 80 et 121 tonnes, représentant une valeur estimée sur le marché de gros de 392 717 à 589 075 talas. Après avoir tenu compte de tous les coûts fixes et variables (y compris les salaires du patron de pêche et des membres d'équipage), on pourrait escompter des bénéfices de l'ordre de 77 474 à 184 560 talas.

Plusieurs améliorations peuvent être apportées au navire, aux opérations de pêche et à l'entretien permanent du navire. Elles sont présentées en détail dans ce rapport.

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APPENDICES

1. INTRODUCTION AND BACKGROUND

1.1 Samoa

Samoa (Figure 1), formerly Western Samoa, has its land area bounded between latitudes 13° 25' S and 14° 05' S, and longitudes 171° 23' W and 172° 48' W. The island group comprises two major islands, Upolu (1108 km^2) and Savaii (1695 km^2); two smaller inhabited islands, Manono and Apolima; and four uninhabited islands (Passfield & Mulipola, 1999). Flora and fauna consist of palm trees (mainly coconut), pandanus, pocket areas of mangroves, and secondary growth woodland along the coastal region. The rest of the islands are covered in thick tropical vegetation, except on recent lava flows (Watt et al., 1998).

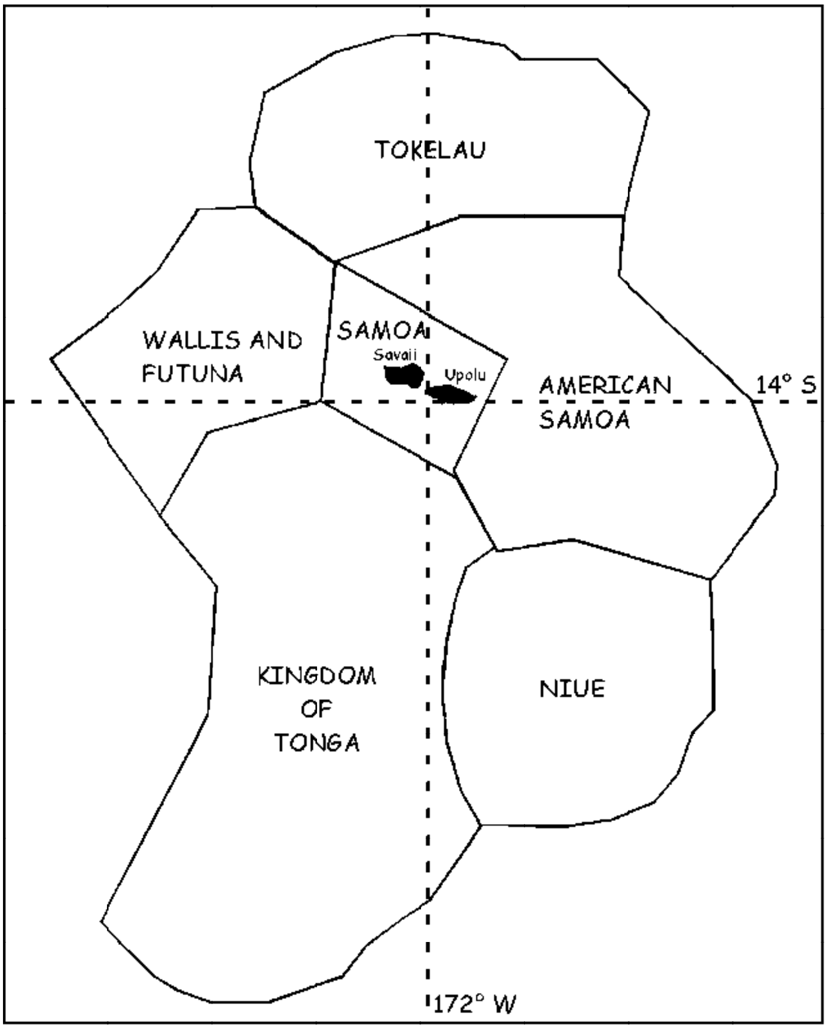

Figure 1: The islands of Samoa

The mid-1999 population estimate for Samoa was 169,200 people (SPC, 2000). Roughly the same number of Samoans have migrated to other countries, particularly New Zealand (Watt & Moala, 1999). The 1991 Samoan census classifies 89 per cent of the population as Polynesian.

Samoa's economy depends on several industries common to many Pacific Island countries and territories: fisheries, coconut-based products, agriculture, tourism and remittances from Samoans living overseas. Of these, fisheries plays a major role in foreign exchange, local business growth, employment and domestic food supply. The development of commercial offshore fisheries between 1975 and 1980, and a further boost in recent years, has allowed several support businesses to flourish. Subsistence fishing is of equal importance in the development of fisheries.

1.2 Development of the Samoan offshore fishery

Samoa, like most Pacific Island nations, places great importance on fisheries and marine resources. Traditionally, Samoans have depended on the sea to supplement their diet. Even today, subsistence and artisanal fishing activities are still an important part of Samoan society. The current trend towards a more cash-based economy has prompted several enterprising locals to capitalise commercially on off-shore fisheries products, mainly tuna.

There are many technical and social issues associated with industry growth, that the Samoan Government has had to consider. These include infrastructure, sustainability of stocks, decisions to expand or restrain vessel numbers, market competition and marketing in general, viable products, sea-safety issues, training requirements, and social impacts.

Samoa has the smallest Exclusive Economic Zone (EEZ) in the Pacific region, covering only 130,000 km^2 (Passfield & Mulipola, 1999). However, in recent years, the development of the domestic tuna longline fishery has generated catches and export earnings of 2,092 t in 1996 (WST 13.8 million—one WST = USD 0.30 cents) and 4,872 t in 1997 (WST 27.5 million). In 1998, tuna exports came to a value of approximately WST 29.6 million with an export weight of 5,072 t, making fisheries the current major export earner in Samoa, (Watt & Moala, 1999).

Because fisheries is the number-one industry in the country, and earns the most foreign exchange, the Samoa Fisheries Division recognises the need to improve the current status of fisheries by carefully monitoring and controlling activities. To achieve this, the Samoan Government sought assistance from the Australian Agency for International Development (AusAID) and established an extension service (Samoa Fisheries Project). The aim was to work with existing government agencies to achieve the goals and strategies necessary for the future development and sustainability of commercial fisheries. Among other work, research was carried out by the Commercial Fisheries Extension Advisor to find out what training is required for the offshore industry, to estimate how much fish is rejected by the tuna industry (from canneries and local processors), and to determine the need for further infrastructure in the developing tuna industry.

Samoans have chosen a catamaran design for their vessels, rather than the more traditional dugout canoe with a single or double outrigger for stability, or a conventional monohull design. Their preference for this design is mainly because it is more comfortable to work on at sea as it is stable, and has a spacious deck area, when compared to monohulls of the same size. Other advantages of the catamaran design include a lower fuel consumption and faster travelling speed due to the streamlined hulls.

Overall, tuna longlining has rapidly developed through the efforts of the Samoan Fishing Industry and the Fisheries Division. The *alia* catamaran was at the forefront of this development, assisting fishermen to expand into several fisheries from the 1970s through the 1990s. With this expansion came the continued evolution of the *alia*, which created new issues, such as sea safety and fish quality, to be addressed by the Fisheries Division and local fishermen.

1.2.1 History of the alia *catamaran and the offshore fisheries it has been used in*

The offshore fishery in Samoa began when up to 120 plywood catamaran-type *alia* vessels were built under a joint FAO/DANIDA project from 1975 to 1979 (Fa'asili & Time, 1997). These original *alias* were 8.9 m long and 2.72 m wide, powered by a single 25 hp outboard engine, with an 8 hp outboard carried as a spare for safety.

At the end of the 1970s, the original design was altered, with aluminium replacing plywood for the construction of the hulls. They were also lengthened to 9.0 m and the outboard size increased to 40 hp. Over 200 of these *alias* were constructed, and some were exported to other countries (King & Fa'asili, 1997).

The *alias* were used offshore, for deep-water bottom fishing in depths to 400 m, and trolling around Fish Aggregating Devices (FADs). The vessels were fitted with four wooden Samoan handreels and two trolling booms (Figure 2) to conduct these fishing activities.

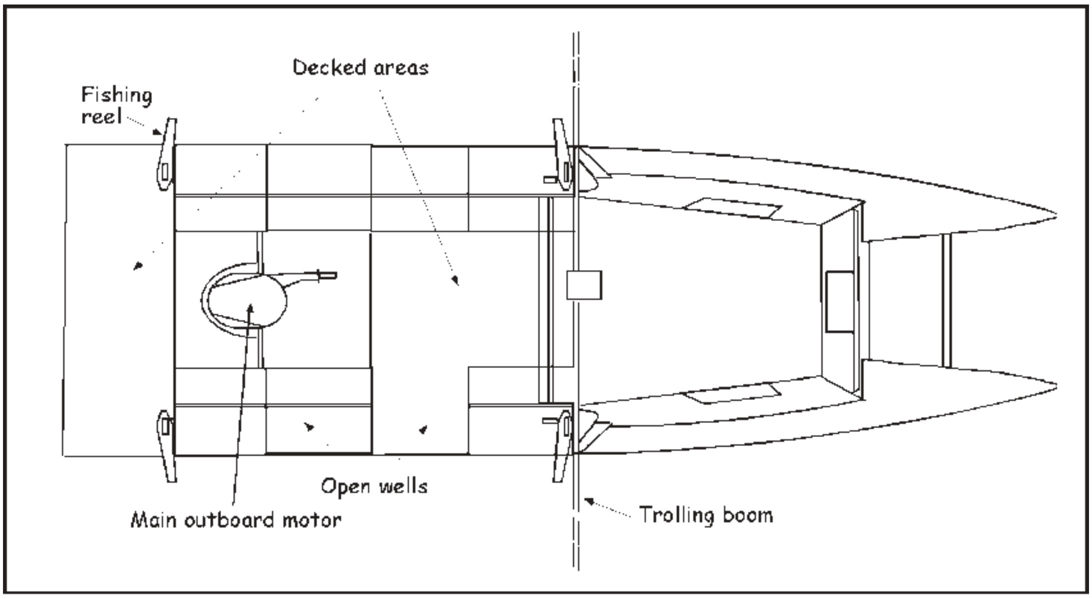

Figure 2: The original aluminium alia *catamaran rigged with handreels and trolling booms*

Catches from deep-bottom fishing were consistent through the late 1970s and early 1980s at around 400 t annually. This catch increased to over 500 t in 1984, and peaked in 1986 at around 950 t (Anon., 1998). Trolling catches from around FADs were also consistent over the same period with peak landings of over 1,600 t recorded in 1986 and 1988 (Anon., 1998).

Two cyclones in 1990 and 1991 devastated the *alia* fleet; over half of the vessels were destroyed and many others damaged. It was estimated that only 40 useable *alias* remained after the cyclone in 1991 (Fa'asili, 1997). The Government of Samoa used its US Treaty funds, administered by the Forum Fisheries Agency (FFA), to rebuild the fleet. Around 60 *alias* were back in operation in 1993 (Fa'asili & Time, 1997).

In 1990, the Government of Samoa approached SPC's Fisheries Programme for technical assistance to promote offshore fishing. An SPC Fisheries Development Officer was then assigned to Samoa for six months (September 1990 to March 1991). The aims of the project were to develop and rig the fisheries research vessel R/V *Tautai Matapalapala* with tuna fishing gear, and to conduct experimental vertical and horizontal longlining trials targeting albacore tuna (*Thunnus alalunga*), yellowfin tuna (*T. albacares*) and bigeye tuna (*T. obesus*). Results from the vertical longline trials conducted around FADs were successful, with 1,866 kg of fish caught in 13 fishing trips (Watt et al., 1998).

Given the success of the vertical longline trials, SPC technical assistance was extended by four months (March to July 1991). The aim of the extension was to transfer the equipment and technology used on the research vessel to the *alia* catamaran, which was the style of vessel used by local fishermen. These trials were also successful, not only in terms of catch (2,819 kg of fish taken in 20 fishing trips), but the numbers of local fishermen that geared up and fished (Watt et al., 1998).

The horizontal tuna longline trials conducted during the initial SPC visit were considered inconclusive. This was attributed to the limited number of trips, the short mainline (only 4.5 km), and an inappropriate hydraulic reel being used (Watt et al., 1998).

A combination of the SPC trials and the loss of FADs through natural disasters and other elements led local fishermen to try offshore horizontal longline fishing. In addition, soon after the SPC trials, impressive catches achieved by a 15 m tuna longliner (F/V *Marengo Bay*), successfully demonstrated the effectiveness of horizontal longline fishing in Samoan waters (Passfield & Mulipola, 1999).

The mid-1990s saw an increase in the number of *alias* converted or built for tuna longlining. Vessel numbers increased steadily to an estimated 200 in 1999, the vast majority of which are *alia* catamarans (Figure 3). In many cases these *alias* have been modified in various ways including: increasing the height of the gunwale by 20 cm; increasing or 'stretching' the vessels' length to 10.5 m; adding aluminium wheelhouses; and strengthening the outboard mounting area to take larger and more powerful outboard engines (Chapman, 1998). Larger vessels have entered the fishery as well. These include some 11.5 m aluminium catamarans, mainly imported from New Zealand, and larger, purpose-built tuna longliners in the 18–25 m range.

Figure 3: Alia ***catamarans with tuna longline gear at anchor in Apia Harbour***

The increase in *alia* numbers has led to more competition for fishing grounds within 20 nm of the reef, especially in the area close to the main ports. Catch rates have dropped, while fishing effort, or the number of hooks set per *alia*, has increased from 180 per set in 1995 to 320 per set in 1999 (Passfield & Mulipola, 1999). Fishing practice has also changed from five to six day-trips per week in 1995 to two, two-day trips per week in 1999. This reflects the added distance *alias* are travelling in order to return with good catches. A good number of fishermen are now venturing to fishing grounds that are, for safety reasons, not suitable for the *alia*. In addition, the quality of the landed fish is low.

In 1999, the SPC provided technical assistance to Samoa in an endeavour to increase the proportion of higher-valued tunas (bigeye and larger yellowfin tunas) in the tuna longline catch, and improve the practices of fish handling, processing and chilling employed in the industry. Other objectives of this project were to train the skipper and crew of the fisheries vessel, and conduct workshops for local fishermen on on-board fish handling and preservation, and basic navigation. The Fisheries vessel R/V *Tautai Matapalapala* was used for this project, with a modified hydraulic mainline reel system. Unfortunately, the results from the fishing trials did not show an increased catch of higher-value tunas. However, all of the training objectives were fully met, with many skills transferred to local *alia* fishermen.

1.2.2 Limitations and problems encountered with the alia *catamaran*

There are a range of limitations and problems that affect the versatility, stability and fishing capability of the *alia* catamaran. These limitations are discussed in some detail in Sokimi et al. (2000), and are summarised here:

Sea safety: Alia catamarans were originally designed to fish close to the reef, making at most a day trip or over-night trip of up to 20 nm, and only in slight-to-moderate weather and sea conditions. Fishermen now venture farther to sea to maintain good catches and avoid gear conflict and congestion close to port. This endangers the lives of those on board; they may capsize during heavy weather, or be lost at sea through lack of navigational knowledge and basic seamanship skills, or mechanical breakdowns.

Vessel construction: During the mid-1990s, modifications were made to the *alia*, stretching the length, increasing the freeboard, and adding more powerful outboards. However, the hulls were still made from the same thickness of aluminium (2.5 mm). It is also reported that the changes to the design were done without the input of a naval architect.

Loss of life: Over a 15-month period between 1997 and 1998, 25 lives were lost at sea in 14 major accidents (Watt & Moala, 1999). These accidents were attributed to changes in vessel design, the greater fishing distances travelled, and in some cases the adverse weather conditions encountered.

Fish quality: Samoa has a high rate of tuna rejected from local processors and the two canneries in American Samoa, where the majority of albacore tuna catches are sold. Fish are rejected as a result of poor on-board handling and chilling practices, extended fishing trips with limited or no ice used to chill the catch, and in some cases, poor onshore freezing practices. Watt and Moala (1999) reported rejection rates of 2.8 per cent in 1996 and 4.2 per cent in 1998 from the two tuna canneries in American Samoa. Local exporters estimated their rejection rate at 5.0 per cent in 1996, 4.4 per cent in 1997, and 6.0 per cent in 1998.

Vessel design: The 9 m *alias* were originally designed for inshore and offshore bottom fishing, trolling and vertical longline fishing, and not for horizontal longline fishing. In addition, no provision was made for proper insulated ice holds to be constructed within the hulls of the alia catamaran. Portable iceboxes (Eski coolers or fish bags) or cast-off domestic refrigerators are used. This restricts the amount of fish that can be properly chilled, resulting in poor-quality fish.

Working area and crew comfort: Nearly all *alias* carry only three crew members. Three are not enough to perform the setting and hauling duties, and at the same time attend to fish preparation and preservation during the hauling operation. In addition, the cabin on the *alias* is small, has limited cooking facilities (a charcoal stove made from cement poured into a biscuit tin), and no bunks for the crew to sleep in on longer fishing trips.

Qualifications and training: Very few skippers or crew of the alias have any formal training in navigation, seamanship skills, boat safety, and fish handling. Neither do they hold formal qualifications as skippers or engineers. This is believed to be a contributing factor to the loss of some vessels, as skippers and crew operate from a limited knowledge base, and may not be able to get out of difficult situations.

1.2.3 Fisheries Division's efforts to overcome alia *limitations*

The Samoan Fisheries Division is aware of the limitations and problems associated with the *alia* catamarans, and has implemented a range of measures to address them. The following is a summary of the measures implemented by the Fisheries Division from Sokimi et al. (2000).

Sea safety: A continuous radio watch is maintained by the Fisheries Division, which provides regular weather news and warnings to fishermen at sea. Each licensed vessel is required to carry a VHF radio and report in on departure and arrival. All offshore fishing-vessel owners are encouraged to register their vessels or face penalties. There have also been several public displays to demonstrate the various safety equipment available to fishermen.

Fish quality: Local fishermen are being encouraged by the Fisheries Division and local processors to carry ice when going to sea to chill their catch and improve fish quality. Fish processors are making the ice available at an affordable price.

Training in fish quality and basic navigation skills: The Fisheries Division AusAID Extension Service and SPC have jointly run several workshops focused on on-board fish handling and preservation, and basic navigation and the use of GPS (global positioning system) (Sokimi et al., 2000). These have proved to be very successful.

Vessel construction and design: The Fisheries Division has identified the need to introduce an advanced design for a small-scale fishing vessel that will be able to fish within all areas of Samoa's EEZ. In late 1999, construction commenced on a prototype *super alia* (12.2 m catamaran with twin diesel inboard engines) that would contain the latest amenities for tuna longline fishing and advanced navigation. This single initiative could have the greatest impact on reducing most of the problems currently occurring in the domestic tuna longline fishery in Samoa.

1.3 Initiation of the project and its objectives

During the final stages of the Fisheries Development Section's technical assistance to Samoa in late 1999, SPC's Fisheries Development Officer involved in the project was asked to provide input to the layout of the new *super alia* under construction in Samoa at the time. This input was provided in a brief report (Sokimi et al., 2000), and outlined some changes to the deck layout that would assist the fishing operation of the vessel.

The Fisheries Division placed a very high priority on the construction of the *super alia*, since, if the vessel proved successful, it would overcome many of the problems encountered by local *alia* fishermen. Fisheries were also keen to ensure that the *super alia* would be put through rigorous sea and fishing trials to prove its effectiveness as a suitable tuna longliner for the Samoan fishery. In support of this, the Fisheries Division officially requested technical assistance from SPC in February 2000 to conduct the initial sea and fishing trials, and modify the fishing arrangement as required. A Memorandum of Agreement was signed between the Government of Samoa and SPC in early April 2000, which clearly defined the roles and responsibilities of both parties and the objectives of the project. The project commenced on 26 April 2000, when Fisheries Development Officer, William Sokimi, arrived in Samoa. The objectives of the project were to:

- conduct sea and tuna longlining trials from the newly designed and constructed fisheries *super alia*, F/V *Ulimasao*, to assess its effectiveness as a suitable tuna longline vessel fishing under Samoan conditions;

- recommend modifications or improvements to the fishing gear and fishing layout of F/V *Ulimasao* based on the sea and fishing trials, and implement these changes wherever possible;

- train the skipper and crew of the fisheries vessel, F/V *Ulimasao*, and other interested fishermen, in the use of the monofilament fishing gear, the hydraulic fishing system, and the correct on-board handling, processing and icing practices for tunas and other species, especially export quality fish; and

- write a comprehensive report on the project outlining the seaworthiness of F/V *Ulimasao*, any improvements and modifications made to the vessel, or needed in the future, the catches achieved during the fishing trials with a costing of all aspects of the fishing operation, and conclusions and recommendations.

The project was originally scheduled to run for three months. However, the Fisheries Division requested an extension to the project in June 2000, as problems encountered with the mainline reel resulted in some project time being lost. The project was therefore extended by six weeks, to cover lost fishing time and to allow the skipper and crew to be trained in the use of a new hydraulic main-line reel installed on F/V *Ulimasao* in July 2000.

2. PROJECT VESSEL F/V *ULIMASAO*

The project vessel, F/V *Ulimasao*, is a new prototype offshore fishing catamaran (12.2 m *super alia*) that has the latest amenities for safe navigation, efficient sea survival equipment, modern tuna longline fishing gear, ample storage space for producing quality fish, stability, proper crew accommodation and twin diesel engines that are economical to operate. The vessel resulted from a project proposal that was developed by the Samoan Fisheries Division, and approved by Government. The Forum Fisheries Agency (FFA), using the Project Development Fund under the US Treaty, duly granted an initial sum of USD 116,700 to activate the project and commence the building of the vessel (Anon, unpub.).

A consultant naval architect, Mr Arild Overa, was given the task of producing a plan for the construction of the *super alia*. Mr Roy Peters and a work crew carried out construction of the vessel at Tony Hill's Boatyard in Vaitele, Apia under a voluntary work arrangement with the Fisheries Division. This deal was agreed to between the two parties with the understanding that the boat builder would have free access and copies of the plans after the vessel had been completed. The initial number of 11 voluntary workers reduced to seven after two weeks, due to work commitments and personal agendas that had to be met by the departing crew. During the later stages of vessel construction, seven experienced boat builders had to be hired to continue the construction work.

The construction schedule of the *super alia* did not correspond with the Fisheries Division's original plans. The contract for designing the vessel was acknowledged on 1 March 1999, with the delivery date of the plans being three months (1 June 1999). Construction was to have started immediately after receiving the plans. The plans were finally received on 7 September 1999, and a contract for construction of the vessel was set for 40 working days, to be completed by 5 November 1999. Further delays occurred that prevented the realisation of the original completion date of the vessel. The initial estimated cost of constructing the vessel had also risen, which prompted the Fisheries Division to approach FFA for two additional amounts of funding (USD 44,468 and 9,248).

The vessel was finally launched on 4 April 2000. Instead of the 40 days estimated for constructing the vessel, the actual construction time came to 23 weeks or 160 days (Anon, unpub.). On 6 April 2000, the vessel was officially christened F/V *Ulimasao*, which means 'to steer straight' or 'to steer safely'.

2.1 Description and layout of F/V *Ulimasao*

F/V *Ulimasao*, (Figure 4) is a 12.2 m catamaran constructed from aluminium plate with the cabin also constructed from aluminium. The wheelhouse section in the accommodation superstructure is located on the starboard side of the vessel. The steering wheel, equipment console and power switches are all located in this area.

Figure 4: Project vessel F/V Ulimasao

The electronic equipment purchased for navigation and fishing purposes were within a moderate price range, sufficient to enable the professional operation of the vessel. These were all centrally located so that the vessel's operator can navigate, steer the vessel, keep a safe lookout and carry out fishing operations.

The vessel is powered by twin 48 hp Yanmar diesel engines with a through-hull drive. The main features of the vessel are presented in this section, while Appendix A summarises the main specifications of the vessel.

2.1.1 Crew accommodation, toilet and galley

The wheelhouse, dining table, sleeping quarters and galley are all located under a single superstructure. The vessel is capable of comfortably accommodating six crew. The sleeping arrangement allows for five crew to be resting at any one time, with the sixth crew member maintaining watch.

There are two main bunks in the accommodation area; one single, and one double. Seats around the dining table also serve as beds for two crew.

The galley contains a two-burner gas stove, a sink with foot-pumped salt water and fresh water taps, food storage cupboards and a dining table (Figure 5).

Figure 5: Galley area on board F/V Ulimasao

The toilet is situated aft of the accommodation area and is flushed by a seawater hand pump. A sink with foot-pumped fresh water is also located in the toilet area. This pump arrangement can be used as a shower by connecting an extension hose to the water outlet.

2.1.2 Gear storage holds

There are two gear storage holds in the fore part of each catamaran hull, forward of the wheelhouse. The holds are capable of storing the sea anchor, mooring lines and up to 25 x 300 mm longline floats each. Each hold has a hatch cover that is lashed down when the vessel is underway.

The drain from the gear storage holds leads under the fish holds to the engine room and is pumped out via a pipe in the engine room.

2.1.3 Fish holds

F/V *Ulimasao* has a fish hold in each hull (Figure 6), each sealed by an insulated hatch cover around two-thirds the length (1.75 m) of the fish hold. These covers are lashed down when the vessel is under-way. Each hold is roughly 2.9 m long, 1.4 m wide and tapers in depth from 1.2 to 1.4 m, although the bottom is tapered to suit the hull shape. The holds have 10 cm of insulation, with an aluminium lining on the inside for ease of cleaning (Figure 7). The two holds add up to a total volume of around 8 m^3 and can hold 3–4 t of ice when completely filled with loose ice. For practical purposes though, the ice has to be carried in bags, so that the storing of fish out at sea is easier to manage. This reduces the vessel's ice-carrying capacity to around 1.8–2.0 t.

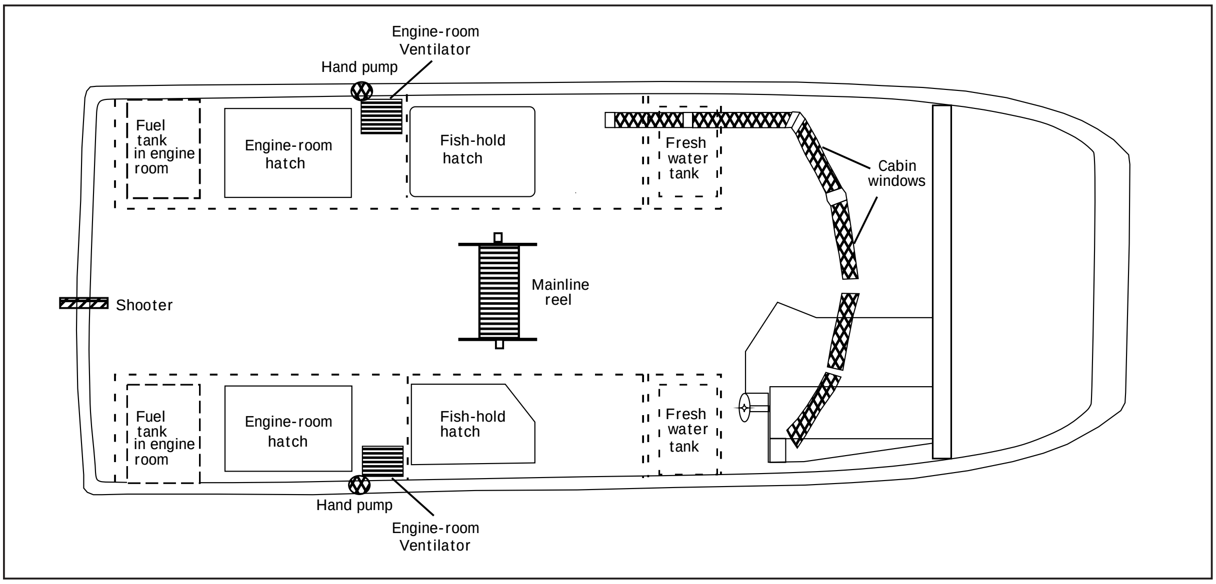

Figure 6: Plan view of F/V Ulimasao *showing location of fish holds and engine rooms*

Figure 7: Fish hold with aluminium lining for ease of cleaning

The fish holds can also be filled with water and ice to form a brine or slurry. Depending on the amount of ice used, the vessel may have to return to port for discharge. Weather conditions will also have to be taken into account when the decision to brine is made. Brining the catch in the fish holds should only be undertaken in calm to moderate seas.

Although the water in the fish hold is pumped from an outlet in the engine room, flooding the fish hold will not automatically allow the water to drain off into the engine room, so there is no danger of flooding the engine room. Tests were carried out to prove this.

2.1.4 Main engines and engine rooms

F/V *Ulimasao* is powered by twin 48 HP Yanmar diesel engines (Model 4LM, Z–drive) that are each situated in engine rooms aft of the catamaran hulls (Figure 6). The exhaust for each engine is on the inside bulkhead of the catamaran hulls. Access to the engine rooms is by way of a 'lift-off' hatch cover. The engines are capable of pushing the vessel at speeds of 9–11 knots depending on the engine revolutions, load conditions and weather situation.

The port engine room also houses the hydraulic pump and the deck water hose, and heat exchanger supply pump. Each engine room has a battery bank with two 12-volt batteries and a 840 litre fuel tank. The engine rooms are ventilated by two ventilator funnels extending above the deck on each side of the vessel (Figure 6).

2.1.5 Bilge and fish-hold pumps

There are only two fixed pumps on board the vessel to cater for pumping the bilge and fish holds. These are both hand-operated pumps. A single pump is located on the seaward side of the ventilator funnel above each engine room (Figure 6). The outlet hose hangs directly over the rails into the sea while the suction hose leads down into the engine room.

To pump out the bilge, the suction hose is put directly into the bilge and the water pumped out. The fish holds and gear storage holds have pipes leading into the engine room. When the need arises, the suction hose is connected to the appropriate pipe and the selected compartment pumped out.

There are two spare pumps and accessories kept in the spares kit.

2.1.6 Main engine cooling line, toilet flush line and salt water tap line

There are four openings in the vessel's hull for water intake and three for discharge. These are for the main engine cooling system in each hull, where two 75 mm cooling lines are used for supply and discharge of cooling water to the main engine and two 38 mm intakes for the salt-water foot pump and the toilet flush system.

The lines for the main engine cooling system have a valve connected to the base of the hose at the intake point that can be shut off when the engine is not in use. The two 38 mm lines do not have any valves connected to the base at the intake ports.

2.1.7 Fuel and fresh water tanks

The fuel tanks are situated aft of the engines in the engine room (Figure 6). Both tanks were built as separate units and designed to fit the contours of the catamaran hulls. Because of the multifaceted shape of the tank (Figure 8), it was difficult to mathematically calibrate and mark the tank capacity at different levels.

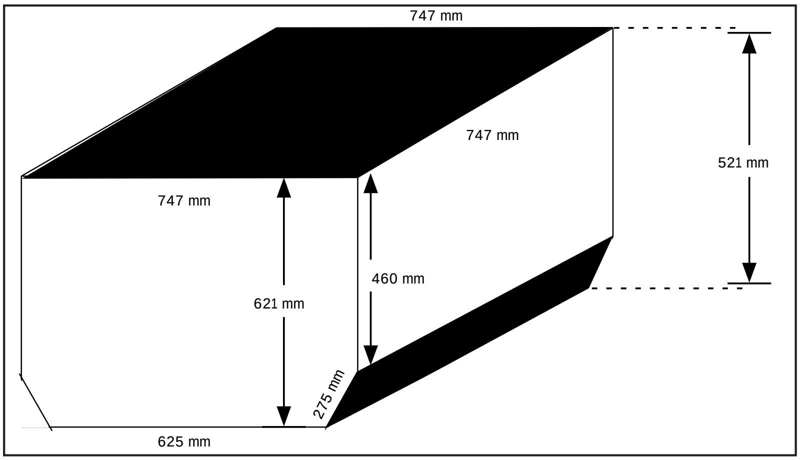

Figure 8: Size and shape of the fuel tanks

To overcome this problem a valve was connected to the bottom of the tank from which a clear hose was connected. To check the fuel level the valve is opened to allow the fuel to flow up the clear hose and show the level at which it settles.

Both tanks now have calibration marks to indicate the amount of fuel remaining at different levels. The calibration marks range from zero to 540 l at 40 l intervals, then from 540 to 840 l marked at 100 l intervals. These marks are notched into the side of the tank, directly in line with the hose, so that the level in the hose can be compared against them.

To obtain these calibrations, both tanks were emptied then refilled using a 20 litre drum and marked at the 40, then 100 l intervals. Although the vessel statistics show a maximum capacity of 1,500 l (refer Appendix A), each tank can actually hold 840 l, bringing the total capacity to 1,680 l.

Two fresh-water tanks are located under the floor, aft of the bunks in the accommodation area (Figure 6) and have a total capacity of 1,000 l. These tanks are also made to suit the shape of the vessel's hull.

2.1.8 Electrical System

F/V *Ulimasao* is fitted with four 12-volt batteries to power the vessel's lighting, electronics and engine starting system. Each engine room has a battery bank with two 12-volt batteries (Figure 9). The vessel's lighting and electronic equipment runs off a 12-volt system, while the main engine starter requires 24 volts to operate. Each battery bank operates independently of the other so therefore each main engine runs an alternator that charges its own bank of batteries.

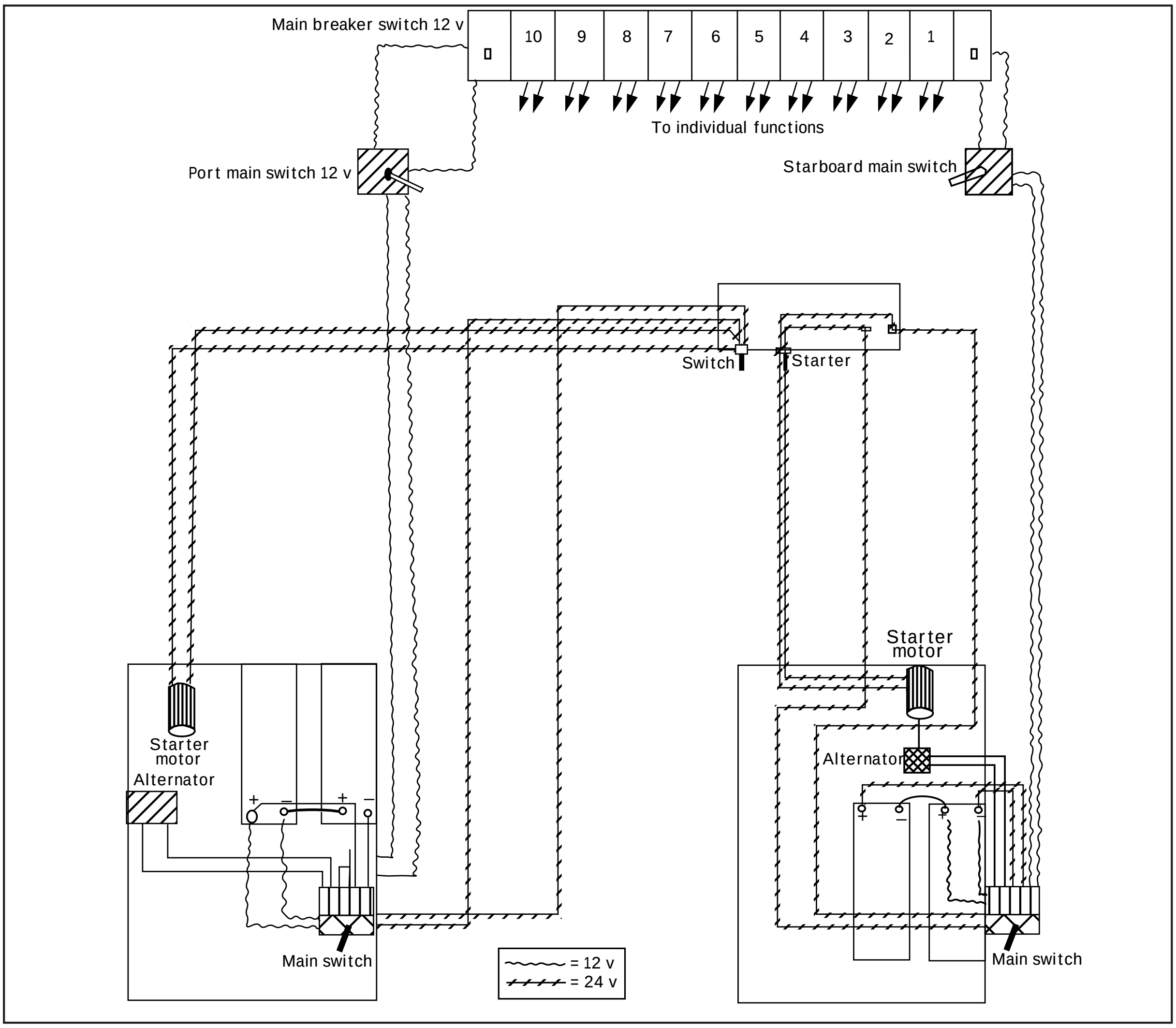

Figure 9: Electrical system (12-volt and 24-volt) on F/V Ulimasao

The power lines for the 12-volt and 24-volt systems both run from the battery terminals to a master switch in each engine room. This switch must be kept on at all times while the engine is running. This is to enable full function of all the navigation equipment, allows the alternator to keep the batteries charged, and avoids backload on the alternator.

The lines for the 12-volt system run from the master switch in the engine room to a main switch beside the switchboard. From the main switch, the line goes to the individual breaker switches for different functions via a main breaker switch on the switchboard. Both the port and starboard systems have their own main switch and main breaker switch at the switchboard (Figure 9). When the starboard system is used, the port main switch at the switchboard must be shut down; and vice versa, for when the port system is used. If both systems are turned on at the same time, 12-volt power will enter the switchboard from both battery banks and will cause an electrical shortage at the switchboard.

The 24-volt system is used only for starting the main engines. The lines for this system run from the battery bank to the master switch in the engine room then onto the engine starter switches in the wheelhouse. From here, the line runs to the starter motor on the main engines.

2.1.9 Hydraulic system for fishing operation

The hydraulic system consists of a single Vickers pump (Vickers VTM Series 42 06 GPM) connected to the port main engine by a durable hard plastic coupling. Hydraulic oil is supplied from a 40 l reservoir situated on the bulkhead aft of the accommodation superstructure.

The hydraulic oil is fed from the tank to the pump, and then supplied under pressure through a *brand* control valve and a flow control valve to the mainline reel and the line shooter. Return lines run from the shooter, reel, flow control valve and the pump back to the reservoir (Figure 10). The hydraulics driving the deck gear are controlled from the wheelhouse through a cable-operated system that is connected to the *brand* control valve. A heat exchanger is connected between the pump and the tank to cool the returning hydraulic oil during operation.

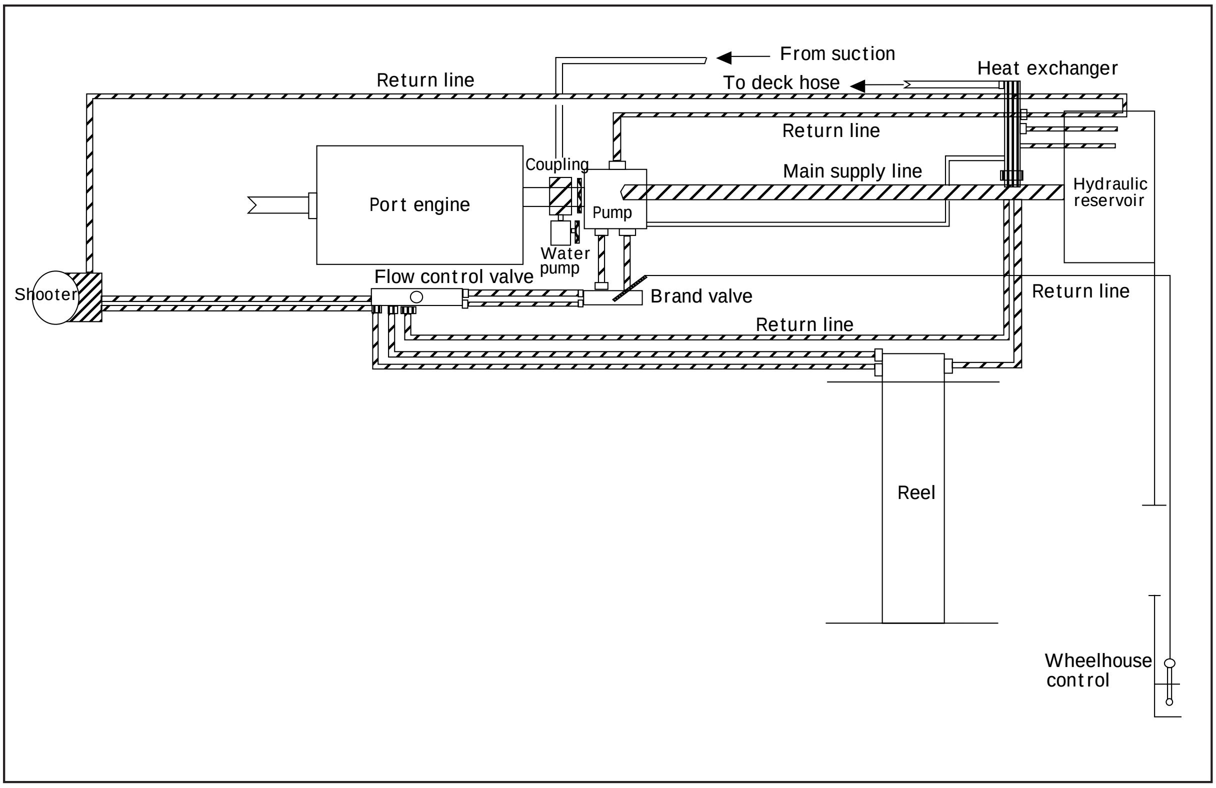

Figure 10: Hydraulic system on F/V Ulimasao

A second, backup hydraulic system was connected to the starboard engine and trialled. The first attempt at hooking up this system resulted in the starboard pump being starved of hydraulic oil. The hydraulics engineer suggested that a ‘T’ connection in the main oil supply system might have contributed to this problem. When one pump is run at a higher speed to the other, it tends to draw all the oil flow towards it, thus starving the other pump of oil. Therefore the pump on the starboard engine was dismantled and the hose system sealed until the hydraulics engineer could set up a workable arrangement.

2.1.10 Steering system

The steering system is based on the basic, but effective, principles of hydraulic steering. The rudders are connected to a steering ram (Figure 11) that is pushed by hydraulic pressure exerted by a manual hydraulic pump driven by the turn of the steering wheel.

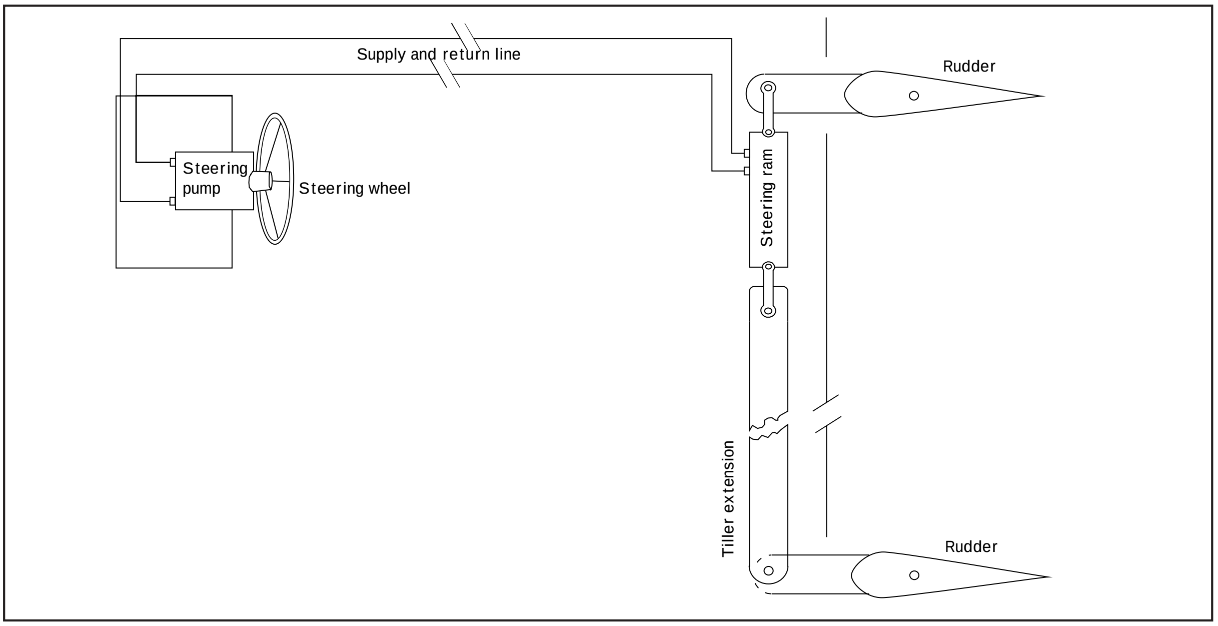

Figure 11: Steering system used on F/V Ulimasao

Instead of using copper or steel hydraulic-fluid supply and return lines, the system is operated through toughened nylon tubing. The hydraulic fluid used is the same as that normally used in *Hynautic* engine control systems, *Glycerine Glycol*.

At the turn of the steering wheel, the pump behind the wheel pushes hydraulic fluid through one of the lines and sucks back fluid through the other. This allows the steering-ram arm to extend smoothly in the opposite direction to that from which pressure is exerted. As the wheel is turned to port, for example, pressure is exerted on the portside of the steering ram thus pushing the arm towards the starboard and allowing the rudder, through the lever system (Figure 11), to give the vessel a port turn.

The starboard steering ram is connected directly to the starboard rudder, while the port steering ram is connected to an extension lever that connects on to the port rudder (Figure 11). This method allows the use of one steering ram to manoeuvre the two rudders at the same instant. The rudders are semi-balanced and are connected to the steering ram by a tiller. While the rudders work effectively to steer the vessel, modifications can be done around the stern of the vessel to protect the rudders, as the twin rudders protrude at the stern.

2.1.11 Mainline reel and line shooter

The mainline reel on board F/V *Ulimasao* at the time of launching (Figure 12) was designed and built by Grant McCleary of Australian Mooring Service. This reel could hold up to 20 nm of 3.5 mm monofilament line, and was hooked up to a hydraulic system driven by a Vickers VTM Series 42 06 GPM pump. The line shooter on board was designed and manufactured by the Power Steering and Hydraulics Company of Tauranga, New Zealand.

Figure 12: Initial longline reel used on the project vessel

The mainline reel was mounted in the centre of the deck between the ice hold hatches facing aft (Figure 6), with the line directed by blocks or pulleys for setting and hauling. The line setter was mounted on a stand in the centre at the stern of the vessel (Figure 6). The controls for operating the mainline reel were mounted in the wheelhouse, while the line-shooter control was mounted on the side of the unit.

Before sea trials were conducted, test runs were conducted in port to work out the operation of the reel. Several deficiencies were noted as follows:

- The level-wind line guide on the reel is permanently closed. Once the mainline is roved through the guide, there is no way of removing it except by cutting the line or at the end of an operation. During the line setting and hauling operation, several instances may arise that would require the removal of the line from the guide. With this set-up, not only will time be wasted in cutting and joining the mainline, but extra knots will appear in the mainline.

- During line setting, the reel controls need to be continuously checked to make sure there is a coordination between the reel and the shooter when running the line off under power. Constant adjustments have to be made to the control valves on the reel to allow it to keep up with the diminishing diameter of the line. This requires an experienced crew to stand by the controls at all times during line setting, and means an extra worker is needed.

- As the diameter of the mainline on the reel decreases during setting, the shooter and reel become less coordinated until the reel speed cannot match the shooter speed. This normally occurs after 8–12 nm of line has been deployed. At this stage, the operation is stopped and the reel is set in free-spooling mode and made to match the shooter speed; or the line is taken off the shooter and free spooled through an open block, off the stern of the vessel. Attempts to have a trouble-free transition from power setting to free spooling, without stopping the vessel, have not been successful.

- The reel controls consist of four valves instead of the normal two. This can be rather confusing, especially since there is no operations manual provided.

2.1.12 Hauling station

The set up of the hauling station is similar to that of other locally built *alias*. In order to reduce costs, the wheelhouse and navigation area is also used as the hauling station. The operator therefore, is located in the wheelhouse, while the crew, who are unsnapping and retrieving branchlines, are situated just outside the aft wheelhouse bulkhead. The only addition to the wheelhouse gear is the main control for the longline reel and an overhead retractable beam to which the hauling block is connected. The hauling block beam can be safely stored away after operations and extended into position when needed.

In the wheelhouse, the operator's seat can be adjusted to face towards the starboard side so that the operator can face directly towards the hauling block. The steering wheel is in a forward-facing position. The operator can watch the hauling operation through a full-length open window on hinges that is drawn upward by a string and lashed open.

2.2 Work completed on the project vessel after launching and modifications during sea trials

Although the vessel was officially launched on 6 April 2000, there was still work to be completed by the designer consultant and the boat builder. Even three weeks after the launching date there was still work to be completed, although the consultant had to return to Norway.

2.2.1 Work completed before the first fishing trip

Upon arrival in Samoa on 26 April 2000, the SPC Fisheries Development Officer and the boat builder prepared the vessel for its maiden fishing trip. Several installations and adjustments were made before the vessel was finally ready.

- A Taiyo ADDF direction-finder receiving and antenna unit was installed. A one-metre antenna stand was erected on the cabin roof, directly above the equipment console in the wheelhouse and on the starboard side of the main mast. The receiver unit was installed on the equipment console and a protected co-axial cable connected between the receiver and the antenna. The power cable for the receiver was connected to the main switch for the navigation and compass lights.

  Care was taken to ensure that the antenna poles were facing in the right direction and that the co-axial cable connected the right poles in the antenna with its counterpart terminals in the receiver. Tests conducted on the equipment recorded a 20° deviation to port, so a 20° starboard correction was made on the direction-finder azimuth (adjustment dial in degrees). The deviation was caused by the antenna stand being deflected to port when the bed was welded. Re-welding the stand bed in the fore and aft line can reset this error, although it is much easier to allow for the error on the direction-finder azimuth.

- Two branchline bins were constructed so that each could contain up to 500 branchlines. Meanwhile branchlines were constructed to a length of 15 m and floatlines to a length of 30 m. Two new radio beacons were pieced together and made ready for use. Twenty nautical miles of 3.5 mm monofilament mainline were wound onto the mainline reel.

- All power switches on board were traced and marked according to the functions performed.

- Fire extinguishers, first aid kit, safety and sea survival gear were installed.

- The ship's compass was installed on the equipment console, a slight distance away from the fore and aft vision of the helmsman. The reason for this was that the radar and GPS were previously placed in front of the helmsman, leaving no extra length on the power cables to relocate them. Having the compass placed in the current position did not pose any difficulties or inconvenience for the helmsman. The power line for the compass light was branched off the switch for the navigation lights.

- A marine AM/FM radio and cassette player was installed above the equipment console, forward of the helmsman position, with the antenna installed on the starboard side, aft of the retractable hauling-block beam. One speaker was installed on the outside bulkhead of the wheelhouse in the after deck, while the other speaker was mounted next to the radio itself. The power line for this equipment was doubled with the switch for the fore and aft hauling lights.

- A forward deck-light and a portable search-light outlet were positioned in the fore deck of the vessel. The power cable was doubled to the GPS switch on the main switchboard.

- A plywood storage box was fitted into the space between the port and starboard bunks. This served as the main storage area for all fishing gear and loose tools.

- The line shooter was repositioned to the centre line of the vessel so that it could be in direct line with the mainline reel. Denso tape (greased tape) was applied to all exposed fittings on the line shooter and the mainline reel.

- The operator's seat was repositioned to allow ease of movement while carrying out the fishing operations.

- Further work was required to install the main hauling-block adjustable beam and the lugs for the relay blocks, in convenient positions that would supplement the hauling and setting operations.

- An MOT (Ministry of Transport) survey was conducted that certified the vessel seaworthy and ready for trials.

2.2.2 Modifications and adjustments made during fishing trials

There were modifications and adjustments made to the project vessel during the course of the trials. These were done mainly to keep the trials alive and to ease the operations without holding up the vessel. A major set back was the failure of the mainline reel to maintain its sturdiness after only two sets, thus preventing further fishing until repairs had been done. Modifications and adjustments made during the course of the trials included:

Repairing and modifying the initial mainline reel while waiting for a replacement: While hauling in the second set of the first trip, the starboard flange on the reel developed a crack right round the welded connection to the drum core. This pushed the flange outwards (Figure 13) so that it rubbed along the main frame of the reel support. Fortunately, the flange did not exert too much pressure on the support frame, and the crew were able to retrieve the rest of the mainline under hydraulic power.

Figure 13: Broken weld and side of mainline reel pushed out

Because of this defect, plans were made to repair the reel and use it until a replacement reel could be purchased and fitted. Careful consideration had to be given to the method of repair because of the work load put on a longline reel, and the amount of stress estimated to be put on the reel by a tightly wound monofilament line.

The method of repair decided upon was simple and effective. The flange was pressed back to its normal position on the drum core and meticulously welded back into place. Two holes were drilled into the drum core through the hub of the flange from opposite ends. A stainless steel tapered dowel (120 mm long and tapering from 15 to 10 mm in diameter) was driven through each of the holes (Figure 14) so that it securely locked the flange into place, thus taking off part of the stress exerted on the welds holding the flange to the drum core. The same method of strengthening was applied to the portside flange to prevent the same defect occurring there.

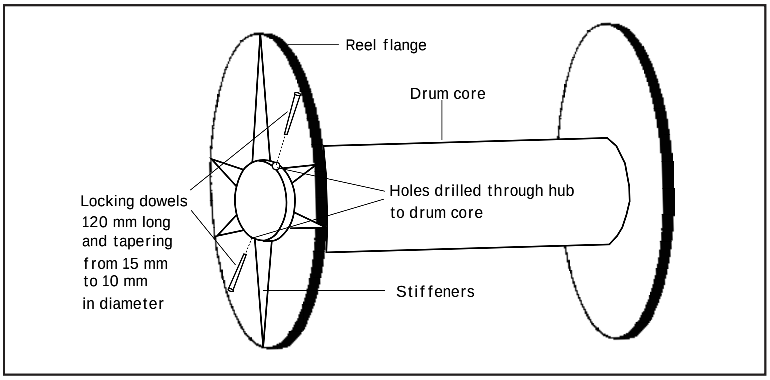

Figure 14: Tapered dowels used to lock the end flange onto the drum core after welding

After the repairs, the reel was able to sustain the workload expected of it without developing further defects. Eighteen more sets were executed with the repaired reel until it was removed to make way for a new reel, which had a greater line-carrying capacity and 'user-friendly' operational functions.

Meanwhile, the line shooter consistently met all its requirements.

Welding stiffeners on the forward-deck plating between the two catamaran hulls: On two occasions corrective stiffeners were welded to the forward-deck plating that joined the two catamaran hulls up forward (Figure 15). This deck plating acts as a walkway between the two hulls and is subject to head-on contact with the seas when the vessel is underway, especially when travelling into the weather. The tack welds on the crossbeams gave way during heavy seas. This was caused by the deck plating constantly buckling due to lack of stiffeners in between the crossbeams. The corrective measures taken were sufficient for the rest of the trials and no more major faults developed in this area.

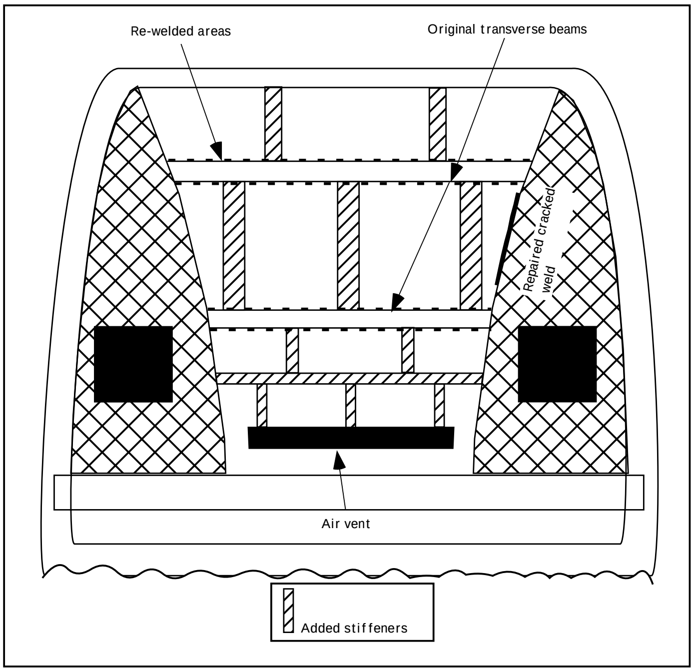

Figure 15: Stiffeners welded in place to strengthen the forward deck plate

Welding handrail to the overhead deck at the starboard working area: This handrail enabled the crew to move safely around the after deck during heavy seas.

Installing the new 'Smart Reel' and Seamech line shooter, including an extra lug to accommodate the relay block for the new reel: The replacement mainline reel and line shooter arrived in Samoa at the end of July, after construction and shipment from Fiji Islands. Because of the need for compatibility of the Seamech line shooter with the Smart Reel, the previous shooter was also replaced, although its performance had been satisfactory.

The reel was installed on the vessel with its length running in a fore and aft position (Figure 16). It would have been preferable to have the reel lying in an athwart-ship position (port to starboard—more space available aft for an ice box to be constructed on deck for carrying extra ice), although the motors on each side of the reel overlapped the fish-hold hatch covers, and would have interfered with the fish storage process.

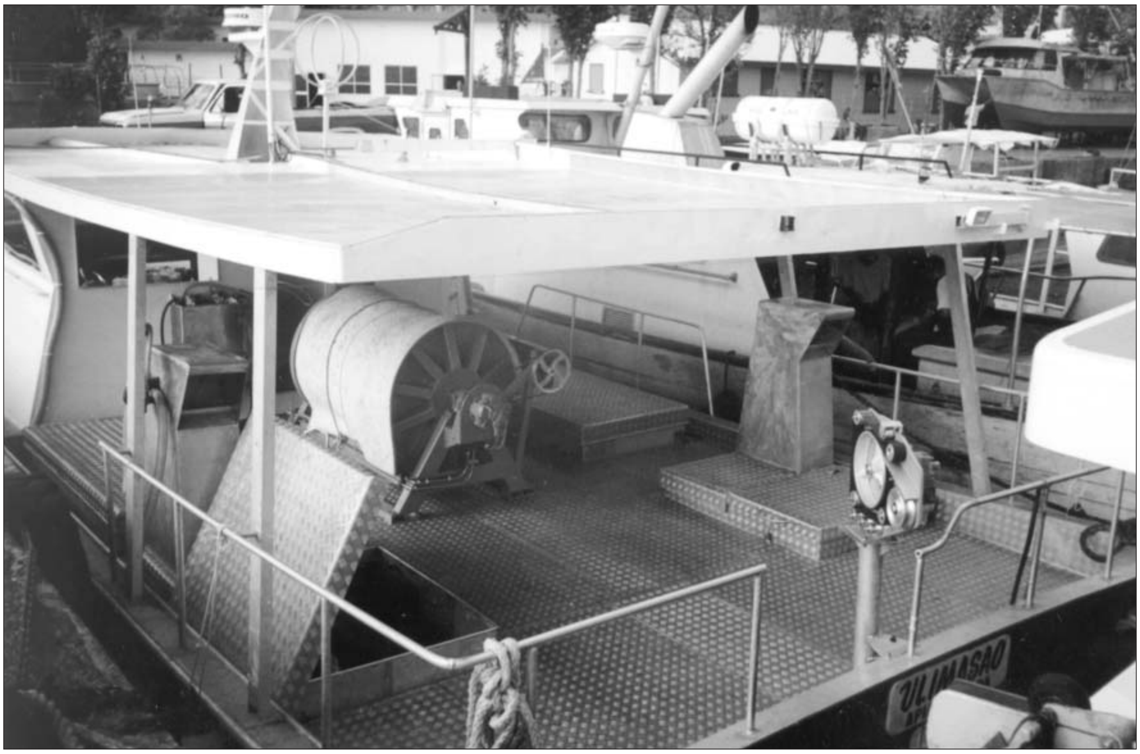

Figure 16: Seamech Smart Reel and line shooter installed on F/V Ulimasao

The Smart Reel and line shooter were much easier to use due to the coordination of the reel and shooter during the setting operation. During this phase, the reel is actively driven and the shooter draws the monofilament line off the reel with a controlled constant tension. This reduces 'line burns' and enables a consistent line-setting operation. Additionally, the Smart Reel is driven by two motors to provide multiple reel speeds and variable hauling power. Should one of the motors fail during operation, the mainline can still be recovered using the second motor. The Seamech line shooter is different to conventional line shooters, and has a rubber belt around the rollers with which to grip and guide the monofilament line to the outlet. An adjustable spring is attached to a roller on the belt by which the belt tension can be adjusted to accommodate knots running through the shooter.

Installing pump for deck water hose and heat exchanger: A new pump was installed in the port engine room to provide salt water for a new heat exchanger for the hydraulic system and deck hose. To install the new pump, improvisations had to be made to accommodate the water-intake hose. This was achieved by branching off through a 'T-piece' on the suction line to the toilet flushing system. The outlet from the pump was routed through the heat exchanger to supply cooling water for the hydraulic system, then out the other end as a deck water hose.

The pump is belt driven and is connected to a pulley coupled to the shaft between the hydraulic pump and the main engine. A link belt is used to connect the two pulleys during fishing operations and is disconnected when the vessel steams to and from fishing grounds. The maximum engine speed for running the pump is 2,200 RPM. This allows a smooth flow without the pump sucking air and thus causing friction on the rubber impeller.

2.3 Temperature/depth recording (TDR) equipment used on the project vessel

TDRs consist of a data logger and an interface unit. The data loggers are small microprocessor-controlled units that store data on temperature and depth over time to an erasable and programmable read-only memory chip (Anon, 1999). The interface unit is used to set the parameters of each logger (temperature and depth range), the time interval that the data is recorded, and the downloading or transfer of the data collected to a computer with the appropriate software, which comes with the equipment.

Close observation of the TDRs, in relation to the position along the line at which a fish is caught, can contribute tremendously to a fisherman's understanding of fish depth and desired temperature zone, and may help in deciding the depth at which to set the line, and increasing the catch rate.

The depth of the line will depend on the preferred temperature zone of the target species. If the depth recorded shows a temperature range not suitable for tuna fishing, the line-setting procedure can be changed by slowing down or speeding up the line shooter, the vessel, or both; by increasing or decreasing the number of hooks between floats; or by lengthening or shortening the floatlines.

During this project, each of the loggers was fitted by means of a one-metre monofilament line attached with a longline snap at the end. This is snapped onto the mainline as the line is deployed. Normally the centre position between floats is sought, as this should give the fisherman a better idea of how deep the line has actually gone in that section, and any changes in depth that have occurred as a result of currents or possibly fish on the line.

Before attaching or deploying TDRs, an initialisation process must be carried out. The activation time interval for the logger to record data, depth range and temperature range is recorded into each logger. This is done by plugging each logger into the Minilog computer interface unit and setting the parameters through the Minilog software programme on the computer used.

After use, the information is downloaded onto the main programme via the Minilog interface unit and an evaluation of the deployment can then be retrieved. The information is depicted in graph form, with a summary table attached.

In order to use the TDR equipment on board, a computer with appropriate software and the interface unit needs to be carried on each trip. The loggers can be set for a period of time that covers the whole trip, or the data can be downloaded after every set is hauled up. For fishing purposes, downloading after every haul will enable fishermen to assess how the previous set has gone and adjust the gear for the next set accordingly.

3. PROJECT ACTIVITIES, ON-BOARD TRAINING AND CATCH RESULTS

This project was originally scheduled to run for three months in Samoa. However, because of problems encountered with the original mainline reel, and the subsequent repairs and replacement with a new mainline reel, the Fisheries Division in Samoa requested an extension to the project. This was granted and the project was extended by six weeks.

During the project, a total of 30 longline sets were made during 11 fishing trips on board F/V *Ulimasao*. During this time, some modifications and adjustments were made to the vessel and fishing gear as outlined in Section 2 above.

As this was a new vessel, the skipper and crew were also learning about the boat and gear. To assist the skipper settle into a standard routine, the Fisheries Development Office developed a set of procedures to be followed for the starting of the main engines prior to departure on each trip. This included the checking of all oil levels and topping up when necessary. The main engine-starting procedures to be followed are listed in Appendix B.

3.1 Selection of fishing grounds

The selection of fishing grounds during the trials initially depended on information provided by other fishermen and careful observation of the catches that were landed. After the first trip, the approach was to go to the spot where fish were caught on the last set, and use this as a rough starting point. During hauling, a careful record was kept of where fish were caught along the line. The next set would be started around the area of greatest catch. If the catch for a trip was poor, the next trip would be started in a new area based on features taken from the chart and reports from other fishermen.

When starting in a new location, fishing grounds can be selected through a process of elimination to determine the more preferable areas. Firstly, navigation charts for the new location would be carefully appraised. Other factors to take into account include the position and depth of seamounts; layout of underwater contours and the depth at which the slope recedes, especially from the 1,000 m contour to deeper waters; and knowledge of the currents.

Other information essential for locating fish is the depth of the thermocline and the seawater temperature. With this knowledge, it is possible to determine areas of upwelling. Fish normally congregate around upwellings if the water temperature in the region is suitable. With modern equipment, seawater temperature and thermocline depths can be determined. Satellite information can be obtained to show the SST (sea surface temperatures) within the region of operation but the fisherman in many cases has to subscribe and pay to obtain this service or information (http://www.ccar.colorado.edu and http://www.cls.fr).

The Internet (http://www.vemco.com) gives free information on sea-surface height anomaly (altimetric maps) that is as good as the SST information. This shows the height of the sea level at different temperature zones. Warmer water has a higher height figure compared to cold water areas (Beverly, 2000). A fisherman may need to seek assistance from someone who has previously worked with SST charts or altimetric maps to be able to fully evaluate the information presented in them.

Altimetric maps were used for the last three fishing trips of the project visit, with good catches recorded on two of these trips. No conclusions were drawn based on the limited use of these maps, however, greater understanding of the information should lead to better catches.

3.2 Fishing gear and method

The fishing gear and method were consistent throughout the project fishing trials. However, effort did increase during the project once the mainline reel was replaced. With the original mainline reel, 700–800 hooks were used per set. These increased to 1,100–1,200 hooks per set with the new, larger-capacity reel.

3.2.1 Gear used

The fishing gear on board F/V *Ulimasao* with the new mainline reel consisted of 1,500 branchlines, 50 floats, five larger inflatable buoys, 50 floatlines, four strobe lights, two radio beacons, and spare snaps, hooks, crimps and 2.2 mm monofilament line. The mainline reel held 30 nm of 3.5 mm monofilament line.

The branchlines were made from 15 m of 2.2 mm monofilament line with a size 3.4 Japanese tuna hook crimped on to one end, and a 0.148 snap with 9/0 swivel crimped on to the other end. The branchlines were stored in three branchline bins, 500 in each. Observations have shown that longer branchlines of between 10 to 20 m in length result in more live fish being landed than shorter branchlines of less than 10 m in length. Therefore, preference was given to constructing branchlines of 15 m.

The floatlines were rigged from 30 m of 6 mm polypropylene rope with a Japanese floatline snap spliced into one end and a 15 cm open-eye spliced into the other. Negatively buoyant rope would have been better for the floatlines; however, this was not available at the time.

The floats were 300 mm diameter hard plastic longline floats. Each float had a 0.5 m by 6 mm polypropylene line spliced into the float handle, with a Japanese longline snap spliced into the other end. One radio beacon had a strobe light attached, with the remaining three strobe lights screwed into longline floats with the appropriate connection. All strobe lights were activated by a photo-sensitive cell. The larger inflatable buoys were of the Polyform A-series type, around 60 cm in diameter.

3.2.2 Method used

F/V *Ulimasao* has its working deck aft (Figures 16 and 17). Hauling is carried out from the starboard side. The vessel is steered from the wheelhouse, where the engine controls and the controls for operating the mainline reel are also installed.

For tuna longline fishing, the line setting operation is very important. The method of setting the line affects catch results and the length of time it takes to haul the line in. Before setting the line, several factors have to be considered that make hauling easier. These include the choice of fishing grounds, wind direction, position of the wind during setting and its relative position when hauling the line back in, direction of current, sea state, number of hooks between floats and the method in which the snaps are attached to the mainline.

Since F/V *Ulimasao* is a starboard-hauling vessel, it would be appropriate to have the wind straight ahead or fine on the starboard bow when hauling the line back in. This would allow the vessel to drift off the mainline when the vessel stops for gaffing fish or for any other reason. With the wind fine on the starboard bow, it would be easier for the vessel operator to manoeuvre the vessel during line hauling. There will also be less engaging and disengaging of the engine clutch, therefore less wear and tear on the gearbox. In order to increase the possibility of having the wind on the starboard bow when hauling the line back in, the wind should be placed on the port quarter when setting the line.

Line setting is conducted at a speed of around 6–7 knots, or 2,200 RPM on both engines. This allows the person baiting the hook sufficient time to remove the branchline from the bin, bait it and snap it on the mainline, and still maintain a consistent distance of 30 to 50 m between hooks. Two methods of line setting were used during the trials. One method free-spooled the line off the stern of the vessel through a block; the other used a line shooter. Using the line shooter is preferred, as it allows greater control over the positioning of the gear at the desired depth. Figure 17 shows the arrangement on F/V *Ulimasao*, when the line shooter is used for setting.

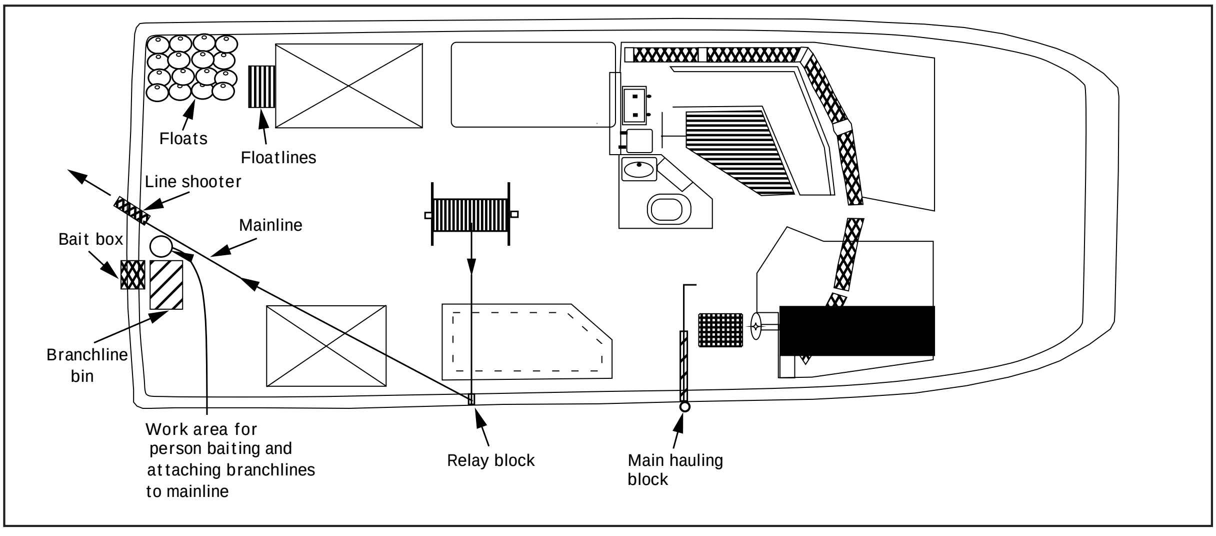

Figure 17: Setting arrangement when using the line shooter on F/V Ulimasao

Several numbers of hooks per basket were tried; 30 hooks between floats achieved better results, so this number was used in most sets. Whenever possible, setting was done across current or at an angle of about 20° to the current. This allowed the line to be trolled down current during the soaking process.

Setting was mostly begun after daybreak (0530 to 0630 hours). This was to prevent the sardine bait from being eaten overnight by undesirable species. Another reason was to allow the crew to observe clearly how the line is deployed and avoid the dangers of handling unfamiliar gear under artificial light. The duration of setting times varied from 3–3.5 hours, depending on vessel speed and on method of line setting.

When the line shooter was used for setting, the shooter speed was kept at 280 RPM. This achieved depths from 180 to 450 m as measured by the temperature/depth recorders. Setting the line at 320 RPM on the line shooter resulted in the mainline reaching 600 m in some places, which was too deep for fast hauling, as a lot of stress was put on the line. Fewer hooks were deployed with the faster setting speed as the space between hooks would be around 50 to 70 m in some places. This is because the crew can not to keep up with the faster rate of deploying the line and are unable to maintain a consistent rate of attaching branchlines to the mainline.

If a faster setting speed is required, this can be achieved by using two branchline bins and two crew to snap the branchlines to the mainline. The line-shooter speed and snap-on time can be calculated so that a consistent distance can be maintained between branchlines. Faster boat speed will require a faster line-shooter speed and a shorter period between ‘snap-ons’. For the purpose of these trials, the first setting method was sufficient for training.

It takes a crew approximately 7 to 10 seconds to unhitch, bait and attach the branchline to the mainline. At 280 RPM the crew is able to maintain a spacing of between 30 to 50 m, which, with 30 hooks per basket, will allow the line to settle at a suitable soaking depth.

Attaching the branchlines to the mainline is done in a left-to-right motion, with the clip in an inverted position. This will allow the person unsnapping the branchlines to do so with a downward movement, which is quicker and puts less strain on the hands.

For line hauling, one person steered the vessel and controlled the mainline reel from the cabin. Two crew were stationed outside the cabin. The first unsnapped the branchlines from the mainline as they came up to the main hauling block. This crew then passed the branchline snap to the second crew, who connected the snap to the bin and pulled the branchline into the bin for storage. The mainline continued around the main hauling block to the relay block, then onto the mainline reel (Figure 18).

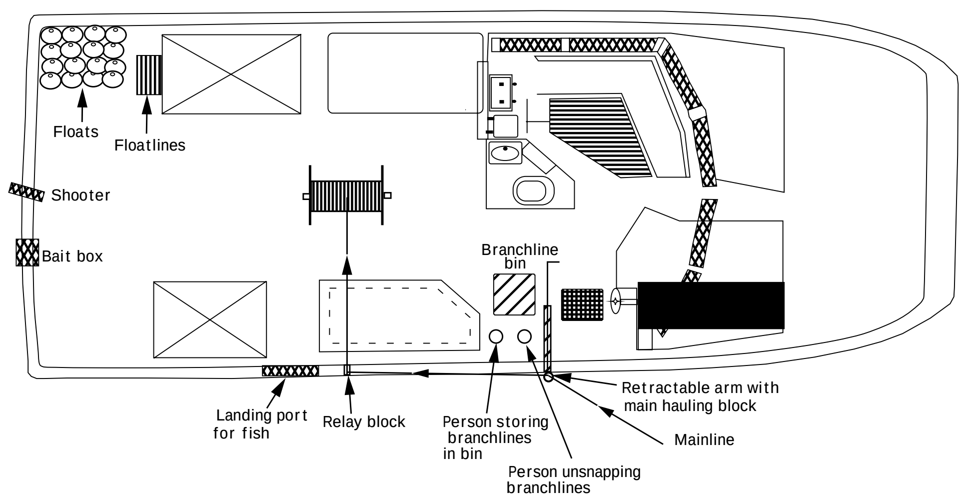

Figure 18: Hauling arrangement on F/V Ulimasao

A set of procedures was developed for both the line setting and line hauling operations by the Fisheries Development Officer. These procedures were followed prior to and during the operations, as a checklist for the skipper and crew. These procedures are presented in Appendix C.

3.2.3 Management of working space

The project vessel has ample working space for both the setting and hauling operation. Because the vessel is a catamaran design, a continuous deck joins both hulls. Management of the working area is important for ease of operations.

During line setting, only one branchline bin is used at a time. This is situated aft on the starboard side (Figure 17). The second bin is placed on the portside in readiness for changeover when the first bin runs out or in times of branchline tangles. The float deployment is done on the port quarter area. An ice chest is placed aft of the reel to hold the cases of bait to be used during the set. Small portions of around 50 baits at a time are transferred to the bait box. This ensures that the bait remains fresh until it is hooked on.

The rest of the working area is kept clear of obstacles to enable better manoeuvrability during line setting. Both engine hatches are kept clear for easy access when required.

For the hauling operation, a branchline bin is placed aft of the wheelhouse next to the hauling block (Figure 18). This enables the person who is unsnapping the branchlines and the person storing the branchlines to be within arm's reach of each other. As soon as a branchline bin is filled, it is immediately transferred aft. All the gear retrieved during hauling is placed in strategic positions on the vessel in preparation for line setting the next morning.

The fish-processing area was set up on the deck abaft the reel next to the shooter. This location is clear from all obstacles and allows the crew plenty of room to process fish.

3.2.4 Fish preparation and icing

Being experienced fishermen, most of the work done on F/V Ulimasao was not new to the crew and the trials served as a refresher period for them.

Figure 19: Fish gaffed in the head for boating

When boating a fish, the person gaffing must always ensure that the fish is gaffed through the head (Figure 19). This ensures that the flesh of the fish is kept intact allowing less chance for bacteria to enter the flesh and spoil the fish. In addition, most markets prefer fish that look whole rather than those marked in appearance.

The fish-processing method used by the crew is standard practice for fresh fish supplied to the Japanese sashimi market. Upon boating a live fish, it is immediately stunned with a fish bat, bled and spiked, and the *tanaguchi* method applied (a neat hole is cut around the soft spot on the head and a 3.5 mm monofilament line is inserted through the hole, and down the neural canal along the backbone of the fish (Blanc, 1996)). Sometimes the live fish is bled after has been stunned, spiked and the *tanaguchi* method has been applied. Fish that are dead when boated are only bled. The bleeding points on the fish are along the lateral line about a palm's width (around 10 cm) from the pectoral fin. A cut about 25 mm long and 25 mm deep is made on both sides of the fish across the lateral line at the bleeding points. The next bleeding points are on both sides of the tail around the fourth or fifth finlet.

Before each fish was cleaned, it was measured, with the length recorded, and tagged with an identification number. This was because it was too difficult to weigh each fish at sea. The tag allowed the identification of each fish when unloaded, so when it was weighed, the recorded weight could be matched to the recorded length.

Next, a hole was cut around the anus and the gill attachments in the gill cavity were severed. The gills and guts were then removed completely through the gill cavity (Blanc, 1996). The gill cavity was thoroughly cleaned of blood and the fish then prepared for icing. Fish were cleaned on a rubber mat at the back of the boat (Figure 20), away from the hauling operation.

Figure 20: Area for cleaning the catch before icing

During the trials, the most manageable amount of ice taken on board was found to be around 70 bags (1,750 kg). When the ice was first loaded, 10 bags (250 kg) were spread around the bottom of each fish hold to serve as the main bed for the first lot of fish. The remainder of the ice was left in 25 kg bags, to be used as fish were processed and stacked in the fish holds.

The space in the fish holds does not allow the crew much room to manoeuvre when storing fish, especially when the holds start to fill. To be able to accommodate a reasonable amount of fish in the holds, the fish had to be layered so they were touching and overlapping (Figure 21), then iced with a 150 mm thick layer over them to separate the fish layers. This method of icing fish is not ideal, although it should be sufficient for fishing trip that last up to five days. For guaranteed quality, it would be better to ice fish separately and without contact with other fish or bulkheads.

Figure 21: Layering the catch in the fish hold for icing

3.3 Training

An important component of this project was the training of the skipper and crew in all aspects of gear construction, fishing method, and handling, processing and chilling of the catch. To achieve this, the Fisheries Development Officer focused on each area of operation with the skipper and crew, individually and in groups, giving careful instructions.

Everyone on F/V *Ulimasao* was trained in: constructing gear; running and maintaining the main engines; steering the vessel and operating it during both setting and hauling operations; reading the GPS unit and using it for steering; using the mainline reel, hydraulic valve adjustments, and line shooter; baiting and attaching and unsnapping the branchlines to and from the mainline at speed; how to correctly handle, process and ice the fish; and how to maintain and clean the vessel properly.

In addition, the skipper was specifically trained in: using all the navigational equipment on board, especially the GPS and plotter; handling the vessel in different conditions, including approaching and leaving the wharf; and the finer points of the fishing operation, such as selecting fishing grounds and planning longline sets.

By the end of the project, the skipper and crew were very efficient at operating the vessel and the fishing equipment. The Fisheries Development Officer was confident that they were able to fully operate the vessel and continue to catch fish.

3.4 Results of fishing activities

Eleven fishing trips were carried out during the assessment trials of F/V *Ulimasao*, with 30 longline sets, using a total of 25,055 hooks. The saleable catch amounted to 1,070 fish weighing 16,838.2 kg, with the three main tuna species (yellowfin, bigeye and albacore) totalling 793 fish for a weight of 14,157.5 kg. The remainder of the saleable catch (277 fish weighing 2,680.7 kg) was made up of 12 different species, with the main ones by number being skipjack tuna (*Katsuwonus pelamis*—156 fish weighing 960.2 kg); mahi mahi (*Coryphaena hippurus*—28 fish weighing 200.6 kg); and wahoo (*Acanthocybium solandri*—21 fish weighing 226.0 kg). Billfish numbers were low at 20 fish; however, the saleable weight (headed, gutted and tail removed) was 983.0 kg. Table 1 summarises the catch taken during the project, while Appendix D gives a more detailed breakdown of the catch and effort by set.

Table 1: Total catch retained and the number of hooks set by the project vessel for all saleable tuna species: yellowfin, bigeye and albacore

Trip	No. of	All saleable spp.		Yellowfin tuna		Bigeye tuna		Albacore tuna	
No.	hooks	No.	kg	No.	kg	No.	kg	No.	kg
1	1,240	196	3,048.3	118	1,833.6	4	60.5	64	1,018.7
2	2,130	105	1,544.8	17	318.0			43	736.5
3	2,170	76	1,114.8	4	52.8	2	18.2	49	895.6
4	2,940	126	1,903.1	33	583.2	3	62.2	62	1,052.0
5	2,920	108	1,765.4	12	325.5	5	79.4	64	1,151.6
6	2,205	103	1,968.5	13	476.0	2	72.0	64	1,151.0
7	730	27	226.4	1	15.0			5	75.0
8	3,300	34	557.3	4	130.8	4	109.8	12	210.3
9	2,300	143	2,281.3	14	298.9	2	82.0	90	1,574.5
10	2,720	102	1,837.7	7	108.3	2	25.6	69	1,258.8
11	2,400	50	590.6			2	47.0	22	408.5
Total	**25,055**	**1,070**	**16,838.2**	**223**	**4,142.1**	**26**	**556.7**	**544**	**9,532.5**

Of the eleven trips, trip number seven was aborted so that the vessel could return to have the new reel installed, with only one set completed. On trip eight, pilot whales ate most of the fish and 90 per cent of the bait on the line for three consecutive sets. This resulted in very few tuna being landed (20 tuna weighing 450.9 kg). The number and size of the fish heads on the line indicated the catch should have been around four times more than was landed.

Table 2 summarises the catch per unit of effort (CPUE) for the main tuna species, with the species composition of the total catch provided in Appendix E. The overall CPUE for saleable species was 67.2 kg/100 hooks, although the CPUE on a per-trip basis varied from a low of 16.9 kg/100 hooks (trip 8), to a high of 245.8 kg/100 hooks (trip 1). Albacore tuna was the most predominant species (544 fish weighing 9,532.5 kg), with an overall CPUE of 38.1 kg/100 hooks. Yellowfin tuna was the second most common species (223 fish weighing 4,142.1 kg), with an overall CPUE of 16.5 kg/100 hooks.

Table 2: CPUE, percentage of catch and average weight (gilled and gutted) for all saleable species (All sale) yellowfin tuna (YFT), bigeye tuna (BET) and albacore tuna (ALB)

Trip	CPUE (kg/100 hooks)				Percentage by weight			Average weight		
No.	All sale	YFT	BET	ALB	YFT	BET	ALB	YFT	BET	ALB
1	245.83	147.87	4.88	82.15	60.15	1.98	33.42	15.54	15.13	15.92
2	72.53	14.93	0.00	34.58	20.59	0.00	47.68	18.71	0.00	17.13
3	51.37	2.43	0.84	41.27	4.74	1.63	80.34	13.20	9.10	18.28
4	64.73	19.84	2.12	35.78	30.64	3.27	55.28	17.67	20.73	16.97
5	60.46	11.15	2.72	39.44	18.44	4.50	65.23	27.13	15.88	17.99
6	89.27	21.59	3.27	52.20	24.18	3.66	58.47	36.62	36.00	17.98
7	31.01	2.05	0.00	10.27	6.63	0.00	33.13	15.00	0.00	15.00
8	16.89	3.96	3.33	6.37	23.47	19.70	37.74	32.70	27.45	17.53
9	99.19	13.00	3.57	68.46	13.10	3.59	69.02	21.35	41.00	17.49
10	67.56	3.98	0.94	46.28	5.89	1.39	68.50	15.47	12.80	18.24
11	24.61	0.00	1.96	17.02	0.00	7.96	69.17	0.00	23.50	18.57
Total	67.20	16.53	2.22	38.05	24.60	3.31	56.61	18.57	21.41	17.52

When looking at the different tuna species as a percentage of the total saleable catch, albacore was the most significant at 56.6 per cent overall, followed by yellowfin at 24.6 per cent. The bigeye catch was low at 3.3 per cent of the catch. The average size of both bigeye and yellowfin was small at 21.4 kg and 18.6 kg respectively, although small numbers of larger individuals were caught. For example, on trip six, the average weight for both yellowfin and bigeye was 36 kg. The average size for albacore was good at 17.5 kg.

Only small numbers of unsaleable fish were taken during the project, with this component consisting of 60 fish weighing 660 kg. Nine blue sharks (*Prionace glauca*) and four oceanic whitetip sharks (*Carcharhinus longimanus*) made up the bulk of this weight (555.0 kg). Although the flesh of the sharks was not sold, it was retained for consumption by the crew. The shark fins were sold to a local buyer.

3.5 Comparison of catch rates

It is difficult to directly compare tuna longlining catch rates between countries in the Pacific, as the species composition of the catch varies and some fisheries target different species. In some countries such as Solomon Islands and Papua New Guinea, the catch rate for yellowfin and bigeye tuna is naturally higher than countries like Fiji Islands, Tonga and Cook Islands. Therefore, the most appropriate countries to compare the Samoan catch rate with are those close by with similar weather and oceanographic conditions, such as Fiji Islands and Tonga.

When looking at the catch rates for domestic tuna longliners in Fiji Islands and Tonga over recent years (1996–2000) for the period May to August inclusive (the same fishing period as the current project), the overall catch rates vary between 38.8 kg/100 hooks and 68.7 kg/100 hooks for Fiji Islands, and 36.4 kg/100 hooks and 52.0 kg/100 hooks in Tonga (SPC Regional Tuna Fisheries Database). The overall catch rate for this Samoa project of 67.2 kg/100 hooks compares very favourably with these catch rates. This catch rate also compares well with that obtained in Samoa in 1999 (62 kg/100 hooks—Sokimi et al., 2000), although the fishing period was from October to December inclusive.

The percentage of the three main tuna species (yellowfin, bigeye and albacore) by weight in the catch, also varied from year to year in both Fiji Islands and Tonga. In Fiji Islands the catch of yellowfin and bigeye tuna combined varied from 15.7 to 27.8 per cent of the catch, while in Tonga the variation was from 14.4 to 45.6 per cent of the catch over the May to August period in different years (1996–2000). The catch of albacore tuna varied from 40 to 68 per cent in Fiji Island and 40 to 65 per cent in Tonga over the same period. The current catch level in Samoa at 27.9 per cent for yellowfin and bigeye tuna, and 56.6 per cent for albacore, fits well within the ranges experienced in Fiji Islands and Tonga. So too does the catch achieved in Samoa in 1999, with 31.3 per cent of the catch being yellowfin and bigeye tuna, with albacore tuna making up 55.8 per cent of the catch (Sokimi et al., 2000).

The one area where there appears to be a significant difference between the tunas in Fiji Islands and Tonga compared to Samoa is in the average size (weight) of some species. In Fiji Islands, the average weight of yellowfin tuna ranged from 23.5 to 28.5 kg, which was considerably higher than in the current project, at 18.6 kg, and also higher than the range in Tonga (17.8 to 19.7 kg). The average weight of bigeye tuna was similar in all three locations: in Fiji Islands the average weight was 20.0 to 24.4 kg; in Tonga 18.8 to 23.6 kg; and in Samoa 21.4 kg. The average weight for albacore tuna in all three locations was in the range of 16.0 to 18.0 kg.

3.6 Results from the temperature/depth recording (TDR) equipment

The use of the TDRs during the fishing trials proved to be an excellent way of determining a suitable setting speed for the vessel and the line shooter, so that the line finally settled around the desired depth for fishing.

During trip one, two sets were made. The first set was made without a line shooter, with the vessel speed at 6–7 knots. The TDRs were deployed between hook numbers 15 and 16, from the fourth section to the ninth section or basket of the full mainline. Each section or basket consisted of 30 hooks between floats, with a hook spacing of 30 to 50 m. The TDRs were meant to be at the centre of the sections so that the deepest depth between the floats could be measured. The shallowest section recorded for set one was 193 m, while the deepest section was 350 m. Average depth for the five TDRs was 285 m.

Set number two was made using the line shooter at a vessel speed of 6–7 knots, and the line shooter set on 280 RPM. The shallowest depth recorded for this set was 276 m; and the deepest 582 m. Figures 22 and 23 show the depths recorded on both set one (no line shooter) and two (line shooter used) on the first trip. On both sets, the line appears to have fluctuated considerably in its depth. This could have been the result of fish on the line (90 fish on 540 hooks during set one and 106 fish on 700 hooks on set two). There also appears to be a large variation in the maximum depth achieved at different locations along the line on set two, which could have been the result of currents at different depths. Also, TDR units may not have been positioned in the centre of the mainline between floats.

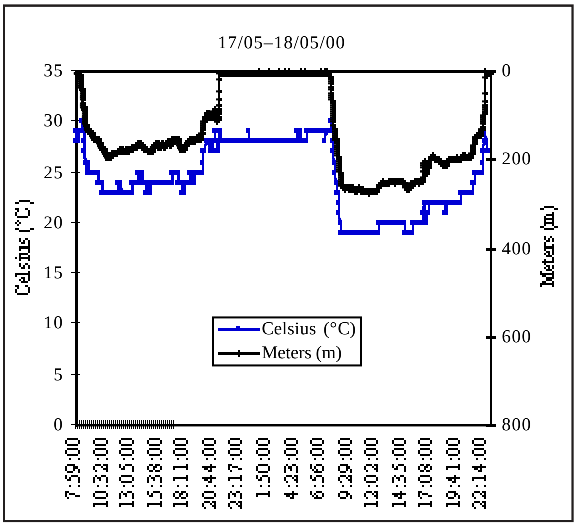

Figure 22: Temperature and depth profile for sets one and two on trip one on TDR No. 2

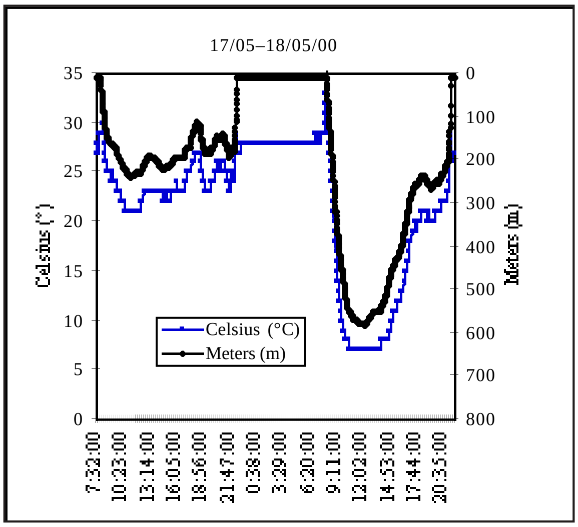

Figure 23: Temperature and depth profile for sets one and two on trip one on TDR No. 3

It was also determined during the trials that the best line-setting speed for the line shooter was 280 RPM, with a vessel speed of between 6 and 7 knots. In most cases, this speed allowed the line to settle at 300 to 600 m, depending on the current. When using the line shooter, the soaking time for the main-line can be shortened from six hours to three hours. The length of the soaking time depends entirely on the fishing master, and his calculations of the anticipated time it will take to haul up the total hooks in the water.

The TDRs provided useful information for comparing temperature preferences among different species. On all sets, the maximum depth targeted was around 500 m (Figure 24). This allowed the line time to sink to a sufficient depth so that, while soaking and hauling, the hooks are trolled through the different mediums of water and thus have more chances of attracting fish to the bait.

Most of the temperatures at depths of 500 m are below the range required for the target species of albacore, yellowfin and bigeye tunas. Temperatures of between 15°C and 19°C are best for albacore and bigeye tunas. These temperatures are commonly found between 200 and 400 m.

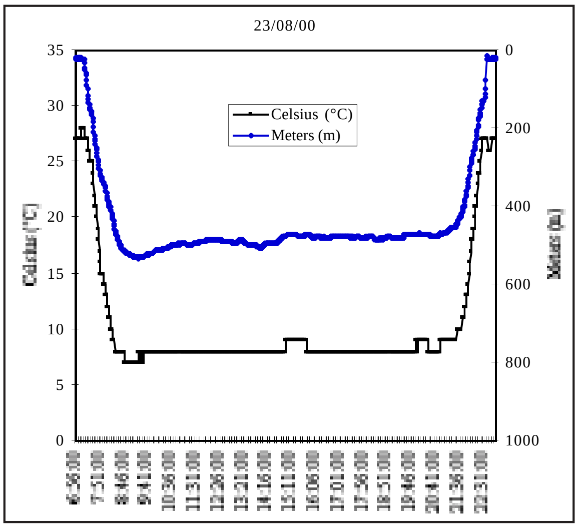

Figure 24: Temperature and depth profile from the last fishing trip, using a standard setting procedure

3.7 Disposal of the catch

The Fisheries Division was responsible for disposing of the entire catch. Export-quality fish and some bycatch were sold to local processors, while fisheries staff purchased some of the non-export species. Fish sales are covered in more detail under Section 4.

3.8 Results of the sea trials

The vessel was tested in several weather conditions and proved its seaworthiness to withstand conditions bordering on 30 knot winds, and very rough seas with swells between three and five metres in height. Although the vessel has shown these capabilities, prudent seamanship will ensure the vessel's safety at all times, and only in unexpected situations should the vessel be allowed to come up against such elements.

A point to note on the vessel's hull construction is that when the vessel is fully underway, the hulls lift and seem to skim on the sea surface. This also happens when fully loaded. During fishing operations, the vessel mostly remains above the wave crests and does not 'dig in' as some vessels tend to do.

When travelling into head seas with swells over two metres or swells that have a short period between wave crests, it is advisable to reduce engine speed so that the vessel rides comfortably above the swells. Running at full steaming speed in these conditions endangers the vessel. Occasionally the odd swell swamps the forward area; this puts a lot of pressure on the cross deck and could swamp the forward holds that are not watertight, as the hatch covers are only secured by ropes.

Additional corrective stiffeners were welded to the forward deck plating that joined the two hulls up forward on two occasions. This appeared to fix the problem of cracked welds. However, this area should be checked after each trip to ensure no future problems occur.

4. ECONOMICS OF THE FISHING OPERATION

One of the main objectives of this project was to assess the suitability of F/V *Ulimasao* as a tuna longliner for Samoan fishing conditions. To do this effectively, the economics of the fishing operation were examined to see if the fishing operation was viable. Given that fishing was conducted over a four-month period, the catch figures were extrapolated to cover the expected fishing period of ten months. This is based on anecdotal information that the period from February to April is unproductive for tunas, especially albacore, and reduces the fishing season of the longline fleet.

4.1 Income from fish sales

The Fisheries Division was responsible for selling all fish during the fishing trials. They sold fish to local processors, as well as to fisheries staff. In some cases, fish was given away to repay favours, or in the case of the first fishing trip, to meet traditional and customary obligations.

All fish were gilled and gutted at sea before chilling. When landed for sale, billfish and opah had the heads and tails removed before weighing and marketing. All other saleable species were sold in a gilled and gutted form, or cut into chunks and sold to fisheries staff. Records were kept of all fish sold, with the weights and value recorded.

The purchase price paid by processors varied by species, and in some cases, such as yellowfin and bigeye tuna, by size of fish as well. The price paid for albacore tuna was consistent at WST 5.95/kg. For yellowfin and bigeye tuna, the price varied from WST 2.20/kg for small fish, WST 3.10 or 4.85/kg for medium fish, and WST 7.50/kg for large fish. Broadbill swordfish sold for WST 4.40/kg (trunked), marlin for WST 2.20/kg (trunked), and opah for WST 5.95/kg (headed and gutted). Other bycatch species sold for an average price of WST 2.20/kg. Table 3 summarises the income from fish sales for the entire project, on a per-trip basis. The total saleable catch of 16,838.2 kg had a wholesale market value of WST 81,956.80, which gives an average price of WST 4.87/kg.

Table 3: Income from fish sales (an average price of WST 2.80/kg was applied to the unsold catch to calculate a total value for the saleable catch)

Trip No.	Landed catch	Catch sold		Saleable catch unsold		Estimated value of total catch
	Weight (kg)	Weight (kg)	Value (WST)	Weight (kg)	Estimated value (WST)	(WST)
1	3,048.3	2,313.9	9,791.19	734.4	2056.32	11,847.51
2	1,544.8	1,088.2	5,657.47	456.6	1278.48	6,935.95
3	1,114.8	969.1	5,477.62	145.7	407.96	5,885.58
4	1,903.1	1,789.2	9,273.18	113.9	318.92	9,592.10
5	1,765.4	1,549.2	9,221.92	216.2	605.36	9,827.28
6	1,968.5	1,722.3	9,954.14	246.2	689.36	10,643.50
7	226.4	98.2	357.00	128.2	358.96	715.96
8	557.3	395.0	2,568.07	162.3	454.44	3,022.51
9	2,281.3	1,864.8	10,040.84	416.5	1166.2	11,207.04
10	1,837.7	1,733.5	9,087.29	104.2	291.76	9,379.05
11	590.6	420.4	2,423.75	170.2	476.56	2,900.31
TOTAL	**16,838.2**	**13,943.8**	**73,852.47**	**2,894.4**	**8,104.3**	**81,956.8**

All sharks caught during the fishing trials were retained for the crew to take and share with their families. The fins from these sharks were sold at WST 30.00 per set (dorsal, two pectoral and bottom tail lobe). The value of the shark fins has not been included in the total value of the catch.

4.2 Costs associated with the vessel and expenditure for the fishing operation

It is difficult to come up with an exact cost for the first vessel built to a new design, which is the case with F/V *Ulimasao*. This is due to a range of issues, including additional costs being incurred through minor changes to the design during the construction, possibly some trials or experiments to correct certain aspects of the vessel, and sorting out where different equipment will fit best, especially in the engine rooms. Quite often, the design of the vessel evolves with the construction to iron out any problems that are encountered. Therefore, the second or third vessel built to a new design will often cost less to construct than the first.

Table 4 summarises the main costs of constructing and rigging F/V *Ulimasao*, while Appendix F provides a more detailed breakdown of this expenditure. The overall cost of F/V *Ulimasao*, ready for fishing, was around WST 384,713 (USD 124,101). This included the latest in electronic equipment and appropriate sea safety equipment for this size of vessel. For ease of calculation, a nominal value of WST 400,000 has been applied to this boat.

Table 4: Summary of costs associated with the construction and rigging of F/V *Ulimasao* (costs provided by the Samoan Fisheries Division with some fishing gear costs estimated)

Item	Cost in Samoan tala (WST)	Cost in New Zealand dollars (NZD)	Cost in US dollars (USD)
Cost of boat and labour	144,461	91,431	46,600
2 Yanmar diesel engines	98,682	62,457	31,833
Electronic and navigation equipment	36,474	23,085	11,766
Sea safety equipment	3,496	2,213	1,128
Smart Reel, line shooter and hydraulics	51,150	32,373	16,500
Sub-total	**334,263**	**211,559**	**107,827**
Fishing equipment	50,450	31,930	16,274
TOTAL	**384,713**	**243,489**	**124,101**
Additional six-man liferaft	9,480	6,000	3,058
Additional sea anchor	6,000	3,797	1,935

Exchange rates used: USD 1.00 = WST 3.10; NZD 1.00 = WST 1.58

Note: A vessel value of WST 400,000 is suggested for all calculations

4.2.1 Fixed costs

The fixed costs associated with a fishing operation include the repayment of a loan on the vessel, annual depreciation of the vessel's value, insurance, boat repairs and maintenance, and licensing or registration fees. Table 5 summarises the fixed costs for F/V *Ulimasao*, based on a vessel value of WST 400,000.

Table 5: Summary of the annual fixed costs based on F/V *Ulimasao* valued at WST 400,000

Item	Annual value (WST)
Annual loan repayment based on 12 per cent interest	48,000
Depreciation of the vessel at 10 per cent per year	40,000
Insurance based on 9 per cent of the vessel's value	36,000
Annual cost for repairs and maintenance estimated at 3 per cent	12,000
Annual licence or registration fees	700
TOTAL	136,700

4.2.2 Variable costs

The variable costs are those associated with the actual operation of the vessel. Table 6 summarises the variable costs for the fishing operation of F/V *Ulimasao*, while Appendix G provides the variable costs on a per-trip basis.

Table 6: Variable costs recorded for all operations of F/V *Ulimasao* over 11 fishing trips

Item	Amount	Value (WST)
Diesel fuel @ WST 1.1959/l	5,292 l	6,329.46
Oils (lube and engine)	160 l	865.38
Bait in kg (in cartons of different sizes)	1,205 kg	9,621.62
Ice in 25 kg bags (WST 8.00 reducing to 6.00/bag)	672 bags	4,916.00
Victuals (food)	–	2,240.00
Replacement fishing gear	–	950.00
Other	–	1,437.00
Sub-total	–	**26,359.46**
Crews' wages based on 20 per cent of the sold catch value shared between them	–	14,702.44
Total		**41,061.90**

The total for the variable costs excluding wages came to WST 26,359 for the 11 fishing trips, or an average of WST 2,396 per trip. The trips themselves varied in length from three to six days (one to four sets). The effort also varied from 700–800 hooks set on average for the first seven trips, and from 1,100–1,200 hooks used per set for the last four trips. The increased number of hooks being set increased bait usage on the last four trips, and hence the cost of bait. Ice usage also increased from 60 bags per trip for the first 4 trips to 70 bags per trip for most of the remaining trips, although the cost dropped from WST 8.00 to 6.00/bag. Therefore the cost of ice remained somewhat consistent. Wages for the skipper and crew were paid on a flat value of 20 per cent of the income from fish sales shared between them, so if some fish were not sold, the crew did not earn any wages from these fish.

Over the 11 trips, the combined fuel consumption for both engines was recorded as low as 5.206 litres/hour and as high as 8.0 litres/hour (Appendix H). Several factors contribute to the variable fuel consumption recorded, such as engine speed, the vessel's load condition and the weather situation.

On trips two and five when the cruising speed was set between 4 and 5.5 knots with engines at 1,500 RPM, low fuel consumption was recorded. Where the speed was increased to 3,000 RPM during trips one, eight and nine, the vessel's speed reached between 8 and 11 knots, with a high fuel consumption recorded for those trips. The results from the trials reveal that the most practical cruising speed is achieved at 2,500 RPM on both engines. This will give the vessel a speed of between 6.5 and 10 knots and the combined fuel consumption for both engines will vary between 6.5 and 7.2 litres/hour.

4.3 Projection of annual vessel economics and viability

The projections of annual vessel economics and viability are based on the catches and expenditure recorded by the F/V *Ulimasao* over the course of this project. A fishing trip is considered to be four to five days at sea with three sets made per trip. Ideally the vessel should work 1,000 hooks per set. Using the CPUE achieved during the fishing trials of 67.2 kg/100 hooks of saleable fish (Table 2), this would give a catch of 672 kg/set of 1,000 hooks, with a three-set trip catch of 2,016 kg of saleable fish. To give a total value to the catch, an average price per kilo of WST 4.87 is used (average price calculated from Table 3 for the total saleable catch).

The vessel cost is around WST 400,000 (Table 4) with the annual fixed costs calculated at WST 136,700 (Table 5). The variable costs for the fishing trials, excluding salaries, amounted to WST 26,359.46 for the 11 trips. This would average out to WST 2,396.30/trip. Given the increase in bait use and cost associated with setting 1,000 hooks per set that is not truly reflected in the average, the estimated variable cost per trip should be increased slightly to WST 2,500/trip. This does not account for any additional ice that may be carried if a deck ice box is used in future.

Three projections are presented to show a range of different fishing strategies. If two complete crews are rotated on the vessel (one trip on and one trip off), allowing a quick turn-around between trips, then 60 trips could be completed in one year. If the owner wishes to rotate the crew so that each crew member fishes say, three trips and has one trip off, then it is anticipated that 50 trips could be completed in one year. If a single crew is used for all fishing operations, then 40 fishing trips could be realised in one year. Under these three different fishing strategies, the annual profits that can be generated are presented in Table 7.

Table 7: Profit/loss projections for an annual fishing operation using different fishing strategies, based on the catches and expenses recorded during the fishing trials on F/V *Ulimasao*

Item	Value (WST) for 60 trips	Value (WST) for 50 trips	Value (WST) for 40 trips
Income			
Based on one set being 1,000 hooks with 3 sets made per trip, CPUE being 672 kg/set (2,016 kg/trip) and an average sale price of WST 4.87/kg	589,075	490,896	392,717
Expenditure			
Fixed costs for one year	136,700	136,700	136,700
Annual variable costs	150,000	125,000	100,000
Salaries based on 20 per cent of catch value	117,815	98,179	78,543
Total expenditure	404,515	359,879	315,243
ANNUAL PROFIT	**184,560**	**131,017**	**77,474**

The figures presented in Table 7 should be viewed as a guide only, as there are so many variables that can influence income or expenditure. If the catch rate goes up or down, this will have an effect. If the price of fuel or bait or ice increases, then the expenditure will increase, reducing profits. If the average sale price of the catch increases, then the profit margin will also increase. Therefore caution is required when interpreting these figures and the likely profit margin.

5. DISCUSSION AND CONCLUSIONS

The results of the longline fishing and sea trials for the prototype 12.2 m *super alia*, F/V *Ulimasao*, are very encouraging. The vessel is feasible for the fishing operations in Samoa and has proved itself over the eleven trips that were conducted. The present design is adequate to conduct full-scale longline fishing operations and the vessel is a large improvement on the smaller *alias* in the fishery. The increased size and stability of the vessel; below-deck insulated fish holds; the added safety and efficiency of the twin diesel engines; the cabin for accommodation and the latest navigational equipment, all make this a good small-scale tuna longliner that appears to work well under Samoan fishing conditions.

The assessment of the F/V *Ulimasao* focused mainly on six major areas: engine performance; structural durability; hydraulic fishing gear; fishing operations; vessel economics; and the suitability of the ice hold for fish preservation. Unfortunately, the cost of constructing F/V *Ulimasao* went well over budget, and the expected 40-day construction time ended up being 23 weeks. However, with the design on hand and the experience gained in building the first vessel, future vessels of this design should be constructed at a much lower price and in a shorter period than the prototype.

The twin Yanmar engines performed admirably and demonstrated that the horsepower produced by both engines was more than sufficient to power a boat of this size and take the load of the hydraulic fishing gear. Fuel consumption by these engines showed that the vessel could be run economically. The new mainline reel was installed using the same hydraulic system except for the installation of a heat exchanger to cool the hydraulic oil. This system is adequate to conduct the fishing operation effectively, although there is room for improvement, especially in the line-setting operation.

While the original plans for the vessel indicate that it can carry up to four tonnes of ice, the trials showed that for practical purposes, 1.8 t is more realistic and comfortable to work with. If need be, 2.0 t can be taken on a fishing trip. The vessel's ice and fish holding capacity is another area that can be improved.

When viewing the economics of this fishing operation, consideration has to be given to the fact that the trials on F/V *Ulimasao* were conducted under semi-commercial circumstances. However, despite this limitation, the economics of the operation based on the achieved saleable catch were profitable. There is room for improvement in some operational aspects, although this will be hard to achieve under a government system.

A second *super alia* is currently under construction by the same boat builder who built F/V *Ulimasao*. This vessel is targeted for the private sector and is expected to be built within the 40-day time frame at a cost lower than that of the prototype. Several modifications to the original design will be made on this vessel, based on the results and recommendations from this project.

Several improvements could be made to the vessel, the fishing operation, and the ongoing maintenance of the vessel. These are discussed below under three headings. These improvements focus on improving vessel and fishing performance and crew comfort, which should in turn relate to increased income or profit over time.

5.1 Changes and modifications to the vessel

At the bow of the vessel, the deck joining the two catamaran hulls developed cracks in the tack welds on two occasions. During heavy seas, this area is constantly pounded by swells when the vessel dives into troughs. Extra stiffeners have already been welded into place although it would be advisable to frequently check this area for defects, and reweld or add additional stiffeners if required. This area should be considered carefully when drawing up new or modified plans, and during construction, so that the stiffeners that are put in coincide with the calculations for supporting the surrounding structure. Another potential problem is that the stiffening ribs are all exposed, with water settling in some locations. It would be appropriate to have a deck plate over the top of the ribs to cover them. This will add strength to the area, allow the water to disperse quickly, and provide a safer walkway for the crew when working in the bow area.

The accommodation ventilation consists of a vent that opens up onto the bow of the vessel (Figure 25), a starboard window for the hauling station and an aft window above the galley stove. While the bow vent works very well in calm weather, the weather board could be slightly corrected to prevent water from splashing into the accommodation during rougher seas. Increasing the height of the board and giving it a forward slant might improve the situation (Figure 25). The portside of the accommodation is fully closed up. Twin ventilators on the cabin roof over this accommodation will increase the airflow in this area a great deal.

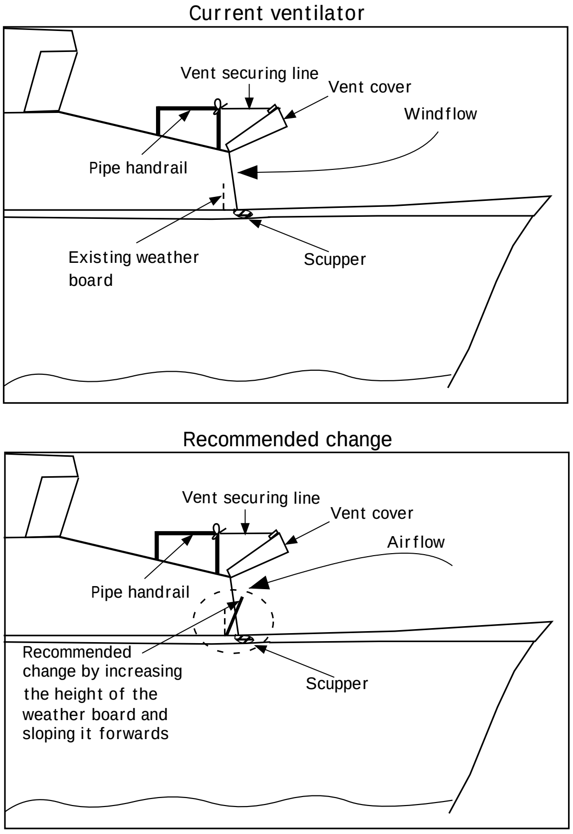

Figure 25: Suggested modification to bow ventilator weather board

The port engine-room ventilator requires a bigger deflection plate to be welded to the bottom of the ventilator. The ventilator opening is directly above the alternator, so that, during heavy weather, water enters through the vent and drips directly onto the alternator. The current deflection plate has been bent to offer better protection to the alternator, although a bigger plate would cover all bases. The vent for the starboard engine room does not lie directly above the alternator; any water entering this vent goes directly into the bilge.

Supporting brackets are rigidly connected to the exhaust to support the main engine from vibrating. It would be prudent to connect a flexible coupling around the area where the exhaust connects onto the rubber hose outlet, as the engines tend to vibrate when starting, stopping and while travelling. With the current rigid connection, continuous vibrations might cause the exhaust to crack over a period time.

The vessel's freshwater capacity (1,000 l) is too much for a vessel of this size. One of the reasons for having freshwater tanks of this size located forward of the fish holds is to act as ballast, to counter-balance the aft weight as fish are loaded into the holds. However, this balance could have been achieved by other methods more advantageous to the fishing operation. The fishing trips undertaken by F/V *Ulimasao* only require 200–400 l of fresh water to be carried.

The freshwater tank continues forward of a bulkhead at the forward end of the fish holds. If the fresh-water tanks are reduced to contain around 150 l each, then the remaining space can be used to carry fish and ice. Instead of ending where it does now, the bulkhead and fish holds can extend to the end of the bunks. The ice and fish in the holds then act as the counter balance for the weight at the stern. This is more permanent since water is continuously used up during the fishing trip, whereas the ice is replaced by fish weight. Thus there will always be weight in the forward area during a fishing trip. This modification would increase the carrying capacity for ice by around 250 kg in each hold.

The freshwater tanks currently do not have air vents, which causes the water to develop a smell reminiscent of unventilated well-water. At the next dry-docking, or sooner if possible, vent lines should be connected to the tanks to allow them to breathe.

The current fish-hold hatch covers are 1.75 m x 1.15 m, and are quite heavy. Having such a large opening for an ice hold is useful for loading ice or for discharging fish. However, for operations out at sea, this opening is too large; cold air is lost when the hatch covers are opened, causing the ice to melt faster. The hatch cover is heavy, so the crew are reluctant to store individual fish away and will wait for a worthwhile number of fish to accumulate before they open the hatch cover and ice them down. The hatch covers also have no handles to aid in lifting.

While every effort is made to train crew in the proper methods of fish handling, cumbersome objects often deter the crew from fully complying, especially during heavy seas and long working hours. The hatch covers should be reduced to half the present size so that two lids cover the fish-hold opening, each with flush handles (Figure 26). One of the lids should have a smaller 'manhole' opening to allow crew to enter and leave the fish hold for small items. In this way the crew have three options for entering the fish hold.

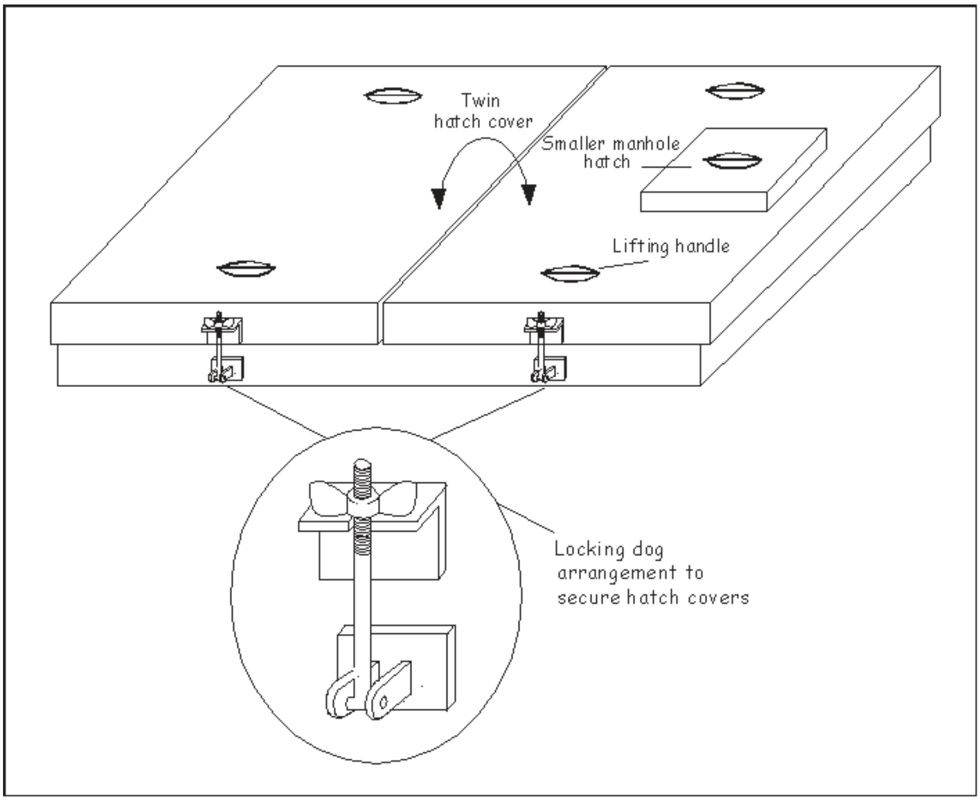

Figure 26: Suggested modification to fish-hold hatch covers, showing flush handles and locking-down dogs

All the hatch covers on board the vessel are lashed down with ropes and are not watertight. This could cause the vessel to be swamped in heavy weather. It is essential that an ocean-going vessel is watertight. Therefore, all hatch covers should be changed to have sit-on hinges on one side and a proper 'dogging-down' arrangement on the other for securing the hatches when underway or not in use. Figure 26 shows a common dogging arrangement that could be used on all hatch covers.

The fishing port in Apia is regularly congested with fishing boats. On most occasions the vessels can be seen tied up three and four deep. In situations like this, when inside vessels want to get out there is always the possibility that anything protruding beyond the hull could be bumped or damaged. An example of this would be the rudders on F/V *Ulimasao*, which protrude out beyond the stern. An overhanging tray covering the rudders should be rigged across the full width of the vessel's stern (Figure 27). Not only will the tray protect the rudder, but it also provides additional space for line setting. The line shooter would need to be moved to the aft top rails of the basket (Figure 27). When travelling to and from fishing grounds, the tray can be used as a storage area for floats, with some netting thrown over the top to secure them. This reduces the need to continuously transfer floats from the forward holds to the setting station aft.

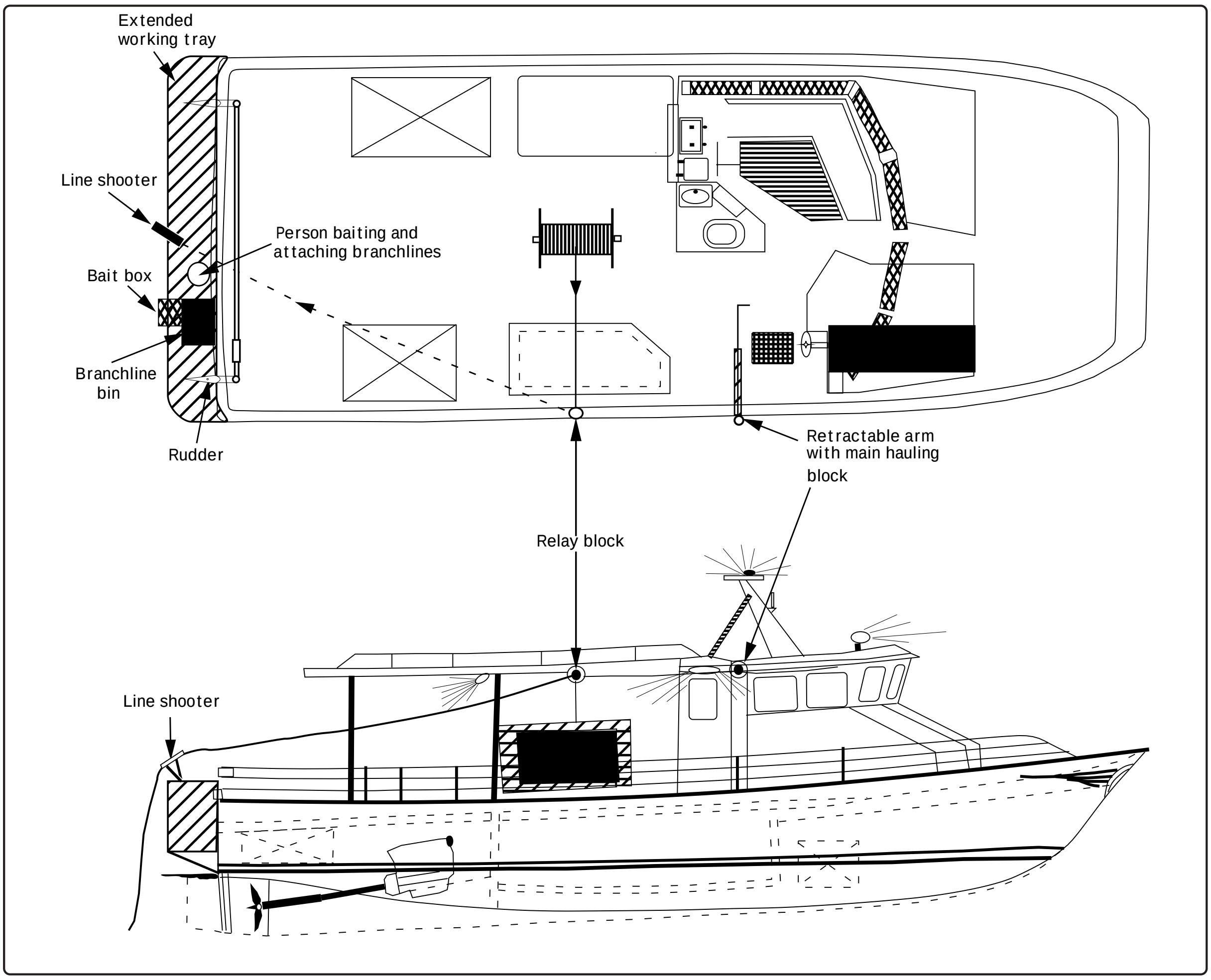

Figure 27: Proposed tray at the stern of the vessel to protect the rudders and provide additional work space

The side rail at the hauling station on the starboard side of the vessel needs to be extended forwards another 80 cm at the same height, to give the person unsnapping the branchlines more room to safely move around while working. This will also add to the safety of the crew moving through this area to get to the bow.

The dining table was hardly used during the sea and fishing trials, because of congestion when meals were prepared and because there was not enough seating for all the crew. The meals were rather set out on the after deck. The table should be removed to allow freedom of movement around the accommodation. The open space can then be used for meals in bad weather, and for sleeping.

5.2 Changes and modifications to the fishing gear and operation

For a vessel with an aft working deck, the ideal hauling station is separate from the wheelhouse console. This enables the operator to perform the three duties involved in line hauling: steering the vessel; unsnapping the branchlines; and controlling the mainline-reel speed. The advantages of having the station aft is that the operator, while having full control of the vessel and gear, can also feel fish on the line and can slow the vessel or adjust the reel speed accordingly so that the fish is not ripped off the line. In this way the hauling operation can be conducted in a shorter period of time and have an extra crew to perform other duties. Where crew are paid according to the catch they bring in, one less crew on fishing trips means a bigger share for each.

The system on F/V *Ulimasao* is workable, although for the long term, it is essential that more than one operator takes the helm. The problem is that the steering wheel and the engine controls face fore and aft, while the operator has to constantly face starboard to perform the hauling duties. Being repeatedly in this unnatural posture will result in the operator losing concentration, getting tired, and being at risk of accidents. If the crew regularly rotate steering duties, there will be less chance of accidents.

The operator's starboard window should be changed to a watertight sliding window to prevent rain and seawater from entering the wheelhouse. This will allow the operator to limit the opening when it is raining or when there are rough seas.

The main engine controls are cable operated and are situated within arm's reach of the operator, on the console to the right of the steering wheel. Each engine has a separate control for engaging the clutch and for operating the engine revolutions. Each engine also has a trolling valve that can be operated to a recommended 1,200 revolutions. While the clutch and engine throttle controls are necessary for manoeuvring the vessel, the trolling valves are unnecessary for longline operations, especially with twin engine vessels, and should not be placed on future vessels.

The pump for the hydraulic system is currently being driven directly off the main port engine. The pump is permanently connected to the main engine by a durable hardened plastic coupling. With this system, the hydraulic pump is continuously operated as soon as the port engine is started. If a problem develops along the hydraulic lines, the port engine will have to be shut down for repair. The hydraulic lines, leading from the tank to the pump then back through the return line and flow control valve, are constantly under pressure as soon as the port engine is running.

Hydraulic oil flow can be diverted to the reservoir without having to go through the whole system, but it still has to travel through the pump and back through the return line. This diversion is done by shutting down the flow control valve, so that the lines leading to the mainline reel and line shooter will have no oil flow and will not be subject to oil pressure during the voyage. The best solution though is to install a clutch system (electric or manual) between the main engine and the pump. In this way, the pump can be disengaged when not required and engaged when fishing operations begin. This will save the pump from unnecessary wear and tear and the oil viscosity from thinning out too soon.

Every vessel operator has a different way or style for hauling back the mainline. The main priority though, must be to ensure that the mainline does not get caught on the propellers and break, as this will result in gear being permanently lost or delays in the fishing time. While hauling, it is wise to keep a narrow angle between the vessel and the mainline and ensure that the vessel absorbs as much of the stress as possible. This will safeguard the line from breaking.

With twin-engine vessels, it is best to use the engine opposite the line-retrieving area to manoeuvre the vessel. This ensures that the engine on the hauling side is idle and less likely to catch the trailing branchlines. Only in rough seas and strong winds should both engines be used for hauling. Normally, only one engine is necessary to carry out fishing movements while the other engine can be used to balance off the movements when necessary. It would also be sensible to have the regularly dormant engine drive the hydraulics during hauling while the other engine drives the vessel.

For future designs, thought should be given to setting-up the system so that the hydraulics run off the engine on the hauling side, while the engine opposite the hauling side can be used to propel the vessel. This will at least divide the work load between the two engines.

Two different-sized mainline reels were used on the vessel during the fishing trials. The first held up to 20 nm of 3.5 mm monofilament, while the second held up to 30 nm of 3.5 mm monofilament mainline. The first reel was mounted athwart-ships, while the second, larger reel had to be mounted fore-and-aft, which used much more deck space. The ideal mainline reel for this size of vessel would be one that holds up to 25 nm of 3.5 mm mainline. A reel of this capacity should be of a suitable size to be mounted athwart-ships close to the back of the cabin. This will minimise the deck space used for installation, thus providing more workspace or storage areas.

The limited ice-carrying capacity of this vessel, and a possible means of increasing the capacity both for ice and fish, was discussed in the previous section. Even with larger fish holds, the capacity for carrying ice remains limited compared to that for fish, if the catch is to be iced correctly. To overcome this, an additional 1,000 kg of ice could be carried in an ice box on deck. A marine architect will need to be consulted to determine whether the extra weight will suit the vessel's load ability, or work against it.

If deemed safe, a suitable ice box should be constructed. However, the deck ice box must only be used for carrying ice, with all fish being iced in the fish hold. No fish should be iced in the deck ice box, as this may alter the stability of the vessel as it fills with fish during a fishing trip.

It was noticed during the last trip of the trials that the forward searchlight and the forward bow light both feed off one line and the same secondary switch. This set up is not practical for searching purposes as the glare of the forward deck light inhibits the searcher from peering out into the wake of the searchlight. When searches are carried out at night, the vessel needs to be in complete darkness with only the searchlight beam searching the waters and the searchlight forward of the user. Separate switches and power lines should be rigged up for the two lights so that they work independently of each other. Main switch number six was not in use, so the forward deck light can be connected directly to this.

Storage space for fishing gear on the vessel is very limited. A plywood storage box has been temporarily rigged in the space between the sleeping berths and directly below the forward vent duct. Fishing gears and spare parts are located in this area for easy access during operations. These include strobe lights, hooks, crimps, crimping machine, tool box, blocks, spikes, gloves, and batteries. A permanent aluminium box should be welded in this area with the edges rounded off to prevent injury to the crew. Permanent storage areas can also be built beneath the galley settee and the Captain's bunk.

The Fisheries Division should look at purchasing an autopilot for the vessel in the near future. It will not be difficult to integrate an autopilot into the current steering system. An autopilot will travel the shorter route between any two given points and will greatly minimise the workload of the crew. One point preventing a good catch is the crew's reluctance to steer the vessel to shift fishing grounds after a hard night's hauling in poor fishing grounds. In most cases, the crew can maintain a good watch but are too tired to concentrate on steering the whole way to a new fishing ground. A watch alarm can be set on the autopilot or the GPS, which requires the crew on watch to reset the alarm at designated times.

During line setting, the autopilot relieves one crew to perform other duties. With an autopilot, the line-setting operation can be pre-planned and the coordinates for altering course fed into the memory. Using the navigation mode, the vessel will automatically steer the coordinates chosen and alter course when required. Fuel consumption will be lower than when manual steering is performed, and the course steered will be straighter.

The landed catch can be recorded in an organised manner if done by the vessel's crew. One person should be held fully responsible for the discharge of fish ashore, the vessel's skipper. At present, many people are involved, which makes it difficult to monitor.

At the off-loading point, four items are necessary: a work table, a weighing scale, a heavy cutting knife and a bow saw. Fish should be discharged from the vessel and recorded one at a time. If systematically controlled, the fish can be discharged very fast and efficiently recorded. No shore personnel should be allowed to touch the fish unless they are appointed by the vessel's crew to assist in carrying the fish across to the weighing table.

Since the fish go directly to a transport vehicle to be processed at a factory, vehicles should be used that have overhead protection from the sun, or better still, full chilling facilities. The Fisheries Division's sales and purchasing officer can take over once the fish have been weighed and stacked in the transport vehicle.

5.3 Vessel maintenance

The operating and periodic maintenance tables provided by the manufacturing company for the Yanmar engines should be strictly adhered to, to ensure maximum lifespan and smooth running. This is especially true for all oil changes (engine and gearbox) and filter changes (oil and fuel). F/V *Ulimasao* does not have a qualified marine engineer to maintain the engines; this duty is delegated to the skipper of the vessel. It would be advisable to have a qualified marine engineer to periodically survey the engines for signs of deterioration and to recommend repairs or necessary upkeep.

Several sets of procedures were developed in the initial stages of the project to assist the skipper of the vessel. These were procedures for starting the main engine prior to departure (Appendix B), and the procedures to be followed prior to and during line setting and hauling (Appendix C). Both sets of procedures were displayed on the cabin wall for easy reference. It is essential that these procedures continue to be followed.

Regular checks should be kept on the engine room when the vessel is underway. The hoses and the hose clip connections especially need checking. The main suction lines from the seacocks to the engines and from the engines to the outlets are all connected by hose clips. These have already been doubled up as a safety measure but regular checks must still be done, as the grips on the clips may unwind due to vibration or corrosion.

The suction and outlet line for the deck water and heat exchanger pump is also connected by hose clips. Only when the vessel is carrying out fishing operations should this pump be run continuously. If a hose becomes loose, the engine room will be flooded in a short time.

Another important item to check in the engine room is the stuffing box on each propeller shaft. If the packing becomes worn, then water will enter the engine room. A simple adjustment can stop the flow, although if the packing is badly worn, it may need replacing.

Because the hydraulic system is permanently connected to the port engine, the hydraulic hoses and connections should also be regularly checked. Should a problem arise with the hydraulics that cannot be repaired at sea, the port engine should be shut down and the plastic coupling removed. This will allow the port engine to continue running.

The port and starboard fuel tanks should be topped up regularly to prevent moisture from forming inside. They should be topped up after every second trip. The water traps on the fuel lines should be checked regularly and the tanks drained immediately, if water exists.

The inlets for the saltwater wash line and the toilet flush line are both directly connected to the hose without any seacock valve at the base. This is not safe as there is no way to stop the flow of water if a leak develops in the middle portion of either inlet line. Therefore it is essential that at the next dry docking, a seacock valve be connected to this and any other through-hull water inlets below water level. The valve can immediately be shut off while repairs are carried out on any leaks that develop.

Regular checks should be made to the vessel's hull to spot any pitting due to electrolysis. Checks for electrolysis should be done mainly around the echosounder transducer and the propeller. The zinc anodes should be renewed as soon as around 75 per cent has corroded. At the end of the trials, the vessel was still free of electrolysis pitting and the zinc anodes were all intact with no sign of having deteriorated.

Regular checks should also be carried out for branchlines around the propeller shaft, as previous experiences have shown that the branchlines can build up and push through the shaft seal and cause leaks and damage to the propeller stern gland, especially when the snaps and hook are drawn into these areas. If any branchline materials are found to be wrapped around the shaft and propeller, they should be removed immediately.

From time to time some equipment will fail while the vessel is at sea. In some cases, repairs can be carried out at sea, while at other times the repairs need to wait until the vessel returns to port. It is important for the skipper to report any breakdowns to the Fisheries Division either before or when the vessel reaches port. If this is done, the person in charge can arrange for the repairs to be made as soon as the vessel arrives in port, and definitely before the vessel heads to sea again.

An important part of any fishing operation is to maintain a clean, tidy and hygienic vessel. The fish holds should be scrubbed out with disinfectant after each trip, well rinsed and aired to ensure no detergent remains. The decks, especially where fish are landed and processed, should also be scrubbed down with detergent after each trip. This includes any mats or pads used under the fish during processing.

6. RECOMMENDATIONS

Based on the work carried out and the range of objectives for this project, many recommendations are made. For ease of presentation, the recommendations are presented here using the same headings as in Section 5 (Discussion and Conclusions), and are based on the observations and experience of the Fisheries Development Officer. Many of the recommendations are made to improve the stature of F/V *Ulimasao*, and be a guide for improvements on future designs for vessels of this type.

6.1 Changes and modifications to the vessel

It is recommended that:

(a) The bow area on F/V *Ulimasao* be regularly checked for possible cracks or defects in the welds and strengthened as and if required;

(b) When drawing up new or modified plans for the *super alia*, consideration be given to adding stiffeners, placed to coincide with the calculations for supporting the surrounding structure;

(c) A deck plate be welded over the top of the bow ribs and stiffeners to cover them and add strength to the area;

(d) The height of the weather board in the bow ventilator be increased and the board sloped forward;

(e) Twin ventilators be mounted on the cabin roof over the portside accommodation to increase airflow;

(f) A larger deflection plate be welded to the bottom of the port engine room ventilator, to stop water dripping onto the alternator;

(g) A flexible coupling be mounted between each engine and its exhaust system, at the rubber hose outlet, to minimise the chance of the exhaust pipes cracking;

(h) In future vessels, the freshwater tanks be made smaller to hold around 150 l each, and be located as far forward as possible;

(i) Future vessels of this design be constructed with the fish hold extended forwards to the end of the bunks, and the bulkhead be altered accordingly, to increase the fish-hold capacity;

(j) At the next dry docking of the vessel, or sooner if possible, vent lines be attached to the freshwater tanks to allow them to breathe;

(k) The hatch covers on the two ice holds be cut in half to make them more manageable, with one half having a smaller 'manhole' opening as well;

(l) All hatch covers have flush handles mounted in them for ease of use;

(m) All hatch covers be fitted with a sit-on hinge on one side and a locking-down dog arrangement on the other for securing the hatches and making them watertight;

(n) An overhanging tray be rigged across the full width of F/V *Ulimasao's* stern to protect the exposed rudders that protrude out the stern;

(o) The side rail at the hauling station on the starboard side be extended forward by 80 cm at the same height; and

(p) The dining table be removed, leaving this space open.

6.2 Changes and modifications to the fishing gear and operation

It is recommended that:

(a) The skipper on F/V *Ulimasao* set up a rotation system with the crew so that they each take turns at all aspects of the hauling operation;

(b) The operator's window on the starboard side be replaced with a watertight sliding window;

(c) When future vessels of this design are built, there be no trolling valve fitted to the engines as this is unnecessary for tuna longlining;

(d) A clutch system (electric or manual) be installed between the main engine and the hydraulic pump, to disengage the pump when not in operation;

(e) For future vessels of this design, the hydraulics be run off the engine adjacent to the hauling side, while the engine opposite the hauling side can be used to propel the vessel during line hauling;

(f) Future vessels of this design be fitted with a mainline reel that holds up to 25 nm of 3.5 mm mainline, with the reel mounted athwart-ships close to the back of the cabin to minimise the deck space used for installation;

(g) A marine architect be consulted to determine whether another ice box to hold around 1,000 kg of ice can be constructed on the aft deck without affecting the vessel's load ability or stability;

(h) If deemed safe, a suitable ice box be constructed;

(i) The deck ice box only be used for carrying ice, with all fish being iced in the fish hold below deck;

(j) The forward searchlight and the forward bow light be placed on separate switches, (the forward deck light could be placed on main switch number six, which was not in use);

(k) A permanent aluminium box with rounded edges be constructed and welded in the space between the sleeping berths, directly below the forward vent;

(l) The areas beneath the galley settee and the Captain's bunk be converted to permanent storage areas;

(m) The Fisheries Division purchase an autopilot for F/V *Ulimasao*, and integrate it into the current steering system;

(n) Whenever the autopilot is used, the skipper ensure the watch alarm is set with a roster of times for resetting the alarm to ensure safety of the vessel;

(o) The skipper of F/V *Ulimasao* be responsible for the discharging and weighing of all catch from the vessel;

(p) A set process be put in place for discharging fish from F/V *Ulimasao* one at a time, with the fish processed if necessary (head removed on billfish), weighed, and the information recorded;

(q) All fish be transported to the processors or fish buyers in covered vehicles with shade for the fish, or preferably, full chilling facilities; and

(r) The sales and purchasing officer at fisheries be responsible for the fish once it has been weighed and placed in vehicles for marketing.

6.3 Vessel maintenance

It is recommended that:

(a) The maintenance tables provided by the manufacturer of the engines in F/V *Ulimasao* be closely followed, especially the changing of engine and gearbox oils and all filters;

(b) The Fisheries Division has a qualified marine engineer do periodic surveys or checks on the engines of F/V *Ulimasao* for signs of deterioration, and recommend repairs or necessary upkeep;

(c) The procedures developed for starting the engine prior to departure, and for use during line setting and hauling be continued;

(d) The skipper of F/V *Ulimasao* make regular checks on all hoses and hose-clip connections, especially those on the main seacocks to the engines, and from the engines to the outlets, and on the deck water and heat exchanger pump;

(e) The stuffing box on each propeller shaft in the engine rooms be checked regularly, making adjustments and replacing packing when needed;

(f) The skipper of F/V *Ulimasao* regularly check the hydraulic hoses and connections. If a problem is found that cannot be fixed at sea, the port engine should be shut down and the plastic coupling removed, so the engine can be run without driving the hydraulic pump;

(g) Both fuel tanks be topped up at least after every second trip to minimise the chance of moisture forming in them;

(h) The water traps on the fuel lines be checked regularly, and the tanks drained immediately if moisture is detected inside;

(i) At the next dry docking of F/V *Ulimasao*, a seacock valve be connected to inlets for the saltwater wash line and the toilet flush line, and any other through-hull water inlets below water level that do not already have a seacock valve;

(j) Regular checks be made on the vessel's hull for electrolysis pitting, and that all zinc anodes be replaced as soon as they are around 75 per cent corroded;

(k) Regular checks be made of the propeller shaft, with any branchline materials tangled or wrapped around the shaft removed immediately;

(l) The skipper of the vessel report any repairs needed to the Fisheries Division before or when the vessel enters port, so that repairs can be made before the vessel heads to sea again; and

(m) A system be set in place to ensure that when the fish has been discharged from the vessel, the fish holds are scrubbed out with disinfectant, rinsed and aired, and the deck washed down with detergent, especially in areas where fish are landed and processed.

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Specifications for the 12.2 m *super alia*, F/V *Ulimasao*

Length overall	12.2 m
Length DWL	10.9 m
Beam moulded each hull	1.90 m
Beam moulded catamaran	5.05 m
Depth moulded rabbet to sheer	1.56 m
Displacement to DWL	8.28 t
Displacement 10 cm below DWL	11.13 t
Hull	Aluminium, 4.0 mm bottom and 3.0 mm sides
Cabin	Aluminium, 2.0 mm
Fish hold volume	8 m3
Ice capacity	4 t
Engine power	2 x 48 hp Yanmar diesel engine
Speed range	9 ~ 11 knots
Fuel capacity	1,500 l (330 imperial gallons)
Endurance	Up to seven days
Freshwater capacity	1,000 l

The vessel is equipped with the following gear for navigation, communications, sea safety and survival, and tuna longline fishing.

Furuno marine radar – Model 821
Taiyo direction finder – Model ADDF TD L1100
2 radio beacons
Compass – Model Plastimo Offshore 105
High frequency radio (VHF) – Model TAIR T2000 II
Single side band radio transceiver (SSB) – Model Furuno FS 1503
Marine AM/FM receiver – Model Maxima Marine
Furuno LCD colour GPS with echosounder – Model GP 1650 F
Binoculars
EPIRB – Model SALCOM MRB4 Rescue beacon. Transmits on 121.5 ~ 243 mhz.
Seamech Smart Reel and line shooter – 1.2 m size (Capacity of reel is approximately 30 nm of 3.5 mm monofilament line)
7 lifejackets
6-person liferaft (requisitioned from the F/V *Tautai Matapalapala*)
First aid kit
2 dry chemical fire extinguishers (3.5 kg and 7.2 kg capacity)
2 life rings
8 flares—2 orange smoke, 2 parachute, and 4 hand held
1 heliograph
Sea anchor

Main engine starting procedures prior to departure

Every new operator on the vessel should consult the Operating Instructions and Periodic Maintenance table attached to the bulkhead in the wheelhouse. For everyday procedures the following instructions will greatly benefit the operator.

- Ensure that there is no water in the fuel tank.
- Top up the cooling water reservoir on the engine.
- Check engine oil level and top up if necessary.
- Ensure that the engine oil and filters are within the recommended time of usage. If not, change all filters and renew oil.
- Check the gearbox oil level and top up to mark if necessary.
- Check battery water level and top up if necessary. The full level mark is the extension below the call port cap.

(It is important that all oil levels are topped up to the mark indicated on the dipstick. Overfilling will cause the oil to build up pressure and leak,out).

- Take fuel level reading before starting each engine.
- Note the engine hours before starting each engine.
- Shut the hydraulic flow control valve on the port engine.
- Disconnect drive belt for the deck water hose and the hydraulic cooling system (port engine).
- Ensure that the main switches on the switchboard in the wheelhouse are turned off.
- Turn on the main keys in the engine room and start engine.
- Turn on the main switch on the switchboard and all power switches. (Note: if the port battery bank is to be the power supplier for the first leg then only the port main switch and the port breaker switch is to be turned on. Make sure that the starboard main switches are turned off. Vice versa if the starboard battery bank is used).
- Remove the camlock cap from the hydraulic tank filling port so that the tank's breather is operational for the trip.

Procedures to be followed prior to and during line setting and line hauling

The following procedures for line setting and hauling were developed for F/V *Ulimasao*, to set a routine in place, plus providing these procedures in writing for future people to operate the vessel.

Setting operation procedures

- Shut down port engine and connect drive belt for the deck water hose and hydraulic cooling system.
- Check cooling water and oil level on the port engine before restarting.
- Ensure that the two control valves on the line shooter are in the ‘off’ position.
- Turn on the hydraulic flow control valve (in the port engine room) to its maximum limit.
- Open up (anti-clockwise) the free-spooling valve on the mainline reel and run the mainline to the line shooter through the guide block.
- Connect up the floatlines, buoys and radio beacons.
- Switch on the radio beacon after a series of test signals.
- Disconnect the level-wind drive belt and wind the guide all the way to the corner.
- Shut the free-spooling valve on the mainline reel and open up (anti-clockwise) the smaller setting valve.
- Push the speed control lever beside the two valves aft—towards the line shooter.
- Set the cable control lever in the wheelhouse to the line-setting position.
- Connect the extra return line from the hydraulic system to the tank through the tank filling port.
- Hook up the bait-setting box.
- Note: Bait has to be thawed out well in advance before setting. Thawing time depends on the frozen condition of the bait. This should be done without running water over it.
- Deploy the first radio beacon and float, then set the vessel in motion at dead slow ahead (1,000 RPM). Mark the position of deployment (latitude and longitude).
- Turn on the main valve on the line shooter, then adjust the speed valve on the shooter to obtain the setting speed required. Gradually increase the setting RPM so that no jerking stress is put on the mainline reel and line shooter rubbers.
- Gradually increase the vessel’s engine RPMs to maximum setting speed (2,200 to 2,500 RPM). This has to co-ordinate with the increase in line-shooter RPMs.
- During line setting, should coordination problems arise between the line shooter and the mainline reel, open up the free-spooling valve on the reel. Do not release the cable control lever in the wheelhouse.

- As the mainline is deployed and further coordination problems arise, release the cable control lever in the wheelhouse to the neutral position. This should be sufficient to carry the setting operation to the end.

- At the end of the setting operation, the line-shooter speed and the mainline-reel rotation should be reduced simultaneously until both are stopped. This is done by having someone gradually reduce the speed control on the line shooter, while another person gradually eases down on the free-spooling valve on the mainline reel until it is shut and the reel stops. Caution should be taken at this time to ensure that the mainline reel does not shut down before the line shooter. If this happens, the line shooter will continue to pull the mainline from the reel, and this can result in line breakage or can put a lot of pressure on the hydraulic lines, which may rupture at some point. On the other hand, having the line shooter shut down before the mainline reel stops rotating will only result in excess line being piled up on the deck.

- Once the setting operation has ceased and the vessel has stopped, open up the free-spooling valve to unwind the remainder of the line on the reel and connect the end of the line to the end radio beacon and floats. Ensure that the signal from the beacon has been tested and that the switch is in the 'On' position before deploying.

- Note down the position where the radio beacon has been deployed and mark this on the GPS. This will serve as a back up to locating the beacon should a failure in the system arise.

Hauling operation procedures

- After retrieving the radio beacon, turn on the hydraulic-flow control valve and connect the main line to the reel.

- Turn off the radio beacon.

- Connect back the drive belt for the level-wind guide.

- Ensure that the belt for the deck water pump is connected and functional.

- While the cable control lever is in the neutral position, shut down the free-spooling valve and the smaller setting valve.

- Set the speed lever on the reel to the preferred hauling speed. If set towards the reel, a higher speed will be achieved. If set away from the reel, a slower speed will be achieved.

- The cable control lever in the wheelhouse engages and disengages the reel.

- During hauling, as the mainline builds up on the reel, a further reduction in speed will be required. This can be achieved by reducing the hydraulic oil flow by adjusting the flow control valve.

Summary of tuna longline catches taken from the *super alia* F/V *Ulimasao*

Weights for all saleable fish are gilled and gutted, except for billfish and opah which are headed, tailed and gutted.
Weights for all unsaleable fish are whole weights except for sharks which are headed, gutted and finned.
Other saleable catch included blue marlin, striped marlin, shortbill spearfish, broadbill swordfish, wahoo, skipjack, barracuda, oilfish, pomfret, opah, mahi mahi and sunfish, while unsaleable species consisted of sharks, lancetfish, snake mackerel and pelagic rays.

Number of sets	Approx. position Lat. (S)	Approx. position Long. (W)	Hook Nos.	Time set	Time haul	Catch by species: 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 1: 16 to 19 May 2000																	
1	14° 39'	171° 30'	540	0655	1540	57	948.0	1	11.0	28	441.2	4	99.5	90	1,499.7	3	5.9
2	15° 08'	172° 02'	700	0730	1405	61	885.6	3	49.5	36	577.5	6	36.0	106	1,548.6	6	13.8
Sub-total			**1,240**			**118**	**1,833.6**	**4**	**60.5**	**64**	**1,018.7**	**10**	**135.5**	**196**	**3,048.3**	**9**	**19.7**
Trip 2: 5 to 9 June 2000																	
1	14° 36'	171° 32'	720	0640	1435	4	60.5			8	145.0	20	190.3	32	395.8	8	115.0
2	14° 38'	171° 30'	700	0700	1600	5	100.0			20	345.0	7	82.0	32	527.0	6	51.8
3	14° 34'	171° 42'	710	0650	1510	8	157.5			15	246.5	18	218.0	41	622.0		
Sub-total			**2,130**			**17**	**318.0**	**0**	**0.0**	**43**	**736.5**	**45**	**490.3**	**105**	**1,544.8**	**14**	**166.8**
Trip 3: 12 to 16 June 2000																	
1	12° 52'	170° 53'	600	0635	1430	4	52.8	2	18.2	10	187.0	1	4.8	17	262.8		
2	12° 58'	171° 04'	750	0620	1530					18	329.3	12	101.8	30	431.1	3	6.4
3	12° 51'	171° 20'	820	0640	1530					21	379.3	8	41.6	29	420.9		
Sub-total			**2,170**			**4**	**52.8**	**2**	**18.2**	**49**	**895.6**	**21**	**148.2**	**76**	**1,114.8**	**3**	**6.4**
Trip 4: 24 to 29 June 2000																	
1	13° 11'	173° 34'	740	0700	1515	1	22.0			14	215.8	8	64.8	23	302.6	3	44.2
2	13° 08'	173° 46'	740	0650	1440	6	118.2			19	331.6	10	92.2	35	542.0	3	43.2
3	13° 12'	173° 37'	740	0900	1520	10	176.2	2	49.8	7	129.8	5	27.6	24	383.4	1	1.1
4	13° 27'	173° 09'	720	0715	1445	16	266.8	1	12.4	22	374.8	5	21.1	44	675.1		
Sub-total			**2,940**			**33**	**583.2**	**3**	**62.2**	**62**	**1,052.0**	**28**	**205.7**	**126**	**1,903.1**	**7**	**88.5**

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 5: 3 to 8 July 2000																	
1	13° 09'	170° 54'	730	0640	1500	3	48.4			7	124.4	8	54.7	18	227.5	3	6.7
2	13° 10'	171° 05'	730	0700	1510	1	24.8	4	64.4	16	288.6	2	10.7	23	388.5	3	45.2
3	13° 02'	170° 59'	730	0700	1500	3	88.2			16	288.2	4	55.2	23	431.6		
4	13° 02'	171° 08'	730	0650	1535	5	164.1	1	15.0	25	450.4	13	88.3	44	717.8		
Sub-total			**2,920**			**12**	**325.5**	**5**	**79.4**	**64**	**1,151.6**	**27**	**208.9**	**108**	**1,765.4**	**6**	**51.9**
Trip 6: 10 to 14 July 2000																	
1	13° 01'	171° 12'	735	0640	1515	2	85.0	1	44.0	14	260.0	5	84.0	22	473.0	3	45.9
2	13° 02'	171° 25'	735	0650	1500	7	277.0			26	474.0	6	57.0	39	808.0	1	1.1
3	13° 00'	171° 30'	735	0630	1515	4	114.0	1	28.0	24	417.0	13	128.5	42	687.5		
Sub-total			**2,205**			**13**	**476.0**	**2**	**72.0**	**64**	**1,151.0**	**24**	**269.5**	**103**	**1,968.5**	**4**	**47.0**
Trip 7: 18 to 20 July 2000																	
1	13° 08'	171° 46'	**730**	0635	1510	**1**	**15.0**			**5**	**75.0**	**21**	**136.4**	**27**	**226.4**	**2**	**2.7**
Trip 8: 4 to 8 August 2000																	
1	12° 26'	171° 46'	1,050	0610	1440			3	95.8	4	65.3	2	25.5	9	186.6		
2	12° 24'	171° 56'	1,150	0920	1700	3	99.8			7	130.0	8	53.6	18	283.4	2	4.4
3	12° 50'	172° 00'	1,100	0800	1550	1	31.0	1	14.0	1	15.0	4	27.3	7	87.3	2	5.6
Sub-total			**3,300**			**4**	**130.8**	**4**	**109.8**	**12**	**210.3**	**14**	**106.4**	**34**	**557.3**	**4**	**10.0**
Trip 9: 10 to 14 August 2000																	
1	13° 26'	173° 05'	1,100	0640	1545	11	234.7			49	859.1	22	193.1	82	1,286.9	4	35.1
2	13° 28'	173° 05'	1,200	0800	1710	3	64.2	2	8.2	41	715.4	15	206.6	61	994.4	2	32.2
Sub-total			**2,300**			**14**	**298.9**	**2**	**8.2**	**90**	**1,574.5**	**37**	**399.7**	**143**	**2,281.3**	**6**	**67.3**

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: 15 to 19 August 2000																	
1	13° 05'	170° 59'	1,100	0625	1520	1	15.0	1	5.2	23	408.9	8	105.4	33	534.5	1	50.0
2	13° 04'	171° 07'	1,200	0650	1550	6	93.3	1	20.4	30	552.9	8	305.2	45	971.8	4	149.7
3	13° 03'	171° 13'	420	0700	1720					16	297.0	8	34.4	24	331.4		
Sub-total			**2,720**			**7**	**108.3**	**2**	**25.6**	**69**	**1,258.8**	**24**	**445.0**	**102**	**1,837.7**	**5**	**199.7**
Trip 11: 21 to 24 August 2000																	
1	12° 53'	171° 26'	1,200	0640	1550			1	27.2	13	233.5	14	71.7	28	332.4		
2	12° 55'	171° 31'	1,200	0640	1545			1	19.8	9	175.0	12	63.4	22	258.2		
Sub-total			**2,400**			**0**	**0.0**	**2**	**47.0**	**22**	**408.5**	**26**	**135.1**	**50**	**590.6**	**0**	**0.0**
TOTAL for the 11 trips																	
30			**25,055**			**223**	**4,142.1**	**26**	**482.9**	**544**	**9,532.5**	**277**	**2,680.7**	**1,070**	**16,838.2**	**60**	**660.0**

Species composition of the tuna longline catch

Family Species English name	Total No.	 Weight (kg)
SCOMBROIDEI (Scombridae, Gempylidae)		
Acanthocybium solandri Wahoo	21	226.0
Katsuwonus pelamis Skipjack tuna	159	960.2
Thunnus alalunga Albacore tuna	544	9,532.5
Thunnus albacares Yellowfin tuna	223	4,142.1
Thunnus obesus Bigeye tuna	26	482.9
** *Gempylus serpens* Snake mackerel	9	23.9
Lepidocybium flavobrunneum Escolar	14	50.0
Sub-total	**996**	**15,417.6**
XIPHIOIDEI (Istiophoridae, Xiphiidae)		
Tetrapturus angustirostris Shortbill spearfish	6	112.0
Tetrapturus audax Striped marlin	3	169.0
Makaira mazara Blue marlin	8	367.0
Xiphias gladius Broadbill swordfish	3	335.0
Sub-total	**20**	**983.0**
LAMPRIFORMES (Lampridae)		
Lampris guttatus Opah or moonfish	5	83.7
Sub-total	**5**	**83.7**
MUGILOIDEI (Sphyraenidae)		
Sphyraena barracuda Great barracuda	11	69.4
Sub-total	**11**	**69.4**

Family Species English name	Total No.	 Weight (kg)
PERCOIDEI (Coryphaenidae, Bramidae)		
Coryphaena hippurus Mahi mahi	28	200.6
Taractichthys steindachneri Pomfret	5	29.0
Sub-total	**33**	**229.6**
TETRAODONTIFORMES (Molidae)		
Ranzania laevis Sunfish	14	78.8
Sub-total	**14**	**78.8**
MYCTOPHIFORMES (Alepisauridae)		
** *Alepisaurus brevirostris* Shortnose lancetfish	21	41.7
Sub-total	**21**	**41.7**
LAMNIFORMES (Carcharhinidae)		
** *Carcharhinus longimanus* Oceanic whitetip shark	4	160.0
** *Prionace glauca* Blue shark	9	395.0
Sub-total	**13**	**555.0**
RAJIFORMES (Dasyatididae)		
** *Dasyatis violacea* Pelagic ray	17	39.4
Sub-total	**17**	**39.4**
TOTAL CATCH	**1,130**	**17,498.2**
** **Unsaleable catch total**	**60**	**660.0**
Saleable catch total	**1,070**	**16,838.2**

Costs associated with the construction and rigging of F/V *Ulimasao* as provided by the Samoan Fisheries Division (some fishing gear costs estimated)

Item	Cost in Samoan tala	Cost in New Zealand dollars	Cost in US dollars
Items for boat			
Aluminium *	78,008	49,372	*25,164*
Boat fittings, materials and supplies *	46,452	*29,400*	14,985
labour costs	*20,000*	12,658	6,452
2 Yanmar diesel engines *	98,682	62,457	*31,833*
Sub-total	**243,143**	**153,888**	**78,433**
Electronic and navigation equipment			
Radar *	7,661	*4,849*	2,471
GPS/plotter with echosounder *	6,495	*4,111*	2,095
Single sideband radio *	6,470	*4,095*	2,087
VHF radio *	2,863	*1,812*	924
Radio direction finder *	*10,872*	6,881	3,507
Compass	343	*217*	111
Binoculars	506	*320*	163
Freight cost on electronics	1,264	*800*	408
Sub-total	**36,474**	**23,085**	**11,766**
Sea safety equipment			
EPIRB	*780*	494	252
Lifejackets	*360*	228	116
Two fire extinguishers	*1,161*	735	375
Pyrotechniques (flares)	*750*	475	242
First aid kit	*95*	60	31
Tool kit	*350*	222	113
Sub-total	**3,496**	**2,213**	**1,128**
Fishing equipment (estimated split of costs)			
Smart Reel and line shooter	44,950	28,449	*14,500*
Hydraulic equipment	6,200	3,924	*2,000*
Longline floats	4,805	3,041	*1,550*
Floatline materials	*2,000*	1,266	645
Strobe lights	*1,000*	633	323
Radio buoys/beacons	8,990	5,690	*2,900*
30 nm of 3.5 mm monofilament mainline	19,375	12,263	*6,250*
Branchline materials	11,780	7,456	*3,800*
Others (estimate)	2,500	1,582	806
Sub-total	**101,600**	**64,304**	**32,774**
TOTAL	**384,713**	**243,489**	**124,101**
Additional sea anchor	*6,000*	3,797	1,935
Additional six-man liferaft	9,480	*6,000*	3,058

Figures in italics are the original currency of purchase * Price of item includes 5% duty
Exchange rates used: USD 1.00 = WST 3.10; NZD 1.00 = WST 1.58

Appendix G

Summary of vessel operating expenses incurred during the project

Trip No.	Diesel fuel (WST 1.1959/l) Litres	Diesel fuel Value (WST)	Oils (lube/engine) Litres	Oils (lube/engine) Value (WST)	Bait (sold by carton) Amount (Kg)	Bait Value (WST)	Ice in 25 kg bags (WST 6–8.00/bag) Amount (bags)	Ice Value (WST)	Victuals Value (WST)	Replaced gear Value (WST)	Other Value (WST)	Sub-total operations Value (WST)	Crews' wages Value (WST)	Total expenses Value (WST)
1	492	588.38	40	218.68	60	570.00	50	400.00	180.00		200.00	2,157.06	1,958.23	4,115.29
2	430	515.00			90	855.00	62	496.00	240.00	100.00	200.00	2,406.00	1,131.49	3,537.49
3	510	609.90			90	855.00	60	480.00	180.00	50.00	100.00	2,274.90	1,095.52	3,370.42
4	750	896.93	20	109.34	120	1,140.00	60	480.00	240.00	100.00	200.00	3,166.27	1,786.63	4,952.90
5	460	550.11			120	1,140.00	70	560.00	240.00	200.00	200.00	2,890.11	1,844.38	4,734.49
6	425	508.26	10	50.00	90	855.00	70	560.00	240.00	100.00	50.00	2,363.26	1,990.82	4,354.08
7	225	269.08	10	50.00	30	256.62	70	560.00	240.00		50.00	1,425.70	71.40	1,497.10
8	620	741.46	40	218.68	165	960.00	70	420.00	140.00		219.00	2,699.14	513.61	3,212.75
9	580	693.62	20	109.34	165	960.00	30	180.00	180.00	200.00	109.00	2,431.96	2,008.16	4,440.12
10	410	490.32	20	109.34	175	1,080.00	70	420.00	180.00	200.00	109.00	2,588.66	1,817.45	4,406.11
11	390	466.40			100	950.00	60	360.00	180.00			1,956.40	484.75	2,441.15
TOTAL	**5,292**	**6,329.46**	**160**	**865.38**	**1205**	**9,621.62**	**672**	**4,916.00**	**2,240.00**	**950.00**	**1,437.00**	**26,359.46**	**14,702.44**	**41,061.90**

Engine running hours and fuel consumption by trip

Trip 1		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	540	540
	Arrival reading	340	340
	Fuel consumed	**246**	**246**
	Total fuel consumed	492	
		Port engine	**Starboard engine**
	Arrival reading	86.8	86.1
	Departure reading	26.8	23.1
	Running hours	**60**	**63**
	Combined running hours	123	
	Average fuel consumption/engine/hour		4.000 litres/hr
	Both engines fuel consumption/hour		8.000 litres/hr
Trip 2		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	840	840
	Arrival reading	610	640
	Fuel consumed	**230**	**200**
	Total fuel consumed	430	
		Port engine	**Starboard engine**
	Arrival reading	163.2	170
	Departure reading	94.3	89.2
	Running hours	**68.9**	**80.8**
	Combined running hours	149.7	
	Average fuel consumption/engine/hour		2.872 litres/hr
	Both engines fuel consumption/hour		5.744 litres/hr
Trip 3		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	610	640
	Arrival reading	360	380
	Fuel consumed	**250**	**260**
	Total fuel consumed	510	
		Port engine	**Starboard engine**
	Arrival reading	237.3	244.1
	Departure reading	163.9	170.7
	Running hours	**73.4**	**73.4**
	Combined running hours	146.8	
	Average fuel consumption/engine/hour		3.474 litres/hr
	Both engines fuel consumption/hour		6.948 litres/hr

Trip 4		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	710	730
	Arrival reading	370	320
	Fuel consumed	**340**	**410**
	Total fuel consumed	750	
		Port engine	**Starboard engine**
	Arrival reading	347.1	353.3
	Departure reading	238.1	244.3
	Running hours	**109**	**109**
	Combined running hours	218	
	Average fuel consumption/engine/hour		3.440 litres/hr
	Both engines fuel consumption/hour		6.880 litres/hr
Trip 5		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	450	440
	Arrival reading	210	220
	Fuel consumed	**240**	**220**
	Total fuel consumed	460	
		Port engine	**Starboard engine**
	Arrival reading	441.9	435.2
	Departure reading	347.1	353.3
	Running hours	**94.8**	**81.9**
	Combined running hours	176.7	
	Average fuel consumption/engine/hour		2.603 litres/hr
	Both engines fuel consumption/hour		5.206 litres/hr
Trip 6		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	630	800
	Arrival reading	415	590
	Fuel consumed	**215**	**210**
	Total fuel consumed	425	
		Port engine	**Starboard engine**
	Arrival reading	508.6	508.5
	Departure reading	441.9	435.2
	Running hours	**66.7**	**73.3**
	Combined running hours	140	
	Average fuel consumption/engine/hour		3.036 litres/hr
	Both engines fuel consumption/hour		6.071 litres/hr

Trip 7		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	415	590
	Arrival reading	300	480
	Fuel consumed	**115**	**110**
	Total fuel consumed	225	
		Port engine	**Starboard engine**
	Arrival reading	543.1	543.2
	Departure reading	508.7	508.6
	Running hours	**34.4**	**34.6**
	Combined running hours	69	
	Average fuel consumption/engine/hour		3.261 litres/hr
	Both engines fuel consumption/hour		6.522 litres/hr
Trip 8		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	740	790
	Arrival reading	440	470
	Fuel consumed	**300**	**320**
	Total fuel consumed	620	
		Port engine	**Starboard engine**
	Arrival reading	634.2	633.3
	Departure reading	558.3	550
	Running hours	**75.9**	**83.3**
	Combined running hours	159.2	
	Average fuel consumption/engine/hour		3.894 litres/hr
	Both engines fuel consumption/hour		7.788 litres/hr
Trip 9		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	520	540
	Arrival reading	230	250
	Fuel consumed	**290**	**290**
	Total fuel consumed	580	
		Port engine	**Starboard engine**
	Arrival reading	709.5	707.5
	Departure reading	636.1	633.3
	Running hours	**73.4**	**74.2**
	Combined running hours	147.6	
	Average fuel consumption/engine/hour		3.930 litres/hr
	Both engines fuel consumption/hour		7.860 litres/hr

Trip 10		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	740	740
	Arrival reading	535	535
	Fuel consumed	**205**	**205**
	Total fuel consumed	410	
		Port engine	**Starboard engine**
	Arrival reading	769.6	771.9
	Departure reading	709.5	707.5
	Running hours	**60.1**	**64.4**
	Combined running hours	124.5	
	Average fuel consumption/engine/hour		3.293 litres/hr
	Both engines fuel consumption/hour		6.586 litres/hr
Trip 11		**Port tank (litres)**	**Starboard tank (litres)**
	Departure reading	535	535
	Arrival reading	320	360
	Fuel consumed	**215**	**175**
	Total fuel consumed	390	
		Port engine	**Starboard engine**
	Arrival reading	818.8	824.6
	Departure reading	769.6	771.9
	Running hours	**49.2**	**52.7**
	Combined running hours	101.9	
	Average fuel consumption/engine/hour		3.827 litres/hr
	Both engines fuel consumption/hour		7.654 litres/hr