FISHERIES DEVELOPMENT SECTION REPORT

OF

TECHNICAL ASSISTANCE TO THE FISHERIES DIVISION OF SAMOA AND THE LOCAL TUNA LONGLINE INDUSTRY

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SUMMARY

The rapid expansion of the Samoa offshore fisheries, especially the tuna longline industry, has prompted the Samoa Fisheries Division to implement moves to regulate and direct the industry towards a focused and sustainable future. This focus has led to the formation of an AusAID-assisted Samoa Fisheries Extension Project, instigated to deal with management and development strategies for the commercial fishing industry.

To complement the work undertaken by the Fisheries Division and the Samoa Fisheries Extension Project, the SPC was approached by the Samoan Government for technical assistance. The requested assistance included: tuna longlining trials using the fisheries research vessel R/V *Tautai Matapalapala* to try to increase the catch of the higher value export species; training the crew in the use of the gear and the correct on-board handling and preservation of the catch; assistance in running workshops on fish handling and preservation, and basic navigation and the use of GPS; and providing input and comment on the design and deck layout of a new *super alia* vessel.

The project began in March 1999. Unfortunately the project was postponed in May 1999, because the SPC Fisheries Development Officer resigned, and time was needed to recruit a replacement. SPC's new Fisheries Development Officer, Mr William Sokimi, completed the project in December 1999.

During Stage I of the project, many problems were encountered with the hydraulic system and mainline reel on the project vessel, as well as some modifications to the vessel being necessary to streamline the fishing operation. Only two fishing trips were undertaken with a total catch of 13 saleable fish weighing 111 kg. The catch rate was low during these trips at 13.9 kg/100 hooks. This is because March to May is the off-season for tunas around Samoa.

Fishing activities during Stage II were much more productive, with 14 sets of 400 hooks being conducted over six trips. A total of 272 saleable fish were taken, weighing 3855 kg. The catch rate was also much higher at 68.8 kg/100 hooks. The three main tuna species, bigeye tuna, yellowfin tuna and albacore tuna made up 87.3 per cent of the saleable catch. Although the catch rate was high, the numbers of higher value species (bigeye tuna and larger yellowfin tuna) were small and the average weight low, which limited the number of these species that were suitable for fresh export.

Priority was placed on training the skipper and crew of the R/V *Tautai Matapalapala* to fully comprehend and practise recommended methods of fish handling and preservation. Attention was also directed at streamlining the tuna longline operations aboard the vessel so that a more efficient and practical method could be maintained in line setting and hauling. Additionally, the crew was constantly briefed on safety and sea survival issues and encouraged to develop their seamanship skills.

Three workshops were completed during Stage II, two on 'On-board fish handling and preservation' and one on 'Basic navigation and the use of GPS. All workshops were well attended, conducted in English with fisheries staff translating into Samoan, with positive feedback from the participants. In addition, the plans for the new *super alia* were examined and a brief report provided to the Assistant Director of Fisheries in Samoa, providing comment and possible changes to the deck layout of the vessel to improve its suitability to tuna longline fishing activities.

RÉSUMÉ

La rapide expansion du secteur de la pêche hauturière au Samoa, et; en particulier, de la pêche thonière à la palangre, a incité le service des pêches du Samoa à traduire dans les faits le souci de réglementer le secteur et de l'orienter vers un avenir mieux planifié et durable. Cette nouvelle optique a conduit à la mise sur pied d'un projet d'extension des pêcheries du Samoa bénéficiant du concours de l'Agence australienne pour le développement international, et ayant pour objet l'élaboration de stratégies de gestion et de développement du secteur de la pêche commerciale.

Le gouvernement samoan s'est adressé à la CPS pour obtenir une aide technique qui compléterait le travail effectué par le service des pêches dans le cadre du projet d'extension des pêcheries du Samoa. Dans le cadre de cette assistance, il s'agissait notamment de procéder à des essais de pêche thonière à la palangre à bord du bateau affecté à la recherche halieutique, le *Tautai Matapalapala*, le but étant d'accroître les prises d'espèces très prisées à l'exportation, de former les équipages à l'utilisation des engins à la manipulation et à la conservation des prises à bord, de faciliter l'organisation d'ateliers sur la manipulation et la conservation du poisson, les techniques élémentaires de navigation et d'utilisation du GPS, et enfin, de donner son avis sur la conception et l'agencement du pont d'un nouveau *super alia*.

Le projet a été lancé en mars 1999 mais n'a malheureusement démarré qu'en mai de la même année; en effet, le chargé du développement de la pêche de la CPS ayant démissionné, il a fallu un certain temps pour recruter son successeur. Le nouveau chargé du développement de la pêche de la CPS, M. William Sokimi, a mené à bien ce projet en décembre 1999.

Durant la première étape de ce projet, le système hydraulique et le moulinet de la ligne-mère du navire ont mal fonctionné, et il a fallu apporter certaines modifications au bateau pour pouvoir rationaliser les opérations. Il n'y a eu que deux sorties de pêche qui ont rapporté au total 13 prises vendables pesant au total 111 kg. Le taux de capture a été faible lors de ces sorties puisqu'il s'est établi à 13,9 kg/100 hameçons, résultat médiocre dû au fait que mars à mai est la saison basse pour les thons au Samoa.

Les activités de pêche durant la deuxième étape ont été nettement plus rentables : il y a eu 14 mouillages de 400 hameçons au cours des six sorties réalisées. Au total, 272 poissons vendables ont été capturés, pesant à eux tous 3 855 kg. Le taux de capture a donc été beaucoup plus élevé puisqu'il s'est établi à 68,8 kg/100 hameçons. Les trois principales espèces de thons – thon obèse, thon jaune et germon – ont constitué 87,3 pour cent des prises vendables. Si ce taux est élevé, le nombre d'espèces de grande valeur (thon obèse et grand thon jaune) et leur poids moyen faibles ce qui a limité le nombre de ces espèces se prêtant à l'exportation à l'état frais.

On s'est attaché en priorité à former le capitaine et l'équipage du R/V *Tautai Matapalapala* pour qu'ils comprennent bien et mettent en pratique les méthodes de manipulation et de conservation du poisson recommandées. On a également veillé à rationaliser les opérations de pêche thonière à la palangre à bord de façon à établir une méthode efficace et pratique de mouillage et de relevage de la ligne. En outre, l'équipage a été en permanence informé des questions de sécurité et de survie en mer et encouragé à améliorer ses compétences en matelotage.

Trois stages ont été réalisés durant la deuxième étape : deux d'entre eux concernaient la manipulation et la conservation du poisson à bord et le dernier les éléments de base de la navigation et l'utilisation du GPS. On a observé une bonne participation à tous ces stages, dispensés en anglais et interprétés en samoan par des personnes du service des pêches, et les réactions ont été bonnes. En outre, les plans de construction du nouveau *super alia* ont été examinés et un rapport succinct a été remis au directeur adjoint du service des pêches du Samoa, accompagné d'observations et de suggestions de modifications de l'agencement du pont qui contribueraient à le rendre mieux adapté aux activités de pêche thonière à la palangre.

CONTENTS

1. INTRODUCTION

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 is comprised of two major islands, Upolu (1108 km_) and Savaii (1695 km_), two smaller inhabited islands, Manono and Apolima, and four uninhabited islands (Passfield & Mulipola, 1999). Flora and fauna consists of palm trees (mainly coconut), pandanus, pocket areas of mangroves and secondary growth woodland along the coastal region with the rest of the islands being covered in thick tropical vegetation, except on recent lava flows (Watt et al., 1998).

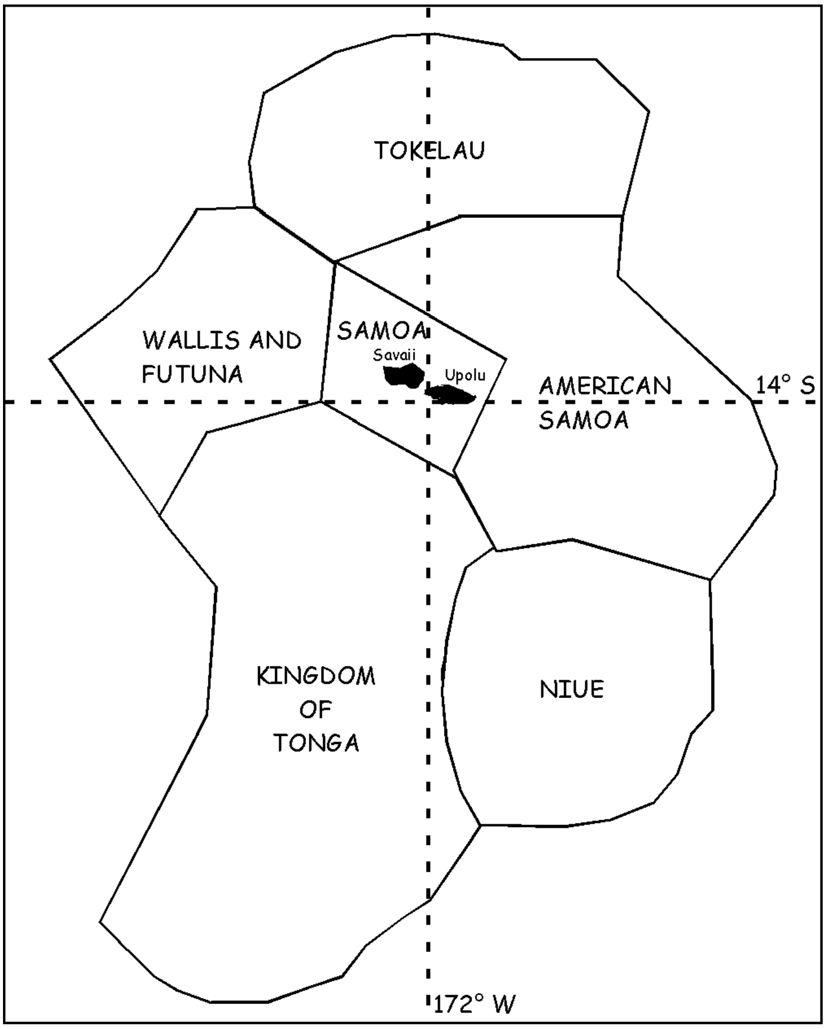

Figure 1: The islands of Samoa

The mid-1999 population estimate for Samoa was around 168,000 people (SPC, 1999). 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 Polynesians.

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 nutritional benefits. The development of commercial offshore fisheries between 1975 and 1980, and a further boost in recent years, has allowed several support businesses have to flourish. Subsistence fishing is of equal importance in the development of fisheries and is of prominence to domestic living.

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 trend of moving away from this to a more cash-based economy has prompted several enterprising locals to capitalise commercially on offshore fisheries products, mainly tuna.

The related technical and social issues associated with any industry growth, are matters 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_ (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 0.33 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, thus progressing fisheries to be the current major export earner in Samoa, (Watt & Moala, 1999).

Because fisheries is the number one industry in the country, and in foreign exchange earnings, 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). With AusAID assistance, an extension service (Samoa Fisheries Project) was established to work with existing government agencies to achieve the goals and strategies for the future development and sustainability of commercial fisheries. Among other work, research was carried out by the Commercial Fisheries Extension Advisor on training requirements for the offshore industry, estimates of rejection in the tuna industry, and the need for further infrastructure in the developing tuna industry.

Overall, the rapid development of tuna longlining has occurred 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 to be addressed by the Fisheries Division and local fishermen, such as sea safety and fish quality.

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

The offshore fishery in Samoa was initiated through the construction of up to 120 plywood catamaran type *alia* vessels, 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. Appendix A outlines the characteristics of the original design *alia* catamaran.

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, with some exported to other countries (King & Fa'asili, 1997).

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

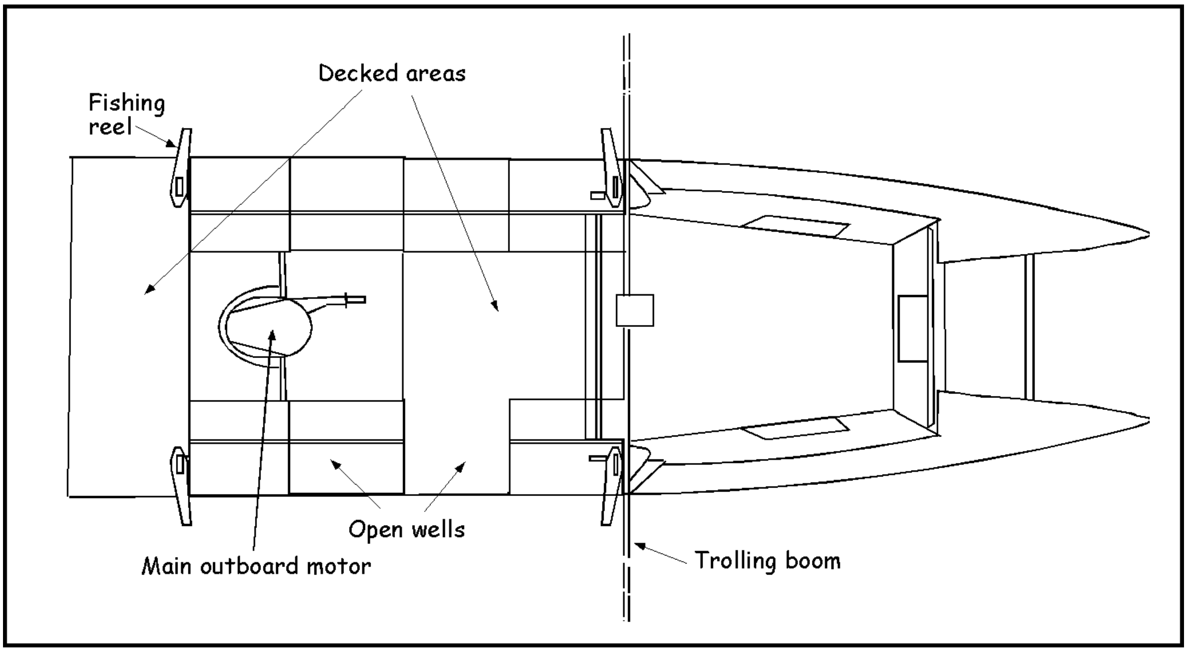

Figure 2: The original aluminium* alia *catamaran rigged with handreels and trolling booms

Catches from deep-bottom fishing activities 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, with over half of the vessels destroyed and many others damaged. It was estimated that only 40 useable *alias* remained after the cyclone in 1991 (Fa'asili, 1997). The Samoa government 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. This request resulted in an SPC Fisheries Development Officer being 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. A wooden reel was constructed and mounted in the centre of the alia to store the vertical longlines (Figure 3). These trials were also successful, not only with the catch (2,819 kg of fish taken in 20 fishing trips), but the numbers of local fishermen that geared up and fished with their version of a reel (Figure 4) to store the vertical longlines (Watt et al., 1998).

***Figure 3: Wooden vertical longline reel mounted on the fisheries* alia**

Figure 4: A vertical longline reel design developed by a local* alia *fisherman

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 elements led to 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 have increased steadily to an estimated 200 in 1999 and the vast majority of these are still *alia* catamarans (Figure 5). In many cases these *alias* have been modified in various ways including: an increase in the height of the gunwale by 20 cm; an increase or 'stretching' of the vessels' length to 10.5 m; the addition of aluminium wheelhouses; and a strengthening of 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 5: Some* alia *catamarans with tuna longline gear at anchor in Apia Harbour

The increase in *alia* numbers has lead 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 at present (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 catch is low.

1.2.2 Sea safety and the alia *catamaran*

Sea safety is a major concern that needs consideration in the ongoing development of the Samoan tuna longline industry. Despite having an industry that was developed through the perseverance of the Samoan fishermen, and their versatile utilisation of the original 9.0 m *alia* for longline fishing, the fact remains that fishermen face grave risks if they continue pursuing tuna longlining in the current manner, that is, venturing farther out to sea on longer trips in 9 m vessels.

A*lia* catamarans were originally designed to fish close to the reef, at most a day-trip or over-night trip of up to 20 nm, and only in slight to moderate weather and sea conditions.

For these vessels to venture farther away from land would mean endangering the lives of those on board through possible capsizing during heavy weather, or being lost at sea through lack of navigational knowledge and basic seamanship skills, or mechanical breakdowns.

In addition, 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 aluminium (2.5 mm) and it is reported that the changes to the design were done without the input of a naval architect.

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

This has prompted the Fisheries Division to commence implementing preventative measures such as strict vessel licensing procedures; vessel safety, communications and monitoring requirements; and crew training programmes. Although some of these programmes are in the pilot stage, eventual implementation will contribute to safer fishing.

Several measures have already been taken by the Samoa Fisheries Division to address sea safety issues. 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 should 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.

The Fisheries Division has also recognised the need to introduce an advanced small-scale fishing vessel design that would be able to fish within all areas of its EEZ boundaries. Work has already begun on the construction of a prototype '*super alia*' (12.2-m catamaran with twin diesel inboard engines) that will contain the latest amenities for tuna longline fishing and advanced navigation.

1.2.3 Fish quality on board alia *catamarans*

Samoa has a high rate of rejected tuna from local processors and the two canneries in American Samoa, where the majority of albacore tuna catches are sold. Rejections are a result of poor on-board handling and chilling practices and in some cases, poor onshore freezing practices. A recent study carried out by the AusAID/Samoa Fisheries Project team has documented the level of rejected fish based on data obtained from the two canneries in American Samoa and the fish exporters of Apia. The report (Watt & Moala, 1999) showed a rejection rate of:

1996: 154 t worth WST 756,560 (2,092 t worth WST 13.8 million exported);

1997: 382 t worth WST 1,871,800 (4,872 t worth WST 27.5 million exported); and

1998: 517 t worth WST 2,662,550 (5,072 t worth WST 29.6 million exported).

The USA is one of the major importers of tuna products from the two canneries in Pago Pago. Because American Samoa is a US territory, Food and Drug Administration (FDA) requirements regarding fish imports from Samoa can be strictly enforced. If this happens, the tuna industry in Samoa in its current state will be significantly affected.

At present, Samoa's tuna rejects at the export destinations, has not sparked an alarm within the importer circles. This is thought to be due to the importers having stringent quality control management or no serious food poisoning cases as yet. Regardless of the threat of losing export markets, another consequence of the fish rejects is the waste of a good protein source, the significant loss of foreign revenue earnings, and the loss of income to fishermen and processors.

Considerable improvements must be made to the current practices of tuna preparation and preservation. This includes on-board handling of tuna, shore-side off-loading, and processing procedures. These improvements or changes must be implemented immediately or as soon as feasibly possible. Some of the current causes of poor fish quality in Samoa and possible legislation that will effect marketing are examined below.

Hazard Analysis and Critical Control Point (HACCP)

The HACCP regulations are established by US FDA to ensure that proper food safety procedures are maintained in food processing plants and in all related hygienic functions leading to food processing. This was introduced to safeguard the American public from unsafe and unhygienic practices at food processing facilities. In doing so, the risk of sickness or injury from eating processed food is reduced and provides a measure of guarantee that proper procedures are followed in the handling of food products by the food processing facilities and suppliers.

With regard to seafood products, the US Seafood HACCP Regulation is in place to provide assurance that seafood products either produced in the US or imported from a foreign country are safe to eat.

The FDA implemented the US Seafood HACCP Regulations at the beginning in December 1997 and has allowed foreign countries time to gradually comply with their requirements. The import of seafood products into the US requires that importers adhere to HACCP principles and standards, and they must check that foreign processors have a written HACCP plan in place and is implementing the plan (i.e. they must perform an affirmative step).

Inspection, approval of plant construction, and certification of HACCP procedures and programmes must be done by qualified HACCP inspectors or auditors. Samoa, as well as other Pacific Island nations, needs several islanders trained as HACCP inspectors if they are to provide evidence to the US that they are able to enforce proper international food safety standards.

Histamine

In a report to the World Health Organisation, Taylor (1985) wrote that, "histamine is a toxin that develops when the histamine producing bacteria in tuna fish are allowed to multiply. These bacteria reside in the intestines and gills of the fish. If the landed fish is kept at elevated temperatures for a prolonged period, the bacterium invades the muscle tissues and this results in the conversion of tissue histidine to histamine".

Tuna and most of the scombroid group of fish are often caught in warm water and are therefore susceptible to histamine levels when proper preparation and preservation methods are not carried out, especially on-board handling and chilling.

Histamine poisoning has been referred to as 'scombroid fish poisoning' but this is not accurate as histamine poisoning has occurred with other non-scombroid fish species and food such as chicken and cheese have been known to be causes of histamine poisoning.

For Samoa, the control of the histamine-producing bacteria is important in order to prevent tuna from spoiling and being rejected. Fish should be gilled, gutted and chilled soon after they are landed. At present, this is not happening on many vessels in Samoa.

Extended fishing trips on alia *catamarans*

The rapid expansion of the tuna longline industry in Samoa has resulted in a decline in tuna quality. This decline is due, in part, to the greater distances that fishermen must travel and a lack of adequate chilling. Before, *alias* would fish close to shore and return the next day with an adequate load of reasonably quality tuna. A minimum of chilling, if any, was required. Now, however, with the increased number of vessels crowding the same fishing grounds, fishermen must venture farther out to sea to get a satisfactory catch that will pay. This means keeping the fish on board longer, increasing the chances of spoilage.

The fierce competition for the closer fishing grounds has led fishermen to extend the length of their fishing trips from one night out, to two or three nights out in the same 9-m *alias* that cannot carry enough ice for the extended trip. A common practice was for fishermen to carry out fish preparation (gilling and gutting) either after completing the hauling operation or just prior to berthing for unloading. This has continued to be the practice on extended trips.

Vessel design—a contributing factor to tuna rejects

Vessel design and construction play a leading role in tuna quality control. The 9 m *alias* were originally designed for inshore and offshore bottom fishing, trolling and vertical longline fishing, and not 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 were the norm for holding fish; and these were carried on deck. Any excess fish was stored in the hollow hull sections and on any available deck space.

Nearly all *alias* carry only three crew members, which is barely sufficient to perform the setting and hauling duties, and leaves no extra hands to attend to fish preparation and preservation during the hauling operation. Two of the reasons for not taking on extra crew are:

- congestion on board where the person performing the gilling and gutting operation would get in the way of the others who require space to arrange gears during the hauling operation; and

- added expenses to the vessel owner in terms of wages and victuals.

Skills development—a prerequisite to the reduction of rejected tuna

Tuna fishing for the world's frozen fish and fresh fish markets requires that the fisherman have sufficient skills to carry out a safe fishing operation, while maintaining proper protocol in fish handling and preservation.

At the initiation of the offshore fisheries project in Samoa, the *alia* crew consisted mostly of fishermen who had been active in inshore and close offshore subsistence level fishing. Most of the fish caught was for family consumption, distribution to neighbours or for sale locally. The amount of fish caught was sufficient to be disposed of by the end of the day, or in most cases, during the morning hours only. When ice was used, it was sufficient for the day's catch but most fishermen did not wish to spend money on the purchase of ice. The necessities required to fish were within ones means.

Commercial tuna longline fishing however, is aimed at supplying tuna canning factories or the fresh fish market, especially the 'sashimi' market. The prices paid for tuna are determined by the grade of the fish. Most sashimi markets look for grade one or grade two fish (grade A or B in some markets) and will take grade three (grade C) if there is a shortage of top quality fish. The same applies to the canning factories, although the grading is different. Fish size, appearance, backbone temperature and flesh qualities are all considered. If the offloaded fish has a backbone temperature that is sufficient but not low enough, the canning factories give it such a grade as to compensate for freezing and freezer storage till the fish can be processed. If the fish has a perfect appearance but flesh sample shows thicker bloodlines, a lower grade will be given to compensate for the less usable flesh available from that fish. The canneries also do random sampling of all unloadings to check histamine levels, this being one of the main reasons for rejecting fish.

With the current development and demands of the tuna industry in Samoa, the *alia* fishermen must be trained in the different aspects of the trade, especially in fish handling, processing and chilling.

1.3 Initiation of the project and its objectives

The Samoan tuna longline fishery has primarily targeted albacore tuna for sale to the two tuna canneries in neighbouring American Samoa. Catches of this species have been high in Samoa since the start of the fishery, although the cannery prices for the different tuna species has fluctuated throughout this time. The cannery price for frozen albacore tuna has been the most stable with the average price from 1996 to 1997 being WST 4,900/t (USD 1,620/t). In 1998 the estimated average price was WST 5,150/t (USD 1,700/t) although the price dropped to WST 4,242/t (USD 1,400/t) in the latter part of the year (Watt & Moala, 1999).

The Fisheries Division, seafood processors, and local fishermen have all been looking to maximise on the economic return from the domestic tuna fishery. In doing so, the focus has been on fresh exports of tuna, mainly bigeye and yellowfin, to overseas markets. With this in mind, fishermen have been trying to increase the catch of the more valuable species by experimenting with gear and fishing farther offshore. Coupled with this has been the need to increase fish quality through better on-board handling, processing and chilling of the catch as well as the need for fishermen to be more sea safety conscious, which includes learning basic navigation skills.

To assist the Samoan fishing industry, the Fisheries Division officially requested technical assistance from the SPC in May 1998 to address the above issues. A Memorandum of Agreement (MoA) was signed between the Samoan Government and the SPC in March 1999, which clearly defined the roles and responsibilities of both parties and the objectives of the project. The project commenced on 12 March 1999, when Fisheries Development Officer Peter Watt arrived in Samoa. The objectives of the project were to:

- conduct tuna longlining trials from the fisheries vessel, F/V *Tautai Matapalapala*, to try and increase the catch rates of the higher value tuna species (bigeye and larger yellowfin) for export;

- train the crew of the fisheries vessel, F/V *Tautai Matapalapala*, and other interested fishermen in correct on-board handling, processing and icing practices for tunas and other species, especially export quality fish; and

- conduct several one-day workshops for interested fishermen on correct on-board handling, processing and icing of the catch.

The project was originally scheduled to run for four months; however, the Fisheries Development Officer resigned and a new one was recruited to replace him. As a result, there was a five month interruption in the project. Stage II of the project commenced on 4 October 1999, when Fisheries Development Officer William Sokimi arrived in Samoa, and concluded on 20 December 1999. The original objectives were retained for the final stage, with minor changes as follows:

- to conduct several workshops in two locations in Samoa on correct on-board handling, processing and icing of the catch, and the fundamental use of GPS (global positioning system) and other simple navigation techniques; and
- to provide input and an independent viewpoint on the design and deck layout of a new 12.2 m '*super alia*' tuna longline vessel design, being built in Samoa.

2. PROJECT VESSEL R/V *TAUTAI MATAPALAPALA*

The fisheries research vessel R/V *Tautai Matapalapala* was used for all fishing activities during both stages of the project. The vessel was built for the Samoan Government Fisheries Division, Department of Agriculture, Forests and Fisheries. Funding was provided from a grant from the United States Agency for International Development and built by Modutech Marine, Tacoma, Washington, USA in August of 1988. The vessel was initially used as a general-purpose fisheries research vessel but with the development of the offshore pelagic fisheries, was converted to carry out small-scale tuna longline fishing.

R/V *Tautai Matapalapala* is a stern working-deck vessel, based on designs for gill net fishing vessels used in the salmon fishery in the Pacific Northwest. It has a hard chine hull constructed from fibreglass-reinforced plastic and a forward wheelhouse and accommodation area. The fish hold has a 2.5 t capacity and is insulated with 10 cm polyurethane sealed in with a fibreglass covering. Figure 6 is a line diagram of R/V *Tautai Matapalapala*; specifications for the vessel are in Appendix B.

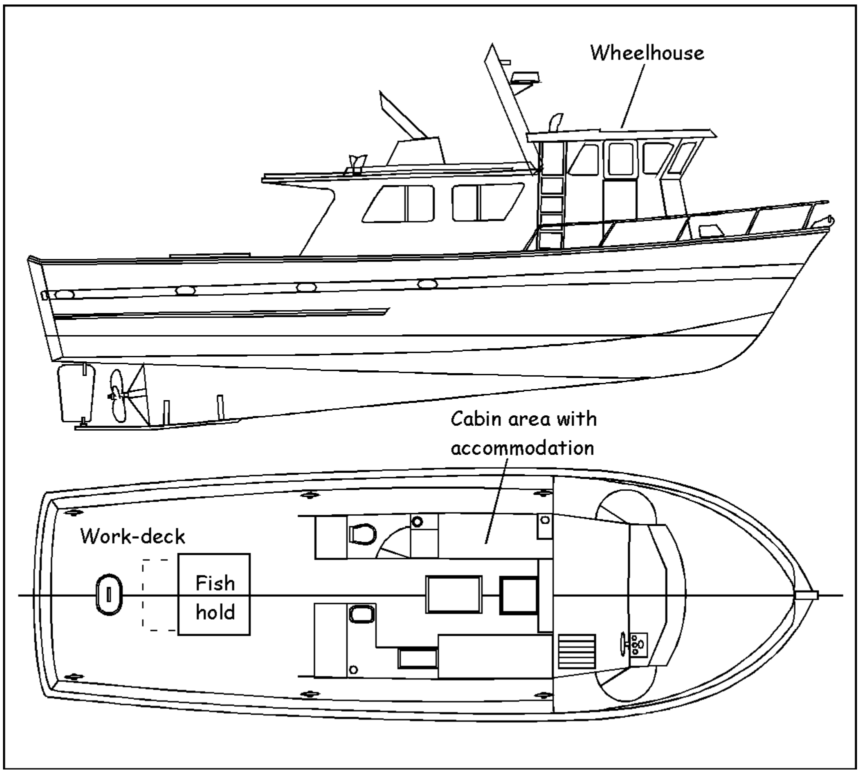

***Figure 6: Original plan and layout of the R/V* Tautai Matapalapala**

2.1 Modifications to project vessel during Stage I of the project

Prior to the arrival of the SPC Fisheries Development Officer in Samoa, the Fisheries Division had made some modifications to R/V *Tautai Matapalapala* in order to fit it with tuna longlining equipment and to prepare it for the fishing trials. Unfortunately, when the SPC Officer arrived, the Fisheries Division was encountering problems with the hydraulic system and longline reel. The arrangement of the gear also needs some changes and a few other minor repairs made.

2.1.1 Hydraulic system

The original hydraulic system on the R/V *Tautai Matapalapala* was set up to operate a 'Sea Tech' mini longline hauler. The hauler was equipped with small interchangeable spools, each with a monofilament line capacity of approximately one nautical mile. The hydraulic pump originally had a small one-litre reservoir for storing hydraulic fluid, but when the new longline reel was installed, an additional 20 l tank was also installed on the deck, to cool the fluid when the reel was operating for extended periods of time. A 12 mm diameter hydraulic hose was fitted into the tank and ran into the intake port on the pump.

This system did not work properly. The one litre reservoir created an air vacuum in the hydraulic system as the fluid from the additional tank did not fill the reservoir when the pump was operating. Also, when the pump was not operating, hydraulic fluid leaked out of the top of the reservoir. A hydraulic specialist from New Zealand inspected the system and concluded that both the 12 mm hose and the 20 l tank were too small for the system.

To correct the problem, the reservoir was replaced by a steel plate, fastened on top of the pump to cover the outflow ports to the reservoir. A 25 mm diameter hole was drilled through the plate to create a hydraulic fluid intake port. A 25 mm diameter nipple fitting was welded over the hole to allow a 25 mm hose to be attached.

A new 60 l tank was fabricated with a 25 mm diameter nipple fitting for the intake on the hydraulic pump, with a 12 mm diameter nipple for the return hose. In addition, the original crossover relief valve was found to be defective and was replaced.

The hydraulic reel control valve was moved from its reel-stand mounting to the wheelhouse, and positioned near the helm so the skipper could control the reel while driving the vessel. The control valve was mounted on the deck and an extension was welded onto the control valve handle to go through the top of the wheelhouse dashboard. Two new 12 mm diameter hoses, 10 m long, were fabricated to run from the reel to the control valve in the wheelhouse. This modification eliminated the need for one crew to operate the reel fulltime when hauling, as this could now be conducted by the skipper.

Longline reel

The reel on R/V *Tautai Matapalapala* was fabricated from aluminium at a local boat building shop. The hubs of the reel were not aligned properly when welded onto the axle and the motor mount was also not properly aligned causing the motor to move back and forth with the mount, bending the reel stand. The combination of these two problems made the sealed bearings bind when the reel was rotating.

To reduce the wear on the bearings four, 5-cm long stainless steel bolts with metal spacers were fastened to the motor through the motor mount (Figure 7). When the motor rotated the axle, the metal spacers on the bolts allowed the motor to move freely back and forth on the bolt shafts, thereby reducing the wear on the bearings.

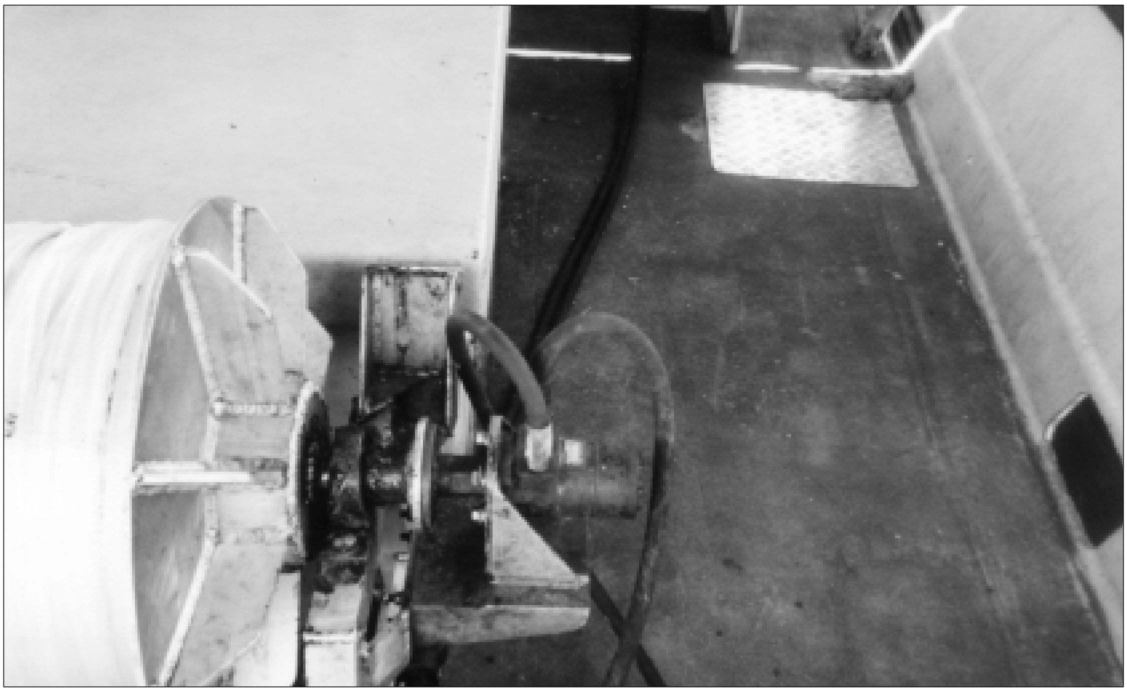

Figure 7: Mounting of the hydraulic motor with metal spacers on the bolts

Longline gear arrangement

The longline reel was mounted near the stern of the vessel behind the fish hold hatch (Figure 8). When the SPC Fisheries Development Officer arrived, there was no system established for setting and hauling the longline gear. The following system was set up by the Officer with the Fisheries Division staff.

Figure 8: Hydraulic longline reel mounted behind fish hold hatch

To set the longline gear the bolts holding the hydraulic motor to the reel axle were removed to allow the reel to spin freely. The mainline was then run directly over the transom, free-spooling off the drum as the vessel motored forward.

The branchline bin was placed on the starboard side of the vessel near the transom. A bait box was lashed to the top of the gunwale on the transom directly in front of the branchline box. As the vessel motored forward paying out the mainline, one of the crew unclipped the branchlines from the branchline box and gave the hook end to the baiter who was positioned in front of the bait box. He then gave the clip end of the branchline to another crew, the clipper, positioned on the port side of the mainline as it rolled over the transom. Butterfly knots (also called harness knots—Figure 9) were tied into the mainline every 50 m to mark where the longline clips should be placed. The clipper then snapped the longline clip onto the mainline a few centimetres before every butterfly knot. If the longline clip was snapped onto the mainline after the butterfly knot, when the mainline was hauled in, there was a danger of the person unclipping not to have enough time to release the clip from the mainline before it came to the pulley.

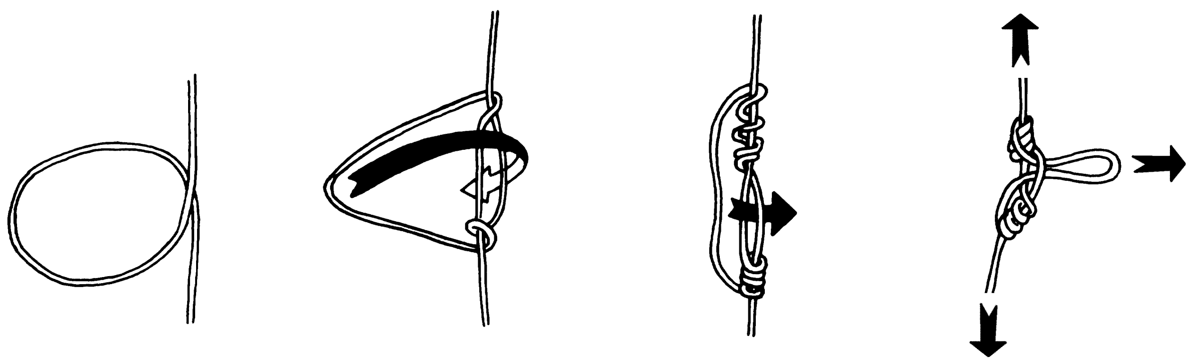

Figure 9: How to make a butterfly or harness knot

To haul the mainline, three pulley stands were fabricated and mounted on R/V *Tautai Matapalapala*. A fairlead was fabricated near the helm on the starboard side of the vessel so that the skipper could easily see the mainline as it was hauled in. Also, with the reel control in the wheelhouse the skipper could safely manoeuvre the vessel and control the mainline to ensure the mainline did not go under the hull.

Before the Fisheries Development Officer changed the hauling system, the mainline was set up to be hauled midships on the starboard side with a pulley attached to the old Sea Tech hauler stand. This hauling arrangement was not practical because the skipper had to stand outside the wheelhouse and look back towards the stern to see the position of the mainline. Constant attention was required to keep the mainline from going under the vessel and wrapping around the propeller. Also, if there was a fish on a branchline the crew had to haul the fish in quickly to ensure the fish did not run under the boat and wrap the branchline around the propeller.

The new hauling arrangement has a fairlead, with a proper snatch block pulley, projecting out over the starboard gunwale by the wheelhouse. It is mounted to the roof of the wheelhouse. A 5 cm galvanised pipe is welded to the fairlead at one end and bolted at the other to the gunwale, to provide additional strength (Figure 10). At starboard midships, near the end of the cabin, a second pulley stand is attached. The stand consists of a 5 cm diameter galvanised pipe with a 30 cm length of 5 cm thick aluminium angle iron welded at the top to attach a pulley. The galvanised pipe is fastened at one end to the cabin roof then to a cleat on the deck at the other, as the gunwale on the vessel is not strong enough to support the pressure of the mainline as it was hauled through the pulley.

Figure 10: Fairlead mounting arrangement

A third pulley stand is fabricated in the middle of the deck behind the cabin. This stand is fabricated from two 10 cm by 10 cm timbers spaced one metre apart. Each timber is notched into the roof of the cabin at the top and nailed into a wooden frame support on the deck. Between the two timbers a 4 mm diameter aluminium pipe is fastened to support the pulley. The aluminium pipe is attached approximately 15 cm from the top of the timbers where they were fastened to the roof. The pulley is then lashed in the middle of the aluminium pipe.

When the mainline is hauled in, it first passes through the fairlead on the starboard side of the wheelhouse, then through the pulley stand near the end of the cabin. The mainline then turns 90° towards port, to the pulley stand placed in the middle of the deck behind the cabin. Lastly, it turns another 90° to the reel. As there is no line guide on the reel, the mainline has to be manually guided onto the reel to spread the line evenly across the spool. The branchlines are unclipped from the mainline before they pass through the snatch block attached to the fairlead. Each branchline is then passed along the starboard side of the cabin to a crew member who clips it onto the branchline bin placed on the stern deck.

The stand for the old Sea Tech hydraulic hauler was dismantled and removed from the deck as it was obstructing the working area when hauling the gear. An aluminium plate was glued then screwed to the deck to cover the holes where the Sea Tech hauler was bolted through the deck.

Other changes and additions

The following changes and additions were made to R/V *Tautai Matapalapala* to prepare the vessel for fishing operations:

- Flood lights were attached to the roof of the cabin to illuminate the stern deck area for setting and hauling the gear at night;
- New floatlines were fabricated for the flagpoles at either end of the mainline;
- The GPS/plotter was programmed for operation in Samoan waters, with Fisheries Division staff trained in the operation of the unit;
- A new life raft was installed on the roof of the cabin; and
- Temperature/depth recorders were used to collect data, which was useful in determining the depth the mainline reached during the set.

2.2 Equipment on the project vessel at the start of Stage II

The mainline reel on R/V *Tautai Matapalapala* was a modified hand-crank reel found on the smaller *alias*. It was manufactured locally and was constructed of aluminium. A modified hydraulic pump and hydraulic system was the main drive for the mainline reel, with a hand-crank sprocket on the opposite end of the drum for back-up in case of problems with the hydraulics.

This system was set up by the SPC Fisheries Development Officer during Stage I of this project, and considering the availability of materials on hand, it would be difficult to improve on it without making a major overhaul to the whole set up. The present system was sufficient for using 400 hooks per set, although a constant check on the end bearings of the mainline spool was made so that action could be taken when wear and tear was spotted on the bearings.

Four hundred and fifty branchlines were constructed for the fishing trials. They were made from 11 m x 2.0 mm x 180 kg-test clear monofilament, with a 0.148 snap (with 9/0 swivel) on one end and a 15/0 circle hook on the other end. Floatlines were constructed from 30 m of Kuralon tarred rope with a Japanese longline snap attached on one end and a 15 cm eye splice on the other. The mainline was of 3.0 mm x 320 kg-test monofilament line, and the buoys used were 300 mm reinforced plastic tuna longline floats.

Swordfish longline gear was constructed for a demonstration set and for future surveys. This gear was set up in much the same way as for tuna longlining except that the floatline lengths differed, and new 20 m lines were made up. The same branchlines for tuna longlining were used. Light sticks and purse-seine, foam-filled floats were purchased for use during the trials.

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 in 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, thereby 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 either 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 with 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 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.

For on-board use of the TDR equipment, 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 either the whole trip, or is downloaded after every set is hauled up. For fishing purposes, downloading after every haul will enable fisherman to assess how the previous set has gone and make gear adjustments for the next set accordingly.

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

Only limited fishing was undertaken during Stage I of this project, due to repairs to the hydraulic system, and setting the project vessel up for fishing. During Stage II, 14 sets were made during six fishing trips, with some changes to fishing practice being implemented after the first trip.

3.1 Fishing activities and on-board training

During Stage I of this project, only two fishing trips setting a total of 800 hooks were undertaken, with the first trip used to test the hydraulic system and reel. This set had 400 hooks with 50 m between branchlines, 25 branchlines set between floats, and 60 m floatlines. The set went well although some alterations were made prior to the second trip, namely, moving the fairlead to the bow of the vessel and the reel control into the wheelhouse.

The temperature/depth recorders (TDRs) were put on the mainline on the second trip. The 400 hooks were set in the same configuration as the first set. The TDRs indicated the gear was not fishing as deep as first thought, with the deepest recorded depth being 193 m. Unfortunately, only one set was made as the engine developed an oil leak, resulting in a need for the vessel to return to port.

During these two trips, the SPC Fisheries Development Officer focused the on board training of the crew on the use of the vessel electronics and fishing strategies (ways to locate fish). The limited catch on these trips restricted the amount of training on the on-board handling, processing and icing of the catch.

Soon after the SPC Fisheries Development Officer arrived for Stage II of the project, the first trip was undertaken. The Officer's aim was to observe and assess vessel capabilities, fishing equipment function and performance, methods of setting and hauling the fishing gear and fish handling, and quality control on board. Based on the observations made, recommendations for improvement were put forward and tried during later trips.

3.1.1 Observations made during the first fishing trip during Stage II

The methods used by the crew of the R/V *Tautai Matapalapala* were similar to those used aboard the local *alias*. It took 3.5–4.0 hours to set 400 hooks and vessel speed was set on dead slow ahead, or around 2.5–3.0 knots. The hauling operation was more reasonable in that it took 4.5 hours to haul the line back in with the vessel moving at slow ahead. Care was taken to avoid increasing the engine speed to safeguard against the pump or the hydraulic hose from developing a leak. The normal crew complement per fishing trip was five.

Setting

Prior to setting the line, a securing bolt through the centre of the axle connecting the pump to the mainline spool, was released to allow the spool to free wheel. The line ran over the top of the branchline storage bin and aft bulwark with no guide to control the line going over the stern of the vessel (Figure 11).

Figure 11: Mainline running over the top of the branchline bin during line setting

At 50 m intervals along the mainline, butterfly knots were tied to indicate the snap-on position for the branchlines. Spool speed was controlled manually by a crew member applying pressure to the mainline spool (using his rubber boots). As an outgoing butterfly knot approached, the reel was 'braked' or slowed down (Figure 12) and the branchline snapped onto the mainline, outside the knot, thereby safe guarding against injuries (hand snatching) during hauling.

Figure 12: Slowing the reel as a butterfly knot in the mainline approaches

The full setting operation required all five crew members, one each to: steer and control the vessel's speed; prepare and deploy floats; control spool speed; bait and release branchlines; and snap the branchlines onto the mainline. With this set up, the crew were fully occupied throughout the 3.5–4.0 hours of line setting. Because of this, other tasks such as the preparation of meals had to be done after the line was set.

Hauling

The conversion of the R/V *Tautai Matapalapala* from a gillnet fishing vessel to a longline vessel was done without installing a separate hauling or workstation aft. Therefore, all manoeuvring and reel operation had to be done from the wheelhouse. For hauling purposes, however, three pulley stands were installed as outlined in Section 2.1.3, to direct the mainline to the reel (Figure 13).

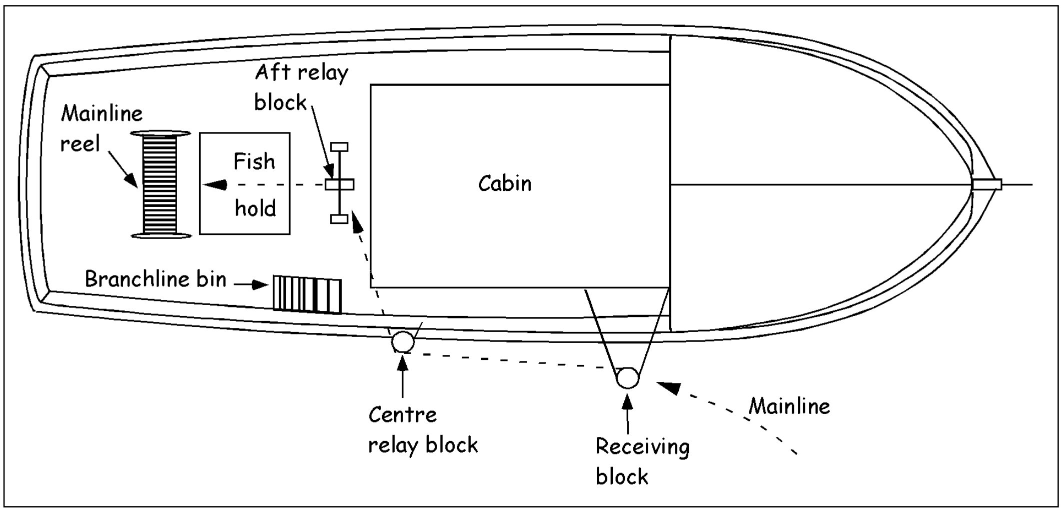

Figure 13: Pulley arrangement used during line hauling

The hauling operation also required the full participation and attention of the five crew members, one each to: steer and manoeuvre the vessel; unsnap branchlines as they were retrieved; pass branchlines along the walkway to the bin man; restore branchlines in the line bin and haul in floats; and manually level-wind the mainline along the mainline spool.

Handling, processing and chilling the catch

When a fish was landed, it was quickly bled and stored on the aft deck to be later attended to, which was normally after completing the hauling operation (Figure 14). The method of gilling and gutting conducted by the crew is common practice in fresh fish longline fishing. However, a few minor improvements would significantly improve the quality of the fish.

Figure 14: Fish left on deck after bleeding, to be cleaned and iced at the end of the set

The initial practice carried out by the crew of R/V *Tautai Matapalapala* was that when a fish is landed it was immediately bled and left on deck to be later gilled, gutted and iced. From this point on improvements have to be made as fish should not be left on deck for 3–5 hours before cleaning and icing if quality is to be maximised. While the current methods may be sufficient to provide fish for the frozen fish market, mainly the canneries at American Samoa, there is still a lot of room for improvement. A recent study has shown an increase in numbers of fish being rejected from the American Samoan canneries as a result of poor quality (Watt & Moala, 1999).

One reason for the practice on R/V *Tautai Matapalapala* is that, with the current set up of equipment, all crew are occupied in other duties involved in retrieving and storing the mainline and fishing gear. Having one crew absent from his duty station would require the hauling operation to be done at a slower pace with a lot of stop/start interruptions. This would set the crews' work pattern on an uncoordinated path and would extend the hauling time by at least two hours.

3.1.2 Suggested changes and improvements

Efficient tuna longlining depends on quick deployment and retrieval of gear while maintaining top quality fish. This ensures that all the line is in the water at feeding time and gives the gear sufficient time to soak and sink to the desired depth. The vessel's crew would also have more hours of rest and be adequately alert during fishing operations to ensure personal safety and good quality fish.

The crew of the R/V *Tautai Matapalapala* had the basic skills required to navigate the vessel to and from fishing grounds and to conduct fishing operations. However, because the previous focus was on supplying fish for the tuna canning market, some habits needed to be phased out if fish quality was to be improved. If the proper procedures are followed and implemented correctly, preparing tuna for the fresh fish or sashimi market will guarantee that tuna will be accepted in other markets. To steer the crew in this direction, change in operating procedures was necessary, and the crew briefed on the necessity for this.

Several minor adjustments were recommended and implemented as a result of observations of the first trip. This resulted in noticeable improvements to the setting and hauling operations and fish quality as presented below.

Fishing strategy

For the five fishing trips conducted after the initial observation trip, new strategies were implemented incrementally to allow the crew to accept the changes and understand the reasons for them.

Firstly, the choice of a fishing ground needs to be considered, and this will depend on many factors including: information collected from other fishermen, features shown on charts like seamounts. underwater contours and currents etc. Sea surface temperature and thermocline depths are also very important, but the R/V *Tautai Matapalapala* was not equipped with appropriate equipment to assess these. Several other factors must be considered before a set can be made. These are: wind direction, current direction, number of hooks between floats, sea state, choice of fishing ground, snapping-on method and unsnapping preference; and method of manoeuvring the vessel while setting.

On fishing trip two, the crew were directed to perform line setting at a faster pace and in an organised and safe manner. Several alterations were made to allow for the planned sequence of operations. The setting speed was gradually increased from around 2.5–3.0 knots, to setting at full speed of around 6.0–7.0 knots. Previously the setting operations required all five crew, however, duties were blended so only three crew were required.

On fishing trips three to six, the crew practised setting and hauling procedures. This included standard procedures for gaffing and landing the fish, correct methods of bleeding, gutting, cleaning and preserving fish on ice.

The importance of adhering to the procedures laid down were emphasised, and any deviation or short cuts were pointed out. Periods onshore were spent in developing seamanship skills such as tying knots, splicing, ship maintenance, protection of fishing gear, fishing gear construction, protective gear netting, sea survival and safety on board issues.

Line setting improvements

The R/V *Tautai Matapalapala* is a 'starboard hauling' vessel, meaning all line setting is done with the wind at around three points abaft the port beam (wind from the stern port quarter). This puts the wind on the starboard bow when hauling. It was also preferable to set ‘across’ the current rather than ‘with’ it; but at the same time, care was taken to keep the wind and swells straight ahead or slightly off the starboard bow. Setting at least 20° diagonally to the current allowed the line to be trolled during the soaking period without off setting it too much for hauling. In addition, the first end set would not collapse onto itself, avoiding line tangle on the end.

The fishing grounds chosen were mainly areas close to seamounts or near contour ‘drop-offs’ from 1000 m to deeper waters. The line was set 5–10 nm on the current side or the leeward side of these areas. This was done to determine where areas of ‘up welling’ occur so that these areas could be targeted for fishing.

Besides floatline and branchline length, fishing depth was mainly attained through line sag between floats. On most sets, 30 hooks were placed between floats, at a spacing of 50 m. The vessel was steered in either a straight line, an ‘S’ or zig-zag manner. For short soaking periods, the ‘S’ pattern was steered to allow the line to settle quicker. In this method, a compass heading was set and the helmsman instructed to ‘waver’ the vessel while generally travelling in the direction given. This was an effective method for obtaining the depth of the target species, albacore tuna.

For setting purposes, a 16 mm shackle was fastened to the awning frame to act as a line-guide for the mainline (Figure 15). The mainline was passed through the shackle and over the stern, where the first marker buoy with flag (high-flyer) was connected and deployed. While facing aft, the branchline snaps were clipped onto the mainline in a left to right motion. This ensured that during hauling, the snaps would come up in an inverted position, requiring a downward unsnapping motion, which is generally found to be less strenuous. The normal setting procedure was then followed, that is, snapping on the baited branchlines and floatlines at the desired intervals.

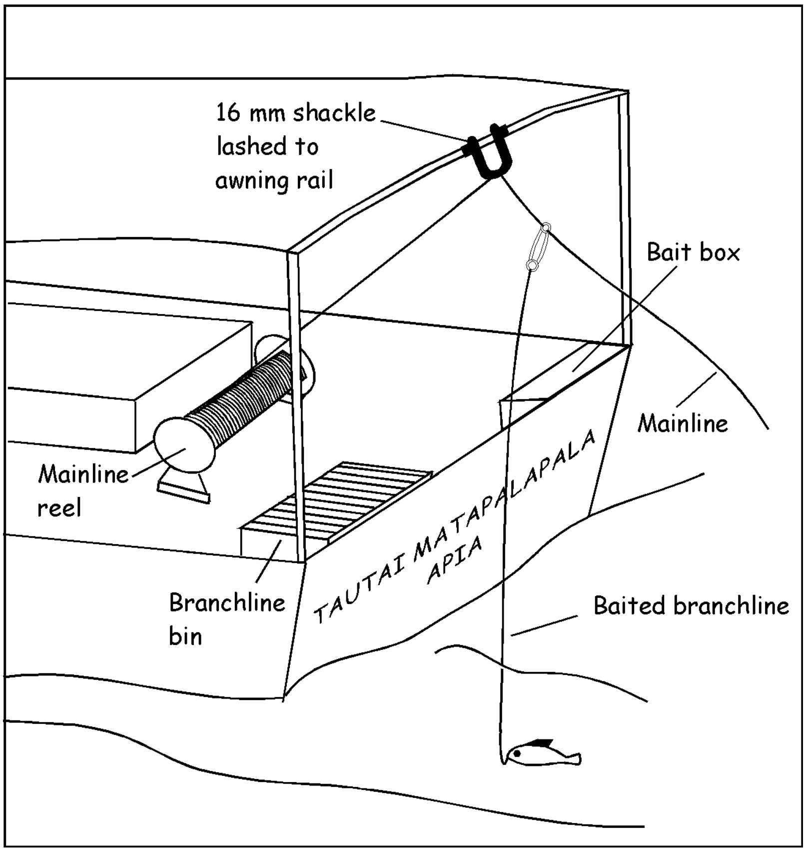

Figure 15: Line-guide made from a 16-mm shackle fastened to the awning frame

With this simple line-guide in place, several factors were improved. The vessel speed was set on full ahead (6.0–7.0 knots), and this reduced setting time to 1.0–1.5 hours, compared with previous times of 3.5–4.0 hours. During line setting, only three crew were required: one for baiting and snapping, one for float and floatline preparation and back up, and the third for steering. The crew member responsible for preparing floats and floatlines also had the duty of controlling the spool speed by applying pressure on the rotating reel with the heel of his work boots. The duties were also rotated so that each crew member became proficient in each task. This also prevented individuals from becoming bored, reducing the risk of accidents.

Line hauling improvements

The addition of a length of 3.0 mm monofilament mainline connected from the fairlead hauling block stanchion to the second hauling block stanchion (making a 'transport line'), made a significant difference to the hauling operation. This allowed the person unsnapping the branchlines to transport the branchline aft by looping it around the 3.0 mm monofilament and sliding it back. The person at the branchline bin simply unlooped the line off the transport line, collected it into the bin and pull it into the bin for storage.

Previously a third crew member would run the line aft after it had been unsnapped. The transport line eliminated this function, releasing this crew person for other duties. Having the extra man available solved the problem of gilling, gutting and fish preservation duties. This system worked effectively and was carried out on a rotational basis.

During hauling, the area in which fish were caught and on which hook between floats was carefully noted. This information was used to decide whether to begin the next set closer or farther away from the initial setting area, and whether to keep the same setting pattern or to set deeper or shallower.

Fish quality improvements

Having a crew person available to clean and ice the catch resulted in a great improvement in fish quality. Also, several additions have improved fish quality and aided the person carrying out gilling and gutting duties. These are:

- the inclusion of a tarpaulin and rubber mat on which to bleed and gut the fish;
- a proper club for stunning the fish;
- a spike for killing the fish;
- sharp knives;
- a sharpening stone;
- hand gloves for protection against cuts and scratches; and
- a piece of mainline for carrying out the *Tanaguchi* method on the fish.

The crew were also encouraged to use their rubber boots when working on deck or in the fish hold, for comfort and protection.

Previously, fish were piled up on deck and tended to after hauling time; now they are immediately bled, gilled and gutted and preserved on ice. Fish quality has improved tremendously and the crew has received top dollar for their efforts.

3.1.3 Swordfish fishing trial

One swordfish set was undertaken for observation and training purposes only. Due to time constraints and and the lack of proper bait, a proper survey of the swordfish grounds could not be carried out. This set was fitted in during a scheduled trip, and was done at the request of the vessel's crew to obtain knowledge for future consideration.

Swordfish fishing grounds have been located around seamounts and the shallower waters surrounding these areas. Unfortunately, the area fished was around 100 nm from the closest swordfish ground.

The fishing method for swordfish differs from tuna longlining in that the gear is set to fish at a shallower depth. Generally, around five branchlines are set between floats, with a light stick attached to the centre branchline. Purse-seine floats are used as more floats are required and these are easier to handle and store. Often the 30 cm plastic floats are used after five or six purse seine floats have been deployed. This is to ensure buoyancy should the weight of fish between a section exceed the buoyancy capacity of the purse-seine float. Setting and hauling preferences for wind, current and setting direction is much the same as for tuna.

Swordfish fishing is most effective when line setting is done before sunset, left overnight to soak, and hauled during day break. The successful period is from the first to the last quarter of the moon. Different areas have different success rates within this period.

During this demonstration set, fish bait was used, with poor results. Squid is the proven bait for swordfish fishing. Besides being one of the swordfish's natural prey, it has a tough texture that enables it to remain on the hook overnight, even after its been attacked by other live squid and tiny nocturnal sea creatures.

The remainder of the operation is the same as that for tuna longline fishing.

3.2 Results of fishing activities

Results from fishing activities varied from trip to trip, with the catch rates in Stage II much higher than those in Stage I. This is due to the seasonal variation in tuna availability; the months from March to May produce low catches of tunas around Samoa. In addition, fishing activities during Stage I were to test gear as well as try out deck machinery.

Table 1 summarises the catch taken during the project, while Appendix C gives a more detailed breakdown of the catch and effort. The total saleable catch for Stage I was 111 kg (13 fish) during two overnight trips, while for Stage II the catch was 3,855 kg (272 fish) over 14 sets during six fishing trips. A total of 6,400 hooks were set during the entire project.

Table 1: The 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 sp.		Yellowfin tuna		Bigeye tuna		Albacore tuna	
No.	hooks	No.	Kg	No.	Kg	No.	Kg	No.	Kg
Stage I									
1	400	10	94.4	9	87.2				
2	400	3	17						
Sub-total for Stage I									
	800	**13**	**111.4**	**9**	**87.2**				
Stage II									
1	400	16	225.3	1	48			8	146.4
2	800	75	1032.2	45	552	4	38.1	18	320
3	1200	80	1062.8	10	130	1	19	49	820
4	400	7	165	1	13.2			5	137.6
5	1600	67	892.1	12	116.5	6	87	28	529
6	1200	27	477.5	6	105.8	1	45.6	14	258.3
Sub-total for Stage II									
	5600	**272**	**3854.9**	**75**	**965.5**	**12**	**189.7**	**122**	**2211.3**
TOTAL									
	6400	**285**	**3966.3**	**84**	**1052.7**	**12**	**189.7**	**122**	**2211.3**

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 D. The overall CPUE for the saleable catch was 61.97 kg/100 hooks, with the most predominant species being albacore, with an overall CPUE of 34.55 kg/100 hooks. If the catches from Stage I are removed, the CPUE for Stage II is higher at 68.84 kg/100 hooks for all saleable fish and 39.49 kg/100 hooks for albacore. Yellowfin was the species with the next highest CPUE at 16.45 kg/100 hooks over both stages, and 17.24 kg/100 hooks during Stage II only.

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)				Percent by weight			Average weight		
No.	All sale	YFT	BET	ALB	YFT	BET	ALB	YFT	BET	ALB
Stage I										
1	23.60	21.80			92.37			9.69		
2	4.25									
Sub-total for Stage I										
	13.92	**10.90**			**78.28**			**9.69**		
Stage II										
1	56.33	12.00		36.60	21.30		64.98	48.00		18.30
2	129.03	69.00	4.76	40.00	53.48	3.69	31.00	12.27	9.53	17.78
3	88.57	10.83	1.58	68.33	12.23	1.79	77.15	13.00	19.00	16.73
4	41.25	3.30		34.40	8.00		83.39	13.20		27.52
5	55.76	7.28	5.44	33.06	13.06	9.75	59.30	9.71	14.50	18.89
6	39.79	8.82	3.80	21.53	22.16	9.55	54.09	17.63	45.60	18.45
Sub-total for Stage II										
	68.84	**17.24**	**3.39**	**39.49**	**25.05**	**4.92**	**57.36**	**12.87**	**15.81**	**18.13**
TOTAL										
	61.97	**16.45**	**2.96**	**34.55**	**26.54**	**4.78**	**55.75**	**12.53**	**15.81**	**18.13**

When looking at the different tuna species as a percentage of the total saleable catch, albacore was the most significant at 55.8 per cent overall, followed by yellowfin at 26.5 per cent. Bigeye catches were low at 4.8 per cent of the catch. The average size of both yellowfin and bigeye was also small at 12.5 kg and 15.8 kg, respectively, although several larger individuals of 45 to 48 kg were caught. The average size of the albacore tuna was good at 18.1 kg.

Sharks made up the vast majority of the unsaleable catch by weight (926 kg from a total of 977 kg), although this consisted of only 14 animals. All sharks were headed and gutted with the fins removed for sale and the meat retained for crew consumption.

3.3 Comparison of catch rates

One of the main aims of the project was to increase the catch rates of the higher value tuna species (bigeye and larger yellowfin) for export as fresh-chilled product. As can be seen from Table 2, the average weight of bigeye (15.8 kg) and yellowfin (12.5 kg) was not large, with most fish of these species being too small for export.

When looking at the percentage of catch by species in Samoa for 1998, albacore tuna is recorded at around 68 per cent, yellowfin tuna at 10 to 20 per cent, and bigeye tuna at around 5 per cent (Passfield & Mulipola, 1999). When comparing the percentage of catch by species from the current project, it would appear that the albacore catch rate was lower (55.8%), the yellowfin catch rate was higher (26.5%) and the bigeye catch rate was around the same (4.8%). Given the short duration of the fishing activities, it is inconclusive as to whether the change in percentage of catch was based on seasonal changes or changes in fishing strategy and gear configuration as a result of the project.

It is also difficult to compare CPUE figures from the Samoan domestic tuna longline fishery with other Pacific countries, where the catch rates for yellowfin tuna and bigeye tuna are naturally higher (e.g. Solomon Islands and Papua New Guinea). Therefore, the most likely countries to compare catches with would be Fiji and Tonga. Unfortunately, data on catches are scarce for the domestic tuna longline fleet in Tonga, while the fleet in Fiji keeps good records.

In 1998, the composition of the domestic longline catch in Fiji was 11.2 per cent yellowfin tuna, 62.6 per cent albacore tuna, and 7.1 per cent bigeye tuna (source, SPC database). These percentages are similar to those recorded in Samoa during 1998. The main difference is that the average size of the yellowfin tuna and bigeye tuna were much larger at 24.7 kg and 24.3 kg, respectively. This means that far more of the Fiji fish were of a suitable size or weight to export, compared to the smaller fish caught during this project.

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

During the course of the six fishing trips, a total of twenty readings were made, with up to five data loggers being deployed on any one set. Information derived from the retrieved TDRs has shown that the starting and ending sections of a longline set tend to be deeper than other sections along the set when the same method of line setting is maintained throughout. That is, the same number of hooks between floats, same length of branchlines and floatlines and same spacing between hooks. These readings showed unexpected depths such as 728 m at the beginning section of the first set (Figure 16), while data loggers more in the centre of the line showed an average depth of around 335 m (Figure 17). The minimum temperature at 728 m was 5.3∞ C, while in the centre of the line, it was around 13.3° C.

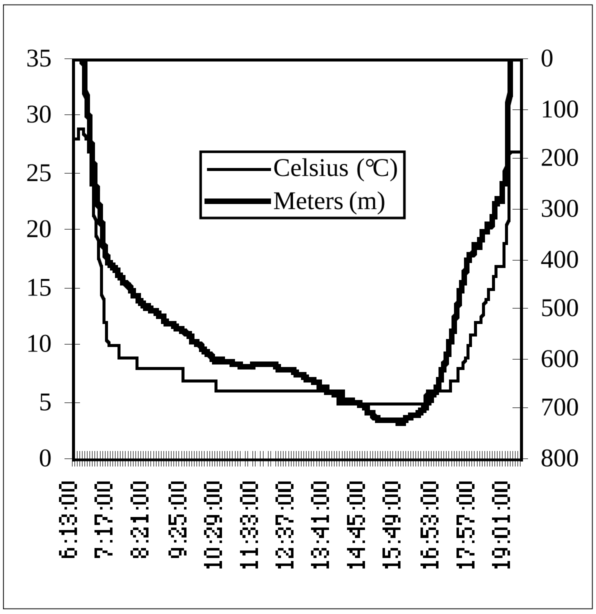

Figure 16: Plot showing the end of the mainline collapsing to a depth of 728 m

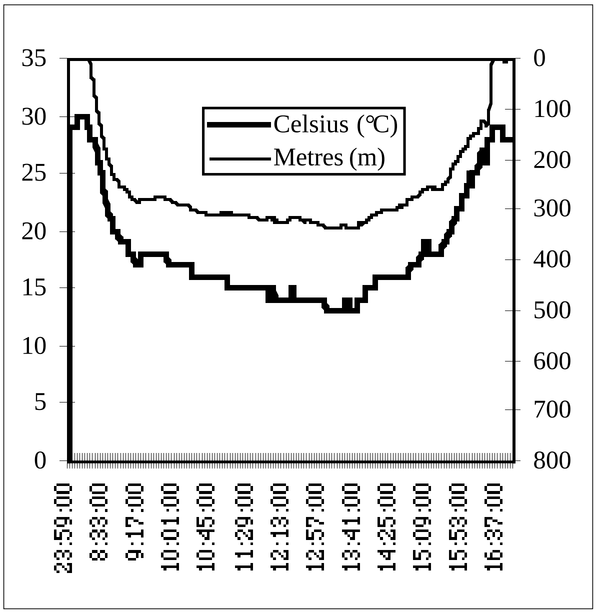

Figure 17: Plot from centre of mainline showing a fishing depth to 335 m

The end section of mainline being light and loose, tended to be pulled in or collapsed by the weight of the branchlines after settling, creating a deeper bight between the first and second floats and the last and second last floats. Reducing the number of hooks and shortening the floatlines in the two end sections corrected this.

Slight fluctuations in depth readings were also noticed, and these can be accredited to many causes. Sea and weather condition will cause the data loggers to show slight fluctuations in its readings and the difference will coincide with the height and trough of the swells at the time the reading is taken. Current and upwellings can either keep the data loggers from sinking too far down or pull them down further than expected.

More studies are needed to correlate the depth and temperature data to actual catch of desired species. Unfortunately, none of the data loggers were close to where the bigeye tuna or larger yellowfin tuna were taken on the gear. Over time, this data will be collected and be valuable to fishermen as they target their gear for specific species.

3.5 Disposal of the catch

Disposal of the catch was the responsibility of the Fisheries Division. An arrangement was made with one of the local processors to purchase most of the exportable fish. The main species sold were albacore tuna, with 119 fish weighing 1,992 kg sold at an average gilled and gutted price of WST 5.70/kg. Thirty-eight yellowfin tuna weighing 535.5 kg, and seven bigeye tuna weighing 131.4 kg were sold to the processor gilled and gutted, at prices ranging from WST 2.20–8.50/kg depending mainly on size, fat content and colour of the flesh. Other species sold to the processor included marlin and wahoo. In total, the Fisheries Division received WST 14,332.11 from the processor from fish sales.

Fisheries Division staff also purchased some fish at prices ranging from WST 0.40–1.20/kg depending on the species, which in many cases were non-exportable. A total of WST 320.00 was raised from these fish sales. On one occasion, all of the tunas from a trip were retained for the fish handling workshops, so that participants had fish to practice on. At the end of the workshop, these fish were consumed by the participants.

The landed catch that could not be sold was divided up amongst the crew of the vessel and other fisheries staff for home consumption. All sharks had the trunk retained for consumption by the crew, their family and relatives. Shark fins were also retained and dried, with 12.8 kg of dried fins sold for WST 30.00/kg to a local buyer.

3.6 Viewpoint on the 12.2 m '*super alia*' vessel and deck layout

One of the objectives of this project was to provide input and an independent viewpoint of the new 12.2-m *super alia* tuna longline vessel design, which was under construction at the time of the project. A short report was produced by the Fisheries Development Officer in December 1999, and provided to the Assistant Director of Fisheries. An edited version of this report is provided at Appendix E.

In summary, the hulls for the vessel were already under construction, so only minor suggestions were made in this area. Deck layout, gear and crew comfort were the main areas of focus for the viewpoint; these areas are important, as there is an increased chance of accidents occurring with a tired crew.

Regarding deck layout, it is important to have everything set out so that only three crew are needed during the setting process, and four during the lax period of the hauling process. In this way the crew can arrange a rotational rest period. Consideration is also given to efficient line deployment and retrieval, safety aspects, fish quality, and the gear needed for the fishing operation.

4. WORKSHOPS

4.1 On-board fish handling and preservation

One on-board fish handling and preservation workshop was held on Upolu and a second on Savaii. These were both organised by the Samoa Fisheries Project's Commercial Fisheries Extension Officer. The Upolu workshop had 15 participants from the private sector and 5 fisheries personnel, while the Savaii workshop had an attendance of 28 interested people. The Samoa Fisheries Project team had already begun work in this area to try and increase the awareness of local fishermen to fish quality. These workshops were designed to complement the work that the Fisheries Division had already undertaken, while taking advantage of the skills and expertise of the SPC Fisheries Development Officer.

Because of the different schedules worked by the alia fishermen, it was difficult to select a time and date that would coincide with the majority of them being on shore. It was decided to have the workshop on a Wednesday, as this would be the day that several groups returned from fishing, having departed on a Monday.

The workshops were advertised well in advance, with regular reminders on VHF radio, personal notification through fishing boat owners, and the distribution of printed leaflets stating the time, date and venue. The workshops were conducted in English and translated into Samoan by staff of the Fisheries Department, making difference to the fishermen's understanding and participation.

Leaflets, in English and Samoan, were distributed to the participants as a guide so they could follow the procedures that were explained, plus they could be used for future reference.

Both workshops lasted four hours, conducted after lunch with light refreshments offered at the end. The SPC video 'On-board handling of tuna', was shown and later elaborated on. A practical demonstration explained the reasons for each step. Most of the bleeding and gutting techniques were generally understood by the fishermen as these were the same practices carried out by them with slight variations. However, the reasons for carrying out these methods was carefully explained and stressed. Questions were later entertained and any queries were attended to.

The workshops focused on:

- proper gaffing methods;
- recommended killing techniques;
- gilling and gutting procedures;
- cleaning;
- chilling methods, including the use of brine; and
- packing and transportation of tuna including recommended methods of carrying fish.

Several other factors were also stressed, the main one being that regardless of the space available and any interference to the hauling operation, fish quality is the sole responsibility of the fisherman. This responsibility begins at the time the fish is landed until it reaches the exporter or processor. Fishermen must find ways to make their fishing operation work in sequence to include all the necessary steps that make the operation whole and complete. Whether this entails taking on extra crew for gilling and gutting duties or a slower hauling process, proper fish handling and preservation must be a priority.

These workshops were well received.

4.2 Basic navigation and use of the GPS

The GPS and basic navigation workshops were conducted in much the same way as the fish handling workshops. The workshop on Upolu was done with ease and again was very well received, as most of the topics covered areas that were of interest to the fishermen. Twenty-two participants attended. The Savaii workshop was cancelled as another training team from New Zealand had already arranged with the Savaii Fishermen's Association to conduct a workshop along these same lines.

The Basic Navigation and GPS workshop was conducted in two sessions. The session on basic navigation was handled by the Samoa Fisheries Project Extension Advisor, while the session on GPS was carried out by the SPC Fisheries Development Officer. During both sessions, the Senior Fisheries Officer (Development) did translations in Samoan.

Basic navigation covered: reading and understanding a nautical chart, understanding latitude and longitude, measuring distance, understanding variation and deviation, and the necessary equipment for chart work. Participants were briefed on how to lay out a course on the chart and how to plot positions.

Several positions of latitude and longitude were written on the board as practical exercises. Fishermen were encouraged to plot these positions, to lay courses between selected positions.

Fishermen were briefed on using a hand-held GPS, and it's relationship with specific orbiting satellites. Each function of the unit was highlighted and explained. Emphasis was placed on understanding and plotting 'waypoints', the use of the 'menu' card, the relevance of the 'enter', 'clear', 'mark' and 'go to' buttons, and the importance of the antenna and satellite signal reception.

Several exercises were conducted in reading and plotting positions, simulated 'event' marking and transiting to and from waypoints. The fishermen were later taken on-board R/V Tautai Matapalapala and demonstrations were given using the vessel's GPS plotter screen.

One of the main topics covered was the demonstration and understanding of the magnetic compass. Several of the fishermen did not know how this worked so this was explained in detail as it is one of the main basic tools for navigation. In addition, sea safety was an underlying theme, with a display of sea safety equipment (Figure 18) that alia fishermen should carry.

With a basic understanding of the functions of a GPS, fishermen will hopefully be able to reduce the chances of losing their lines by actually knowing their position at sea, and by using waypoints to mark off the areas where their lines lie. The exact locations of fishing grounds can also be recorded for future reference. The previous practice of running up to the marker flag every time it drifts out of sight can be relaxed a little until greater confidence is gained from the daily practise of using their GPS.

Figure 18: Sea safety equipment that alia fishermen should carry on their vessels

5. DISCUSSION AND CONCLUSIONS

5.1 General

The intricacies of a tuna longlining operation are not hard to comprehend, however, the actual execution and implementation of the operation needs to be monitored and evaluated periodically according to fish catch rates, fishing vessel design, market demands, personnel efficiency, safety issues, export capabilities and fish processing guidelines.

Besides the importance of having a viable tuna stock, fish catch rates depends a lot on the design of the fishing vessel, layout and type of gear used and the capabilities of the fishermen. Fish quality depends on the method in which the fish is caught, handled, stored on board, off-loaded, processed and transported.

Samoa has a thriving tuna industry that is entering a new phase in its development. A phase that is centred on efficient vessel designs that will enhance the likelihood of better fish catches, better sea safety, and an improvement in fish quality. The current vessel operation designs are being modified to meet the demands of the developing industry, this should be encouraged, especially with proven improvements and modifications.

The approach of the Fisheries Division in having a new super alia designed and built to overcome many of the shortfalls of the current alia is a sound one. It is hoped that this vessel will provide a reasonably priced alternative to local fishermen who want to upgrade their fishing operation into a larger, safer vessel that can stay at sea longer and has proper below-deck storage for the catch on ice. This project should be implemented as soon as possible to allow sea and fishing trials of the vessel to be undertaken to prove its suitability to the Samoan tuna longline fishery.

The inclusion of the 12–15 m plus mono hulls and larger 12-m catamaran fishing vessels to the Samoa tuna longline fleet is the trend to be followed. These vessels have built-in iceboxes or insulated fish holds, have more line carrying capacity, are able to fish the full perimeters of the Samoan EEZ, and provide the required sea safety measures. The Fisheries Division should continue to support operators getting into these larger proven tuna longline vessels, whether they are imported or constructed locally.

The fishermen involved in the Samoa tuna industry have all the necessary basic requirements. Proper guidance in vessel management and fish quality control will enable the industry to obtain a stronger development foothold. However, many of those involved in fishing operations have no specific qualifications or training, and this is true for many of the alia skippers. This is an area that needs to be addressed urgently, although it will need to be phased in gradually to allow current operators to gain the qualifications over time, thus not hindering the future development of the fishery.

5.2 R/V *Tautai Matapalapala*

Work on the fishing vessel R/V *Tautai Matapalapala* was aimed at developing the crew's basic seamanship skills, upgrading operation output and fish quality control. With the minimum resources available, every effort was made to fully use the equipment on board and to make re-adjustments where necessary.

This was carried out successfully with work undertaken on the hydraulic system, the mainline reel etc during Stage I, and the improvisation of a 16 mm shackle and an eight-meter length of 3.0 mm monofilament line. The latter work was directed at developing the crew in efficient fishing operations management, additional seamanship knowledge and stringent on-board handling of the catch. Setting times were reduced to 1.0–1.5 hours from 3.5–4.0 hours previously. Fish catch rate increased up to two to three times the previous figures and quality grade fish, off-loaded.

The Fisheries vessel R/V *Tautai Matapalapala* can be modified to become a demonstration vessel. At present, the vessel will suit research purposes but not a full-scale tuna longline operation. For a vessel of its size—length 11 m, beam 3.8 m—too much space is given over to accommodation, and not enough space allocated to the fish hold and working deck areas. Depending on the funds available and whether such a prospect is considered, several modifications could be made to the vessel that would make it an attractive and viable, small-scale tuna longline vessel.

Before such a task begins, thought should be given to the electronic equipment required for tuna longline fishing. The vessel currently has a Raytheon R20 radar, a Furuno GPS Plotter, Icom VHF radio, Tait 2000 HF radio, Furuno paper echo-sounder, JRC colour video echo-sounder, a barometer and a marine radio receiver. The following equipment would make tuna longline fishing operations easier and more interesting for the skipper and crew. Other equipment could be included that would be of great use to tuna research and recording, but safety and smoother operations will be placed as a priority in this instance.

- For long distance travel and communication, a marine single side band radio (SSB) should be carried on board for safety purposes as well as for general communications and information gathering.

- An auto-pilot should be set up with the vessel's current steering system. This would lessen the burden on the five crew members and at the same time save on fuel consumption and therefore, a reduction in fuel expenses in the long run.

- An auto-pilot inter-phased with the GPS system is an important tool for setting operations. Not only will it steer the vessel on a direct course, but it will also follow a sequence of waypoints. For line setting without a shooter, steering can waver so that the vessel sets in a 'wobbly' fashion, thus allowing the line to settle faster and at a deeper depth than that of a straight run. The auto-pilot also allows line setting to be done by two men only, leaving the third to carry out recordings and to assist when required.

  For fisheries research and FAD deployment duties, the auto-pilot and GPS interphase would be useful for surveys and precision marking.

- The R/V *Tautai Matapalapala* does not have a radio direction finder and radio beacons. The current system relies on having a 'high flyer' marker (flag buoy) on each end of the mainline and the slow drift of the vessel due to the use of a sea anchor. While this system has worked over the years and is much cheaper to have, there is considerable room for error. Even with the use of a GPS, the vessel could back track to the last position of the high flyer but still not locate the marker. The effects on the high flyers due to changes and activities of the currents and wind can be unpredictable.

  Having a radio beacon on both ends of the line and, if possible, another in the centre would minimise tremendously the chances of losing the mainline completely. The beacons would allow the vessel to home in on the mainline using the direction finding unit on board. In times of line breakage at night, these beacons can prove to be the difference between locating the mainline in a short span of time or losing it completely.

- A sea surface temperature gauge would assist the skipper and crew to locate suitable fishing locations, especially when there is a temperature front in the area.

With the inclusion of these equipment together with the present equipment on board, the burden of travelling to and from the fishing grounds and manoeuvring during fishing operations is eased. Further improvements to the deck layout could have a positive impact on the fish catch rate, fish processing and storage as well as an easier working atmosphere.

- Fish catch rates could be doubled with the substitution of a larger mainline reel that would be capable of setting up to 20 nm of line or at least 1,000 hooks per set.
- Fish carrying capacity and a larger working deck area can be achieved by reducing the length of the accommodation superstructure by half and cutting away the starboard side to the midships line.
- An above deck, 2 t fish storage icebox can be constructed in this area. The ice box should be constructed in a way that guarantees ice retaining properties and divided into sections that enables it to be used as a brine box or fish storage bin.
- The fish hold and icebox covers should be constructed in two or three insulated pieces for easy access during operations.
- The current practice of landing a fish is to lift it over the bulwark onto the processing mat. A proper fish landing port can be constructed by cutting an opening in the aft, starboard bulwark area.

Fishing operations, especially line hauling, can be made much simpler and effective by having a separate workstation aft. This would mean that a separate throttle and gear control as well as a steering console be set up aft. The normal set up for stern working deck vessels is to have the separate operations console aft. This could be set up to have one person unsnapping, steering and controlling the reel at the same time. In this way, the extra crew could be used to perform other duties or fit in as a replacement for rotation of duties.

Information collected from the TDR equipment will assist fishermen to adjust their gear for better targeting of the main species. More work needs to be conducted in this area, and the Fisheries Division could assist, with the information provided to the industry to try and assist them. In order for this to occur, the appropriate equipment (at least five data loggers and the interface unit) would need to be purchased. Alternately, fisheries staff could take this equipment on commercial vessels to directly help them with their individual fishing operation.

5.3 Sea safety issues in the Samoan tuna longline industry

Safety at Sea is an important issue in any maritime trade. Frequently, at the beginning of any industry, the full safety requirements are not realised until the industry develops and accidents happen. Anticipation and the mistakes of other nations can indicate the types of laws to be implemented at the beginning of an industry to prevent casualties. There should be one government department in charge of sea safety issues, and this department will need to co-ordinate with other government departments and agencies in the implementation of sea safety laws and requirements. In Samoa, it is unclear which government department is ultimately responsible of sea safety, and this needs to be clarified.

The backbone in the development of the tuna longline industry in Samoa has been the progress of the alia and its fishermen, although this has not been without casualties. At present, the cost of purchasing equipment for safety at sea is high, and in some cases, extravagant. For the alia boat owner, this is an added expense to the already heavily burdened budget. The rising cost of fuel and inflation, in comparison to the prices obtained for fish, do not match.

A presumption could be made that if stringent sea safety laws were to be enforced, it might trigger the decline of the offshore fishing industry or an increase in illegal fishing activities. However, if sea safety laws and requirements are phased in over time, with the most important gear being the first items to be purchased and carried, then this would lessen the burden on the fishermen.

Several suggestions for a simple emergency kit for the alia include: a foam filled wooden raft with lifelines around the edges. This could be carried on the upper deck of the accommodation structure and secured with quick release buckles. A floatable safety-gear box containing at least four lifejackets, required flares, a hand-held 121.5 MHz EPIRB, canned emergency rations, and containers of fresh water, could be stored in an area inside and forward of the accommodation housing.

The purpose is to enforce sea safety regulations without heavy burden to the alia owners. Efficient management, meticulous recording, continuous surveys and an enthusiastic approach will assist in considering and implementing the following points.

- Request a tax free status for sea safety equipment from the appropriate government department, if this is not already in place.
- The appropriate government department provide initial funding for assembling full emergency kits for sale to the alia owners. This can be a requirement upon issue of fishing licenses. The appropriate government department will also need to make regular surveys or checks on the validity and presence of these kits on board vessels.
- Work out a soft loan plan that is agreeable to the alia owners that will assist them in repaying the purchase of the sea safety equipment over a period of time.

Another important step towards sea safety is ‘seamanship training’. Seamanship training plays a role in a seafarer’s attitude towards the care of his vessel and the importance of the lives on board. A better understanding of his role and responsibilities will automatically generate a trained seafarer to implement safety procedures and maintain them. Note that seamanship training can be provided through workshops and possibly formal classes that may lead to certification over time.

5.4 Fish quality and fishing operations

Several *alias*, especially the extended ones, have made provision for carrying ice boxes on board. This is a step in the right direction but is of little use should the current practise of gilling, gutting and icing the catch be done after hauling is complete.

The AusAID/Samoa project team is well along in their endeavours to ensure that proper quality control and fish handling practices are implemented, by educating the fishermen on the current practises of tuna longline fishing and the standards required for maintaining fish quality. There is an ongoing need for specific training in this area, especially with new fishermen continually entering the industry, which the Fisheries Division can provide through the occasional workshop. However, some experienced fishermen may tend not to care too much about quality. This is because the incentive is not there and there is no repercussion or consequence.

Thought should be given to encouraging or convincing the *alia* owners to restructure their payment to fishermen. At present, fisherman are paid for their catch, on a per-fish, unloaded basis. At the processing plant or en-route to the market destination, fish may deteriorate because of poor onboard handling. That same fish might have been out in the open, uncleaned and unchilled, for four to eight hours before offloading. This does not affect the fisherman because he has already received the money for the fish he brought in. Whether it deteriorates on the way to the market is of no concern to him.

If the crew payment structure was to be based on earnings per trip, the crew will automatically become professional fish handlers overnight. Regardless of the amount of fish brought in, only fish that actually reach market destinations in good condition will generate income, so the incentive is to land as much good quality fish as possible to its destination for sale.

Directing a percentage of the 'money earned' towards crew wages will definitely contribute to quality fish. This percentage can then be divided into shares and allotted among crew members. The example presented here is to illustrate the possible system only, as the percentages and number of shares can be changed to match this system to the wages paid under the per-fish system at present.

Example:

Total fish earning (est. 50 x 18 kg albacore sold at WST 5.70/kg)	WST	5,130.00
Allot 15 per cent of money earned for all salaries (15% of 5,130)	WST	769.50
Total share distribution is say 23 (one share is 769.5 ÷ 23)	WST	33.45

Split of shares:

Skipper/fishing master—10 shares (10 x 33.45)	WST	334.50
Two alia crew—5 shares each (5 x 33.45 each crew)	WST	167.25 ea
New crew—3 shares (3 x 33.45)	WST	100.35

There is a need for fishermen to carry and use ice at sea. Encouragement should come from the processors, and to a lesser extent, the Fisheries Division. The best encouragement is through the price paid for the fish, with poor quality fish either attracting a low price or being rejected. This will only work if all processors implement the same quality standards for the fish they purchase. It is no use having one processor rejecting fish and the next one purchasing them at the normal price. Processors may wish to look at temperature probes to conduct random checks on the core temperature of landed fish. This will quickly identify whether a fish has been on ice.

If the same quality standards are implemented by all processors in Samoa, and fish are being rejected, fishermen will try and sell these fish on the domestic market, to local consumers, hotels and restaurants. In some cases this may be alright if the fish is not too old, and it is cooked and eaten soon after purchase. However, there is also the chance that people may become ill through food poisoning or histamine poisoning as a result of eating low quality tuna that has been rejected from processors.

This creates a potentially serious situation with several possible solutions. The first would be to have the rejected fish either confiscated by the processor or have it dipped in kerosene, oil, diesel etc so that it becomes non-saleable. It is doubtful that this would be acceptable to local fishermen and the government, as fish would need to be disposed of, either at sea or at a rubbish dump. The alternative would be to have health standards in place that are enforced by inspectors. Whether there are health standards in place that cover fish quality is not known. However, if there are not, then it would seem appropriate that health or fish quality standards are developed by the responsible government department. When standards are in place, there will then be a need for inspectors from the responsible government department to conduct random checks to enforce the standards.

For the tuna industry to survive, the prerogative should be given to the fishermen and processors to lead the way. Initial guidance is essential but eventually the helm should be handed over with the appropriate supervision and inspection by the authorities.

6. RECOMMENDATIONS

Based on the work carried out and the range of objectives for the 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.

6.1 General

It is recommended that:

(a) The Fisheries Division encourage sound and proven improvements and modifications to vessel design to meet the demands of the developing industry;

(b) The Fisheries Division undertake the sea and fishing trials as soon as possible on the new super alia, to determine its suitability to the Samoan tuna longline fishery;

(c) The Fisheries Division continue to support operators getting into larger proven tuna longline vessels (over 12 m in length), whether they are imported or constructed locally; and

(d) Skippers and possibly crew of all offshore commercial vessels be required to have some formal seamanship training that can lead to a certificate, with this needing to be phased in over time so as to not hinder the future development of the fishery.

6.2 R/V *Tautai Matapalapala*

It is recommended that:

(a) The Fisheries Division determine whether the R/V *Tautai Matapalapala*, should be a demonstration vessel or a viable, small-scale tuna longline vessel and make appropriate modifications accordingly;

(b) Regardless of the future use of R/V *Tautai Matapalapala*, the vessel's electronics should be improved to include a single side band radio for long distance communication and an auto-pilot to assist with steering of the vessel, with the auto-pilot interphased with the GPS for easy and accurate navigation;

(c) The Fisheries Division purchase a radio direction finder and at least two radio beacons, preferable three, to assist in locating the mainline after it is set; and a sea surface temperature gauge to assist in locating suitable fishing locations;

(d) The following modifications to R/V *Tautai Matapalapala* be made if the Fisheries Division decides it should be used as a small-scale tuna longliner:

- installation of a larger mainline reel that holds 20 nm of line or has enough mainline to set at least 1,000 hooks;

- reducing the length of the accommodation superstructure by half and cutting away the starboard side to the midships line;

- construction of a two-tonne fish storage ice-box on deck, having appropriate ice retaining properties, divided into sections for possible use as a brine box or fish storage bin, and having the covers constructed in two or three insulated pieces for easy access during operations; and

- construct a proper fish landing port by cutting an opening in the aft, starboard bulwark area.

(e) The Fisheries Division consider installing a separate throttle, gear control and steering console aft, so that one person can unsnap, steer, and control the reel; and

(f) The Fisheries Division consider purchasing at least five data loggers and an interface unit to continue the work on recording depth and temperature of their gear during fishing operations.

6.3 Sea safety issues in the Samoan tuna longline industry

It is recommended that:

(a) The government determine which department will be in charge of sea safety, so that laws and requirements can be implemented and enforced;

(b) The responsible government department consider phasing in of sea safety laws and requirements, with the most important gear being the first items to be purchased and carried, so as to lessen or spread out the financial burden on alia fishermen;

(c) The department consider a requirement for alia vessels to be equipped with a foam-filled wooden raft with lifelines around the edges as an alternative to an expensive life raft;

(d) The department consider a requirement that alia vessels be equipped with a kit consisting of life jackets (one for each crew member), flares, 121.5 MHz EPIRB, and canned food and water in a floatable, watertight box;

(e) The department consider giving sea safety equipment a tax-free status, provide initial funding to purchase and assemble sea safety kits for sale to offshore commercial fishermen, especially alia owners, and work out a soft loan repayment scheme to minimise the financial burden on local fishermen;

(f)The department work out a system of surveys or checks on the expiry date and presence of these sea safety kits on board vessels, if they become a requirement; and

(g) The department include seamanship training as part of any sea safety requirement, with this training provided through workshops and formal classes, leading to a certificate over time.

6.4 Fish quality and fishing operations

It is recommended that:

(a) The Fisheries Division continue to hold occasional workshops that target all fishermen in the area of on board handling, processing and chilling of catch;

(b) The Fisheries Division consider encouraging local fishermen to change the method of payment of skippers and crew from the per-fish system to a percentage of the catch actually sold at the final destination, as a mechanism to improve fish quality;

(c) All processors implement the same quality standards for fish they are purchasing as an incentive to fishermen to properly chill their catch at sea, with the possible use of temperature probes to conduct random checks on the core temperature of the fish being landed; and

(d) Health or fish quality standards be developed by the responsible government department, if there are none already in place, with inspectors from that department to conduct random checks to enforce these standards.

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Specifications of the original design *alia* with first conversion to aluminium hull and plywood superstructure

Length overall:	8.90 m (29 feet)
Beam overall:	2.72 m
Beam—each hull:	0.88 m
Depth—each hull:	0.76 m
Cubic number (2 hulls):	12 m^3
Weight, with engine:	580 kg
Spare 8-hp engine:	20 kg
Normal load, 4 men plus gear:	400 kg
Weight loaded:	1,000 kg
Engine:	25 hp outboard, 25” shaft
Spare engine:	8 hp, 25” shaft
Maximum speed with normal load:	13 kts
Fuel consumption:	11 l/h = 0.85 l/nm
Fishing methods:	Trolling for tuna 8–12 kts; deep-water handline fishing with 4 reels.
Construction:	Aluminium 2.5 mm, welded. Built upside down over jig. Superstructure of marine ply.

Projected cost in 1986:

	USD
Hull and cabin with reels	4,400
Engine	1,000
8 hp spare outboard	700
Total	6,100

Specifications for R/V *Tautai Matapalapala*

Length:	11.0 m
Beam:	3.8 m
Draft:	1.8 m
Main engine:	Detroit Diesel 6-71N (6 cylinders)
Maximum speed:	12 knots @ 1600 rpm
Fuel capacity:	5,000 l
Fishing equipment:	Locally manufactured aluminium hydraulic longline reel with approximately 12 nm main-line capacity, capable of accommodating 400–500 hooks. Other fishing equipment includes: 30 cm x 30 cm plastic floats, 3 fibre-glass pole high-flyers rigged with two purse-seine floats and 10 kg weights at the bottom, 1 branchline bin consisting of 500 hooks (bin dimensions of 1.5 m x 0.9 m x 1.5 m), 3 strobe lights and 50 m x 50 m floatlines.
Wheelhouse electronics:	Raytheon R-20 radar, 24-mile range Furuno GPS, GP-1610c VHF radio - Icom IC-M100 HF radio - Tait 2000 Furuno paper echo-sounder, FE-881 MKII Video colour echo-sounder, JRC JFV-90 Barometer, Seth Thomas Marine radio receiver, Maxima Marine.

Summary of tuna longline catches taken from R/V *Tautai Matapalapala*

Weights for all saleable fish are gilled and gutted, unsaleable are whole weight estimates and sharks are headed, gutted and finned.
Other saleable catch included blue marlin, wahoo, skipjack, barracuda, oilfish, pomfret, opah, and mahi mahi.
Unsaleable species consisted of sharks, lancetfish and pelagic rays.

Number of sets	Approx. position Lat (S)	Approx. position Long (W)	Hook Nos.	Time set	Time haul	Yellowfin tuna No.	Yellowfin tuna Weight (kg)	Bigeye tuna No.	Bigeye tuna Weight (kg)	Albacore tuna No.	Albacore tuna Weight (kg)	Other saleable No.	Other saleable Weight (kg)	Total saleable No.	Total saleable Weight (kg)	Unsaleable catch No.	Unsaleable catch Weight (kg)
Stage I, Trip 1: 9 April 1999																	
1	13° 49'	171° 43'	400	0700	1400	9	87.2					1	7.2	10	94.4	2	9.6
Stage I, Trip 2: 20 to 22 April 1999																	
1	13° 18'	172° 10'	400	0520	1330							3	17.0	3	17.0		
Total for Stage I (2 trips)																	
2			**800**			**9**	**87.2**					**4**	**24.2**	**13**	**111.4**	**2**	**9.6**
Stage II, Trip 1: 7 to 8 October 1999																	
1	13° 01'	172° 11'	400	0600	1510	1	48.0			8	146.4	7	30.9	16	225.3	1	89.0
Stage II, Trip 2: 18 to 21 October 1999																	
2	12° 51'	171° 16'	800	0630	1600	45	552.0	4	38.1	18	320.0	8	122.1	75	1032.2	5	183.0
Stage II, Trip 3: 25 to 29 October 1999																	
3	13° 10'	170° 56'	1200	0620	1530	10	130.0	1	19.0	49	820.0	20	93.8	80	1062.8	9	262.0

Number of sets	Approx. position Lat (S)	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)
Stage II, Trip 4: 1 to 3 November 1999																	
1	13° 25'	171° 26'	400	0615	1525	1	13.2			5	137.6	1	14.2	7	165.0	4	8.0
Stage II, Trip 5: 22 to 26 November 1999																	
4	12° 35'	171° 26'	1600		various	12	116.5	6	87.0	28	529.0	21	159.6	67	892.1	7	246.0
Stage II, Trip 6: 29 November to 3 December 1999																	
3	12° 47'	171° 12'	1200		various	6	105.8	1	45.6	14	258.3	6	67.8	27	477.5	10	179.0
Total for Stage II (6 trips)																	
14			**5600**			**75**	**965.5**	**12**	**189.7**	**122**	**2211.3**	**63**	**488.4**	**272**	**3854.9**	**36**	**967.0**
Total for Stages I & II combined (8 trips)																	
16			**6400**			**84**	**1052.7**	**12**	**189.7**	**122**	**2211.3**	**67**	**512.6**	**285**	**3966.3**	**38**	**976.6**

Species composition of the tuna longline catch

Family / Species / English name	Stage I No.	Stage I Weight (kg)	Stage II No.	Stage II Weight (kg)	Total No.	Total Weight (kg)
SCOMBROIDEI (Scombridae, Thunnidae, Gemplidae)						
Acanthocybium solandri			10	112.0	10	112.0
Wahoo						
Katsuwonus pelamis	2	11.2	32	150.9	34	162.1
Skipjack tuna						
Thunnus alalunga			122	2211.3	122	2211.3
Albacore tuna						
Thunnus albacares	9	87.2	75	965.5	84	1052.7
Yellowfin tuna						
Thunnus obesus			12	189.7	12	189.7
Bigeye tuna						
Revettus pretiosus			3	36.0	3	36.0
Oilfish						
Sub-total	**11**	**98.4**	**254**	**3665.4**	**265**	**3763.8**
XIPHIOIDEI (Istiophoridae)						
Makaira mazara			1	35.4	1	35.4
Blue marlin						
Sub-total			**1**	**35.4**	**1**	**35.4**
LAMPRIFORMES (Lampridae)						
Lampris guttatus			3	87.3	3	87.3
Opah or moonfish						
Sub-total			**3**	**87.3**	**3**	**87.3**
MUGILOIDEI (Sphyraenidae)						
Sphyraena barracuda	1	2.0	10	48.4	11	50.4
Great barracuda						
Sub-total	**1**	**2.0**	**10**	**48.4**	**11**	**50.4**

Family Species English name	Stage I No.	 Weight (kg)	Stage II No.	 Weight (kg)	Total No.	 Weight (kg)
PERCOIDEI (Coryphaenidae, Bramidae)						
Coryphaena hippurus Mahi mahi	1	11.0	2	13.0	3	24.0
Brama sp. Pomfret			2	5.4	2	5.4
Sub-total	**1**	**11.0**	**4**	**18.4**	**5**	**29.4**
MYCTOPHIFORMES (Alepisauridae)						
Alepisaurus ferox Longnose lancetfish	1	5.0	14	28.0	15	33.0
Sub-total	**1**	**5.0**	**14**	**28.0**	**15**	**33.0**
LAMNIFORMES (Carcharhinidae)						
Carcharhinus falciformis Silky shark			1	50.0	1	50.0
Prionace glauca Blue shark			12	871.0	12	871.0
Carcharhinus spp. Shark	1	4.6			1	4.6
Sub-total	**1**	**4.6**	**13**	**921.0**	**14**	**925.6**
RAJIFORMES (Dasyatididae)						
Dasyatis violacea Pelagic ray			9	18.0	9	18.0
Sub-total			**9**	**18.0**	**9**	**18.0**
TOTAL	**15**	**121.0**	**308**	**4821.9**	**323**	**4942.9**

Appendix E

Viewpoint on the 12.2 m '*super alia*' project (December 1999)

SUMMARY

The prototype 12.2 m *super alia* project is an important project for Samoa as well as for other Pacific Islands involved in domestic longline fishing for the world market. The initial draft report was provided to the Assistant Director of Fisheries in December 1999. This version has been edited and the format changed slightly, although the content and intent has not been altered.

Because the vessel is currently under construction, having completed the hull stage, only minor suggestions can be put forward; ones that will not cause more delays in the construction of the *super alia* or interfere too much with the plans that have been drawn up.

These alterations or adjustments are necessary elements that can make a difference during fishing operations and crew comfort, which in turn affects fish catches. Crew comfort has been down played in many fishing vessel designs, but the bottom line is: a weary crew produces poor results and more chances of accidents. The crew's fitness also plays an important role in fish quality.

Focus is therefore given to setting up an efficient and practical working deck area that will allow a minimum of three crew working during setting times and four during the lax period of the hauling operation. In this way, the crew can arrange a rotational rest period. Consideration is also given to efficient line deployment and retrieval, safety aspects and fish quality.

CONTENTS

1. LONGLINE OPERATIONS

Commercial tuna operations, as with industries that operate vehicles or vessels, is more or less based on the principle of keeping the vehicle on the road or the vessel out at sea as often as possible, therefore, focus should be kept on minimising the vessel's 'down-times'. To be able to do this, careful consideration should be given during the planning stages of operations. Here, several factors should be carefully thought out.

1.1 Vessel design

Aside from designing the vessel to be stable at sea, compliant with less fuel consumption, and having sufficient speed to travel to and from fishing grounds, careful consideration should be given to deck layout for setting and hauling procedures. The vessel should be designed in such a way that operations can be carried out smoothly and effectively.

Crew comfort, satisfactory installation of fishing gear and proper deck layout can determine the results of fishing trips. For normal commercial trips of 7–14 days, the capability of a system to allow as minimum as possible the number of crew working during a fishing operation, will permit the crew to work on a rotational basis thereby ensuring that they are alert and efficient when on duty. This in turn will increase the chances of returning with quality fish.

Line setting

For a thousand hooks to be set at 10-second intervals between hooks, would take up to 2.8 hours to complete a set. With two crew working the aft deck in the first 1.4 hours and the other two in the next 1.4 hours, the crew will be sufficiently rested to be alert enough during the setting exercise. A professional crew can consistently provide seven-second intervals between hooks.

Line setting is the most important part of tuna longlining. It is during setting that the vessel's crew has to ensure that proper spacing of the hooks are kept, the right shooter speed is used, and proper baiting methods are employed. This is also the most dangerous part of longlining, especially when hydraulic gear is used. The whole operation is carried out at a fast pace, which is why emphasis is placed on the crew's fitness and alertness, which in turn depends on the design and layout of the working deck. During line setting, factors to be aware of are:

i) Direct access of the mainline from the mainline spool to the line shooter. This would eliminate friction on the shooter rubber thus reducing wear and tear. On the other hand, this positioning of the reel must compatible with the requirements for the hauling operation.

   The point to consider is that the least number of blocks used will accomplish a reduction in wear and tear of fishing gear.

ii) Proper hook-up of the hydraulics to ensure that the shooter and mainline spool coordinate during deployment.

iii) Proper bait-bin holder aft, positioned on the opposite side of the bait-man from the shooter. In other words, the bait-man should be standing between the bait-bin and the shooter.

iv) Efficient layout of the fishing gear during deployment so that a minimum of two persons will be able to do the setting—not including the helmsman.

1.1.2 Hauling operation

The hauling time for 1,000 hooks can take from 8 to 15 hours. This will depend on weather conditions, regularity of fish intake, and the direction in which the line is set. More often, hauling finishes later than the times mentioned rather than earlier. During the hauling operation, all five crew are required, unless the operation is slow, meaning that fish are being boated at a leisurely pace. In most cases, the first stages of the hauling operation progress at a slower pace, picking up after about 25% of the way. During hauling, the main aspects to consider for ease of workload are:

i) Proper positioning of the hauling block to ensure ease of unsnapping and minimum friction on the fishing gear (hauling blocks, mainline and level wind roller guide). The wider the angle of the line entering and leaving the blocks, the less friction workload on the block. In terms of pulley advantage and disadvantage, this would be the opposite.

ii) Close positioning of the person unsnapping and the branchline retriever. The ideal position of the person relocating the branchlines to the bin would be directly within arm's reach of the person unsnapping the branchlines.

iii) Clear passage for shifting and changing the branchline bins around.

iv) Easy access to the fish holds.

v) The vessel's helmsman should have a clear view of the line entering the first hauling block. The more forward of the helmsman the first hauling block is, the better it will be for him to guide the vessel, without too much strain on his neck. A normal approach of the mainline from the sea to the reel would be between 30∞ to 45∞ to the perpendicular.

vi) A fish landing port, in an appropriate section along the aft rails clear to the processing area, would greatly support fish quality and reduce crew strain in having to lift the fish over the bulwark or rails.

vii) Proper fish processing area clear of obstructions.

1.2 Quick turn around

Effective vessel performance and evaluation for fish catches and vessel durability will depend a lot on the vessel being turned around within a short time after having unloaded the catch. For the sake of the crew's family, this period can be extended to 24 hours in port before returning to fishing operations. The quick turn around of vessels depends mainly on three factors:

i) The immediate availability of funds to replenish fishing gear and other requirements such as victuals, bait, ice and machinery parts if necessary.

ii) Availability of sufficient crew that will enable everyone on board to get a break after two or three trips. This can be done by having the skipper and four crew members on the vessel and one crew member on shore for the duration of the fishing trip. After every trip, a changeover is made. This would mean that each crew member will have three trips on and one trip off. This would free the vessel for a quick turn around without having to worry about the crews welfare and domestic situation.

iii) Availability of replenishments such as victuals, fuel, water, ice, bait and machinery parts if required.

1.2.1 *Funds*

One of the major problems in the delays of turning a government vessel around is the non-availability of funds or the delays in obtaining allocated funds. The ideal system would be to have an account set up to deal directly with the vessel's needs, especially a quick turn around. In this way, obtaining funds would be quicker and through a more direct channel instead of the current method of having to go through so many time-consuming procedures.

With the current system though, immediate funds for fishing trips can be on-hand when needed, but this will require proper planning. After the initial funds for the first fishing trip has been obtained, the application for the funds for the next trip should be lodged. In this way, the funds will have already been processed and waiting while the vessel is still out at sea. Upon arrival, this money can be utilised to finance the next fishing trip and application for the next funding lodged and so on. The problem though, is that if there is a major overhaul or repair job to be done, obtaining immediate funds to finance the work will be time-consuming and will contribute to delaying the vessel.

2. QUOTATIONS FOR TUNA LONGLINE GEAR

The following is a list of items that are necessary to carry out a full commercial operation. The costing for these items were obtained from an earlier edition (1998) of the Ocean Producers International (OPI) sales catalogue. Prices will most likely have varied since then, but the figures give an indication of the costs involved.

Further quotations for the New Zealand equivalents of the same items, were obtained by Peter Meredith of Samoa Marine. These are recent figures and show a marked difference with that of the OPI figures. Also note, that the quotation for the line shooter, mainline spool and monofilament mainline is not included in the list.

Miscellaneous (Can be purchased locally—quotes required)

- Floatlines x 6.4 mm x 1,200 m (tarred Kuralon or polyester)
- Rain suit x 5
- Rubber boots x 5
- Wool work gloves x 1 dozen pair
- Foam fish processing mattress, one at 1 m x 2 m
- Mallet (or club) x 2
- Fish spike
- Oil stone x 1
- Wire cutters x 2
- Swedish fid x 2

Longline equipment

ITEM	QTY	COST NZD	COST USD
10 cm hauling block	3.00	807.00	537.00
3 branchline bins (400 hooks each)	3.00	1650.00	1425.00
Snaps 148 x 1/8 x 8/0	1200.00	1920.00	1368.00
Japanese longline snaps	100.00	90.00	145.00
2.1 mm mono (450 lb) test	21.00	1680.00	588.00
Circle hooks size 15/0 (100/box)	12.00	600.00	336.00
Crimps 2.2 mm (500/bag) D size	10/500	245.00	538.40
Bench presser with dye	1.00	395.00	288.00
'D' dye for 2.0–2.1 mm mono	1.00	43.00	32.57
Dexter slime knife S125	1.00	15.20	10.69
Dexter utility slicer S142	1.00	19.25	12.37
Meat saw	1.00	56.00	40.83
Spare blades	4.00	20.00	17.52
Floats 360 mm	60.00	2700.00	2370.00
Strobe light floats OPI 360 mm	3.00	135.00	118.50
Gaff hooks x 1.2 m OPI	2.00	84.00	63.30
Plastic tubing coils	5.00	50.00	35.50
Monofilament cutter (Moimoi)	2.00	78.00	56.00
Strobe lights	5.00	345.00	295.35
Taiyo ADF#TD-L1100	1.00	5500.00	3500.00
OPI radio buoy assembly	2.00	2780.00	3140.10
		NZD 19,212.45	**USD 14,918.13**
		WST 29,779.30	**WST 46,992.11**

3. DAILY RUNNING COSTS

ITEM	RATE (WST)	DAILY COST (WST)
Fuel/oil	185.7 l/day x 0.9026	180.00
Ice	800kg/day x 0.11	88.00
Bait	8 (20 kg) boxes x 86.36	690.88
Food	10.00/crew/day x 5 crew	50.00
Fishing gear		100.00
Maintenance		200.00
Crew wages		60.00
Insurance @ 9% v/l	400,000 x 9%	103.00
Total		**1,471.88**

4. POSSIBLE ADJUSTMENTS TO THE VESSEL'S GENERAL LAYOUT

With the design and building of the vessel having reached the current stage of having the hulls constructed, it would not be prudent to make major adjustments as these may further delay the construction of the vessel. With the current layout though, several areas need to be adjusted or allowed for, these being:

i) For hauling purposes the No.1 block or the initial line entry block needs to be situated in an area forward of the helmsman. This will enable the helmsman to see the line entry clearly without straining his neck by constantly looking over his shoulder. The block davit can be constructed so that it can be folded back on the side of the wheelhouse and out of the way when not in use. An important point to note here is that in normal situations, the line entry from the sea to the No. 1 block is done so at around an angle of 30∞ to 45∞ to the perpendicular. Only during shallow drops and when approaching the floaters will the angle exceed 45∞. Often, especially when there are fish on the line, the mainline will lead straight downwards.

   If the block is abeam or abaft the helmsman he will have to either look sideways or backwards to view the mainline coming in. This will definitely be an inconvenience and will lead to fatigue and accidents.

ii) The walkway just alongside the wheelhouse is too narrow to be used as a working platform for unsnapping lines. In rough weather the narrow walkway can pose a danger to the person unsnapping. A suggestion here is to construct a folding work platform on hinges. This can be lowered down when required for operations and folded back and used as a bulwark when travelling. When the platform is lowered, safety rails can be slotted in and removed and stored when not in use. This work platform should be wide and long enough to accommodate a branchline bin as the line-collector should be within arm's reach of the person unsnapping.

iii) A fish landing port should be allowed for at the aft working deck. This can easily be arranged by having a gap closed off with snap-on chains.

iv) A bait box holder should be constructed about 1 m away from the shooter.

Attached are the suggested alterations as shown on the vessel's drawing.

5. CONCLUSION

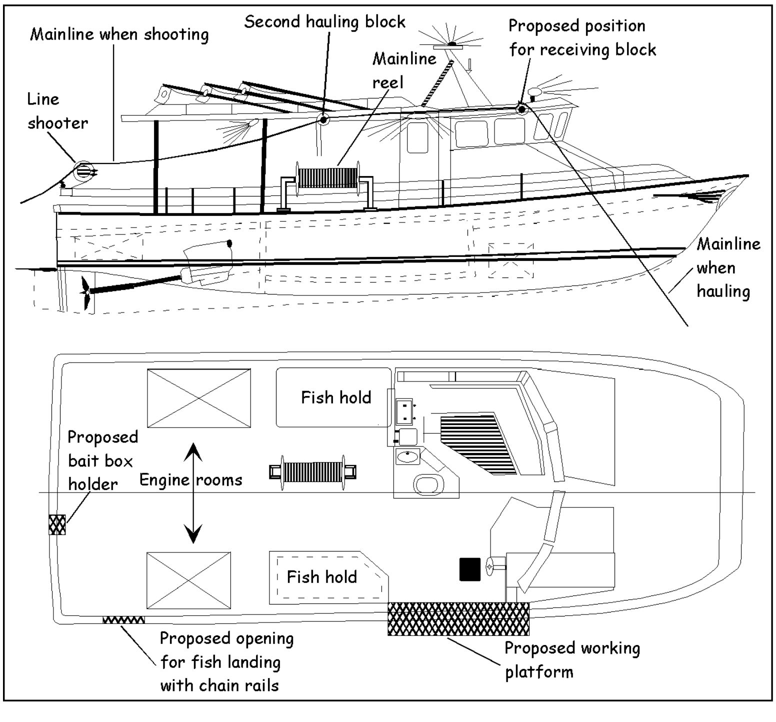
These four minor alterations should not interfere too much with the current construction of the vessel. Had this been during the earlier stages of construction, several major alterations might have been suggested. Like shifting the wheelhouse over to the port side so that a wider walkway would be created on the starboard side thus allowing for a natural work platform.

The normal and recommended system for aft deck longline vessels is to have a separate control station on the stern deck. From this point, the vessel can be steered and the longline spool controlled during operations. For navigational purposes, the wheelhouse command is used.

Thought should also be given to installing an auto-pilot at a later date. This will contribute immensely to line setting operations and reduction in fuel consumption. Although it might seem expensive to install initially, the amount of fuel wasted in the collection of future trips would amount to much more than the cost of having an auto-pilot installed.

It is also imperative that a radio direction finder be installed and at least two radio beacons purchased. The cost of fishing gear in the water tremendously outweighs the cost of having to purchase these pieces of equipment, which would minimise the chances of losing the fishing gear. Several fishermen would swear by just having high-flyer markers (flag buoys) and would not see the necessity of having a direction finder and radio beacons. Several of these same fishermen have become victims of lost gear at sea, amounting to a loss of thousands of dollars and in some cases triggering the decline of fishing companies.

For the vessel's trial period, better results can be achieved if the vessel is set up to conduct fishing trips on a quick turn around basis. The initial stages of the trials will mainly involve adjustments and alterations if necessary. Fish catch results should start to pick up around the fourth trip, when it is hoped that the necessary 'fine tuning' will be completed. Therefore, the initial stages will require several trips back-to-back and it is important that the funding for these trips is readily available.



Vessel drawing showing the suggested changes as covered in this report