

South Pacific Commission



Coastal Fisheries Programme

CAPTURE SECTION REPORT
OF
TUNA LONGLINE FISHING ASSISTANCE TO
THE NATIONAL FISHERIES CORPORATION (POHNPEI DIVISION)
FEDERATED STATES OF MICRONESIA

27 MARCH – 19 JUNE 1996

by

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SUMMARY

Following a request from the Government of the Federated States of Micronesia (FSM), Masterfisherman Steve Beverly was assigned to Pohnpei to work with the National Fisheries Corporation for a period of two to three months. The objectives of the project were to try and increase to catch rates for the project vessel, *NFC Waab*, and to assess whether the Lindgren-Pitman (LP) monofilament gear used on this vessel was suitable for operation in FSM waters. Upon arrival in FSM, the Masterfisherman found that the project vessel needed considerable maintenance work before any fishing trips could be undertaken.

After five weeks of maintenance work, *NFC Waab* was ready for fishing trials. During this time, while the Masterfisherman was either conducting or supervising the repairs, the remaining crew used materials ordered from Hawaii to make up 1,320 new branchlines. These replaced the 600–700 poorly maintained monofilament branchlines formerly used by *NFC Waab*. The new branchlines were of a style becoming more popular in Hawaii, consisting of tarred red polyester three-strand line with a stainless steel wire leader. The LP reel only had about 15 nautical miles of mainline on it, so 20 miles more were added. During the project, NFC spent over US \$15,000 on fishing gear, replacement parts and spares; and had on order several thousand dollars worth more of necessary parts and gear.

Due to the necessary maintenance of the project vessel, only two trips were made during the three-month project. Unfortunately, *NFC Waab* broke down during both trips after only three sets had been made. On the first trip, in May, the line shooter was not working during the first two sets, so the fishing turned out to be more of a practice run for the crew using the new gear. On the third set everything worked fine. The catch for this set was quite good: 15 yellowfin tuna (*Thunnus albacares*) and three bigeye tuna (*Thunnus obesus*) on 1000 hooks. NFC's target CPUE for all its vessels is 50 kg/100 hooks (110 lb/100 hooks) or 0.5 kg/hook (1.1 lb/hook) for the combined catch of yellowfin tuna and bigeye tuna. On the one good set of the first trip, this target was almost achieved, with a CPUE of 46 kg/100 hooks (101 lb/100 hook) or 0.46 kg/hook (1.01 lb/hook). The second trip was made in June and the results were similar to the first trip: the boat broke down after only three sets, and the catch rate was much better than in the past.

After becoming familiar with the vessel and its capabilities, the Masterfisherman concluded that *NFC Waab* and her sister ship *NFC Kosrae* (and two identical vessels owned by Chuuk State) are not suitable as commercial longline fishing vessels (in FSM waters) because some of their design features, such as limited fuel, fresh-water and fish-hold capacities, limit their operational range. However, the catch rates achieved indicate that the LP gear works well in FSM waters, as elsewhere, if used properly and maintained regularly.

RÉSUMÉ

Suite à une demande des autorités des États fédérés de Micronésie, le maître de pêche Steve Beverly a été détaché pour une période de deux à trois mois, à Pohnpei, pour collaborer avec la Société nationale des pêches (*National Fisheries Corporation*). Sa mission avait pour objet d'essayer d'améliorer les taux de prise du *NFC Waab* et d'établir si le monofilament Lindgren-Pitman (LP) utilisé par ce bateau était adapté aux opérations de pêche dans les eaux des États fédérés de Micronésie. À son arrivée dans ce pays, le maître de pêche a constaté que ce navire avait besoin d'être entièrement révisé avant de reprendre la mer.

Après cinq semaines d'entretien, le *NFC Waab* était prêt à partir pour des essais de pêche. Pendant ce temps-là, tandis que le maître de pêche effectuait ou surveillait les réparations, les autres membres de l'équipage confectionnaient, à l'aide d'articles et de fournitures commandés à Hawaï, 1 320 nouveaux avançons qui devaient remplacer les 600-700 avançons à monofilament, mal entretenus, utilisés jusqu'alors par le *NFC Waab*. Ces nouveaux avançons sont de plus en plus prisés à Hawaï : ils sont composés d'une ligne à trois torons en polyester rouge goudronné terminée par un bas de ligne en fil d'acier inoxydable. L'enrouleur LP ne contenait dans son magasin que 15 milles nautiques de ligne-mère et il fut donc rallongé de 20 milles. Pendant la période d'exécution du projet, la NFC a dépensé plus de 15 000 dollars É.-U. en engins de pêche et en pièces de rechange et elle en a encore commandé pour plusieurs milliers de dollars.

L'entretien étant incontournable, le *NFC Waab* n'a pu réaliser que deux campagnes en trois mois. Malheureusement, il est tombé à chaque fois en panne et seulement après trois poses de palangre. Lors de la première croisière effectuée en mai, l'éjecteur de ligne n'a pas fonctionné lors des deux premiers mouillages et l'équipage s'est contenté d'expérimenter le nouveau matériel. Lors de la troisième tentative, tout s'est parfaitement déroulé. Cette fois, le taux de prise a été tout à fait satisfaisant puisque 15 thons jaunes (*Thunnus albacares*) et trois thons obèses (*Thunnus obesus*) ont été capturés pour 1 000 hameçons mouillés. Le PUE que la NFC s'est fixé comme objectif pour toutes ses unités est de 50 kg pour 100 hameçons soit 0,5 kg par hameçon, prises de thons jaunes et de thons obèses confondus. Pour la pose réussie lors de la première croisière, l'objectif a été pratiquement atteint avec un PUE de 46 kg pour 100 hameçons, soit 0,46 kg/hameçon. Une deuxième campagne a été réalisée en juin 1996 et les résultats ont été semblables à ceux obtenus la première fois : le bateau est tombé en panne après avoir mouillé la ligne à trois reprises et les taux de prise ont été bien meilleurs que jusqu'alors.

Après s'être familiarisé avec le navire et son potentiel, le maître de pêche a conclu que le *NFC Waab* et son frère jumeau le *NFC Kosrae* (ainsi que deux unités identiques appartenant à l'État de Chuuk) n'étaient pas adaptés à la pêche commerciale à la palangre (dans les eaux des États fédérés de Micronésie) en raison de leurs caractéristiques de conception, telles que la capacité limitée de leur réservoir de carburant, de leur réservoir d'eau douce et de leur cale à poissons, qui réduit leur rayon d'action. Toutefois, les taux de prise enregistrés montrent que les engins LP fonctionnent bien dans les eaux des États fédérés de Micronésie, comme ailleurs, s'ils sont utilisés correctement et entretenus régulièrement.

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For recommendations and advice provided to the project, the Commission thanks Gerald Russo, Chief Operating Officer, Micronesia Longline Fishing Company; and Captain Mark Tickell of *F/V Hawaiian Rohi*.

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1. Introduction and Background

1.1 GENERAL

The Federated States of Micronesia (FSM) consists of over 600 islands in four states (Yap, Chuuk, Pohnpei and Kosrae) which span 2.9 million km² (1,119,400 square miles) of ocean (Hampton, 1991) but contain only 700 km² (270 sq. m) of land. FSM is part of the Caroline Island Archipelago and lies between the equator and 14° North latitude and between 135° and 166° East longitude (the Eastern Carolines are Kosrae, Pohnpei, and Chuuk, while the Western Carolines are Yap and Palau). Figure 1 shows FSM's boundaries and EEZ. The land varies from large volcanic mountains (Pohnpei State) to small coral atolls (Woleai in Yap State). FSM has a central National Government with its headquarters in Palikir, Pohnpei, and four State Governments, each with its own capital. The people are all Micronesian, with the exception of the Polynesians of Kapingamarangi and Nukuoro Atolls, and the Kapingamarangians living in Pohnpei. The population of FSM was estimated at 109,200 in mid-1996 (SPC, 1996).

FSM entered into a 'Compact of Free Association' with the United States Government in 1986 which will run out in the year 2001. Under the Compact, FSM will receive payments totalling over US \$1.3 billion over a 15-year period (Stanley, 1992). The Compact and other forms of international assistance comprise most of the Government of FSM's revenue. Approximately 70 per cent of the gross domestic product (GDP) in FSM is accounted for by Government expenditure which, in turn, is fuelled by such grants. The balance of revenue is derived from local taxes (about 8%) and fishing licence fees. There is a grave imbalance in FSM between export earnings and the FOB (free on board) cost of imports and this will become critical as the Compact comes to an end. Approximately 27 per cent of the workforce is unemployed (Hood, 1991) and this does not account for the heavy out-migration of labour to the United States (FSM citizens have free access to the US and its territories). About 7 per cent of the workforce is engaged in fisheries, but most of this is at the subsistence or artisanal level.

The exclusive economic zone (EEZ) of FSM was declared in 1979. It is amongst the largest in the region and contains a rich tuna stock of the three main sought-after species: yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), and skipjack tuna (*Katsuwonus pelamis*). Most of the catch in FSM waters is taken by vessels from distant-water fishing nations (DWFN), and most of this is skipjack tuna and yellowfin tuna taken by the foreign purse-seine fleet. Total catches have averaged over 153,000 metric tonnes (t) since 1989, with purse-seine catches being 129,000 t, longline catches 13,000 t, and the balance from the pole-and-line fleet.

In 1995 the longline catch was 17,255 t (Anon., 1996) which is a 9 per cent increase over 1994. Again, most of this was caught by DWFNs. During 1995, 638 vessels fished in FSM waters, including 444 longline vessels. Fifty per cent of these vessels were from the People's Republic of China (PRC), 30 per cent Japanese, and 16 per cent Taiwanese. The remaining vessels were either from US (Guam) or were domestic FSM vessels.

The annual export value of the longline catch from FSM probably averages about US \$150 million (this is an extrapolated figure based on the longline catch of 17,255 t multiplied by the reported average price of about ¥ 1000/kg for bigeye tuna and yellowfin tuna). The domestic share of money earned from longlining is much smaller than that of the DWFN fleet because of the much smaller size of the domestic fleet, but the share is also disproportionately small because of the relative lack of success of the domestic fleet in conducting longline fishing.

1.2 THE NATIONAL FISHERIES CORPORATION

The National Fisheries Corporation (NFC) started tuna longline fishing in 1992 with four small tuna longline vessels. These were two Delta Marine vessels, *NFC Waab* (Figure 2) and

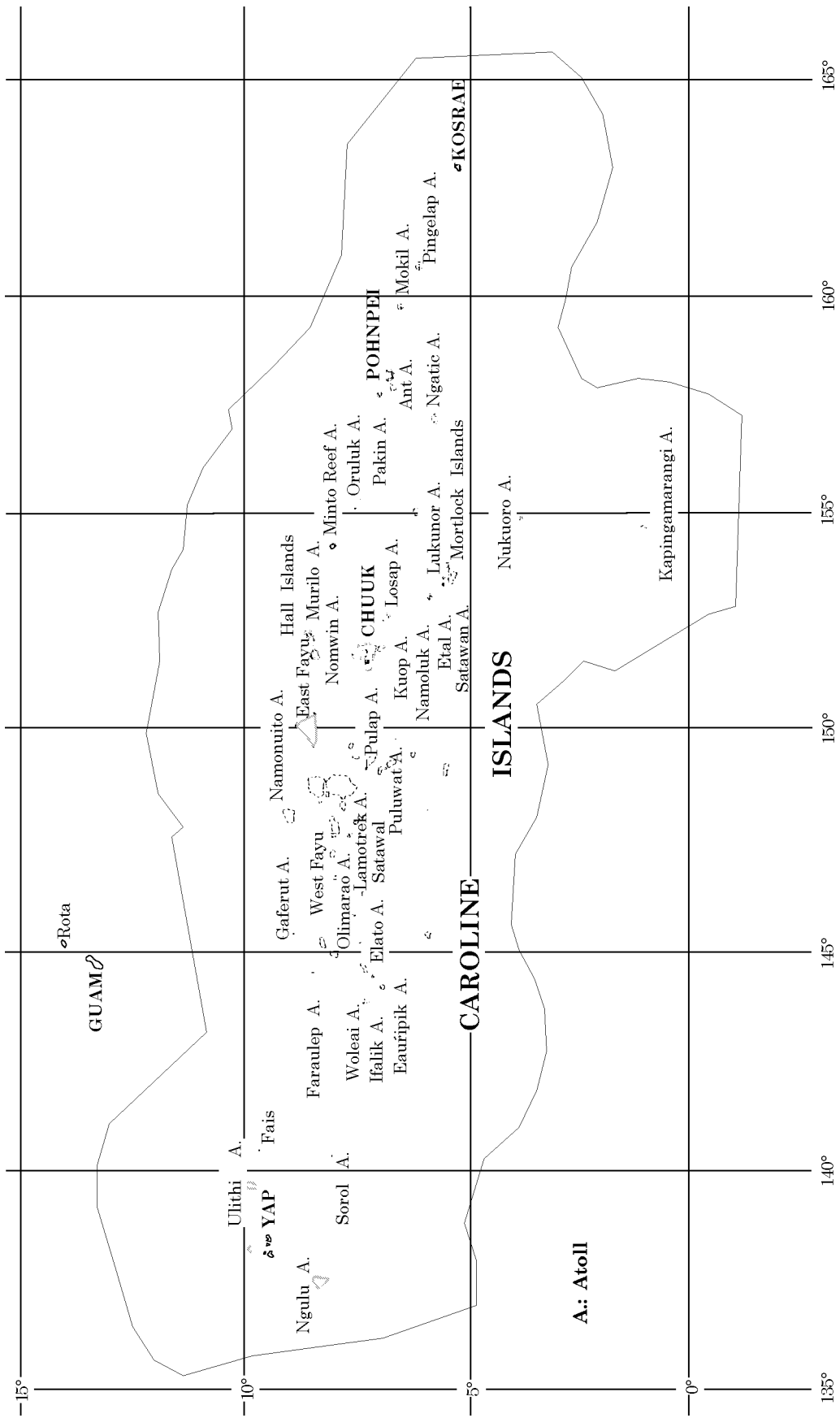


Figure 1: Map of FSM showing the boundaries of its EEZ

NFC Kosrae, and two 15 m Japanese-made fibreglass longliners, *NFC Pohnpei* (Figure 2) and *NFC Chuuk*.

By 1995 NFC was managing a fleet of 11 FSM-registered vessels (Friberg, 1995). Besides the original four vessels, it has acquired another Japanese-built fibreglass longliner, *Captain Honda*, which is equipped with monofilament 'cassette'-style gear. It also manages three Taiwanese fibreglass 25 m (82 ft) longliners which it owns jointly with Kosrae Sea Ventures Incorporated (KSVI). These three vessels, *KSVI 1*, *KSVI 2*, and *KSVI 3* are all equipped with Taiwanese-style basket monofilament gear.

Two other vessels that NFC manages, *Nom Sepei* and *Ik No. 3*, are owned by municipalities. *Nom Sepei* is identical to the KSVI vessels while *Ik No. 3* (Figure 2) is similar to *NFC Pohnpei* and *NFC Chuuk*. Finally, NFC acts as agent for *Hawaiian Rohi*, a privately-owned and operated Japanese fibreglass longliner equipped with Okinawan-style 'automatic' basket gear. The vessel was formerly of Japanese registry, but was seized for illegal activities and purchased through tender by a local entrepreneur. Of all these vessels only the two Delta boats, *NFC Waab* and *NFC Kosrae*, are equipped with Lindgren-Pitman (LP) fishing gear. Chuuk State owns two identical Delta vessels, *Aryanne* and *Nien Weno* (Figure 2), which are also equipped with LP gear, but these have been inoperable for at least two years.



Figure 2: Three of the NFC vessels, from left, NFC Waab, Ik No. 3 and NFC Pohnpei, with the two Chuuk State-owned vessels, Nien Weno and Aryanne

In addition to the longline fleet, NFC has two other major operations: three transshipment facilities (that also transship the catch from about 30 PRC vessels) and an air-cargo operation that has a lease-charter arrangement with two dedicated Boeing 727B air-cargo planes. The transshipment plants are located in Yap (Yap Fresh Tuna), Chuuk (Chuuk Fresh Tuna), and Pohnpei. The operations on Yap and Chuuk are jointly owned by NFC and the states, and are managed by NFC. The operation in Pohnpei is jointly run by the Economic Development Authority and NFC. There is another transshipment facility on Kosrae, Pacific Tuna Industries, that operates independently.

Yap Fresh Tuna and Chuuk Fresh Tuna are 'state-of-the-art' facilities with packing rooms, freezers, cold stores, generators, desalinators, ice plants, modern offices and dedicated wharf space. Each is capable of processing, packing and transshipping 40–50 t of fresh tuna daily. The facility in Pohnpei is not quite as modern as the ones in Yap and Chuuk, but it operates very efficiently. However, all the facilities are generally under-utilised, as the fishing fleet tends to migrate from one part of FSM to the other, following the tuna. When the vessels are fishing out of Pohnpei, for instance, there is little activity at Yap Fresh Tuna, and vice-versa.

The two dedicated 727B air-cargo planes, similarly, are not always busy. To be economical a cargo plane must fly out its maximum capacity in air cargo each time it makes a trip. The two 727Bs each have a capacity of 16 t (nett) of fresh-chilled tuna. Often there is a logistical problem in landing 16 t of export product at any one of the transshipment facilities on any given day. Conversely, there is often not enough space on the plane to accommodate all of the fish landed and some otherwise quality fish remains behind as reject fish. In spite of these minor problems, NFCs two ancillary operations, on-shore processing and transshipping by air, seem to be running smoothly and economically. The relative success of NFCs transshipping and marketing operations is due in part to their association with an Okinawan based fishing company.

1.3 THE OKINAWAN TUNA FISHERIES COOPERATIVE ASSOCIATION

Japan's Okinawan Tuna Fisheries Cooperative Association (OTFCA) began trial fishing and exporting in conjunction with the Micronesian Maritime Authority in 1991 (Anon., 1993). This eventually led to a joint-venture arrangement with NFC. At present OTFCA operates a fleet of 10 fibreglass longline vessels under the joint-venture arrangement. As part of the arrangement, it supplies a qualified grader to oversee all transshipping operations out of Pohnpei and to grade all fish from OTFCA, NFC, and NFC-managed and/or contract vessels. Under the joint venture, NFC is able to take advantage of OTFCA's expertise and marketing connections. FSM-registered vessels fishing for NFC can also gain considerable information on location of tuna schools and optimum setting and hauling times by observing and communicating with the Okinawan fleet.

1.4 INITIATION OF THE PROJECT AND ITS OBJECTIVES

NFC requested assistance from SPC's Capture Fisheries Section in 1995 to help with the operations and fishing techniques of its two Delta Marine tuna longline vessels, *NFC Waab* and *NFC Kosrae*, both of which were equipped with LP monofilament longline systems. NFC had concerns that LP gear was not suitable for FSM. Other vessels in NFC's fleet (and vessels in the DWFN fleets in FSM) were equipped with either Okinawan-style or Taiwanese-style gear, and had better catch rates. Management at NFC therefore theorised that the gear on *NFC Waab* and *NFC Kosrae* was the problem and the cause of poor fishing.

Since NFC first acquired the two Delta Marine boats, neither had performed to expectations. Catch rates averaged around 18 kg/100 hooks (39.5 lb/100 hooks) or 0.18 kg/hook (0.39 lb/hook) from 1992 to 1995 (Friberg, 1995). The average catch rates of other vessels fishing for NFC, including their own, were about twice as high, and DWFN vessels averaged even greater catches. NFC wanted to increase *NFC Waab's* CPUE to somewhere near 50 kg/100 hooks (110 lb/100 hooks) or 0.5 kg/hook (1.1 lb/hook).

In August 1995 the SPC Masterfisherman paid a visit to NFC while participating as a tutor in the SPC Post-Harvest Section's Tuna Handling Workshop held in Chuuk State, FSM. He examined *NFC Waab* and *NFC Kosrae* and determined that both vessels had severe maintenance problems, not the least of which was that safety equipment was not properly serviced and in date.

By March 1996 NFC had assured SPC that *NFC Waab* was in good working order, and that all safety gear had been either upgraded or ordered. SPC agreed to send the Masterfisherman on a duty assignment to FSM to help NFC with *NFC Waab*.

The objectives of the project were:

- to increase the catch rate of the project vessel by working with the skipper and crew to improve their fishing techniques and fishing strategies, and instruct them on the proper use of LP monofilament longline gear; and
- to determine whether or not LP monofilament longline systems were suitable for FSM waters.

When the Masterfisherman arrived in Pohnpei, he found that the project vessel was still in need of some repairs. Therefore, the project objectives had to be broadened to involve some routine work on the project vessel and the fishing gear before the main objectives of the project could be addressed.

2. The Project Vessel *NFC Waab*

NFC Waab (Figure 3) is a 16 m (53 ft) fibreglass longliner powered by a 3406B Caterpillar main engine and an Isuzu auxiliary engine with a 20 kilowatt generator. She has two stern wing fuel tanks that hold a total of approximately 6.8 t (1,800 US gallons).¹ *NFC Waab* is equipped with an LP monofilament longline system manufactured in Florida, USA. The vessel also came equipped with an LP LS-3 line setter, or shooter; three branchline tubs for coiling branchlines; an outside hauling station with a davit for the hauling block and outside engine and steering controls; a buoy cage for storing the round plastic buoys; a leader cart for coiling floatlines; and two fish holds.

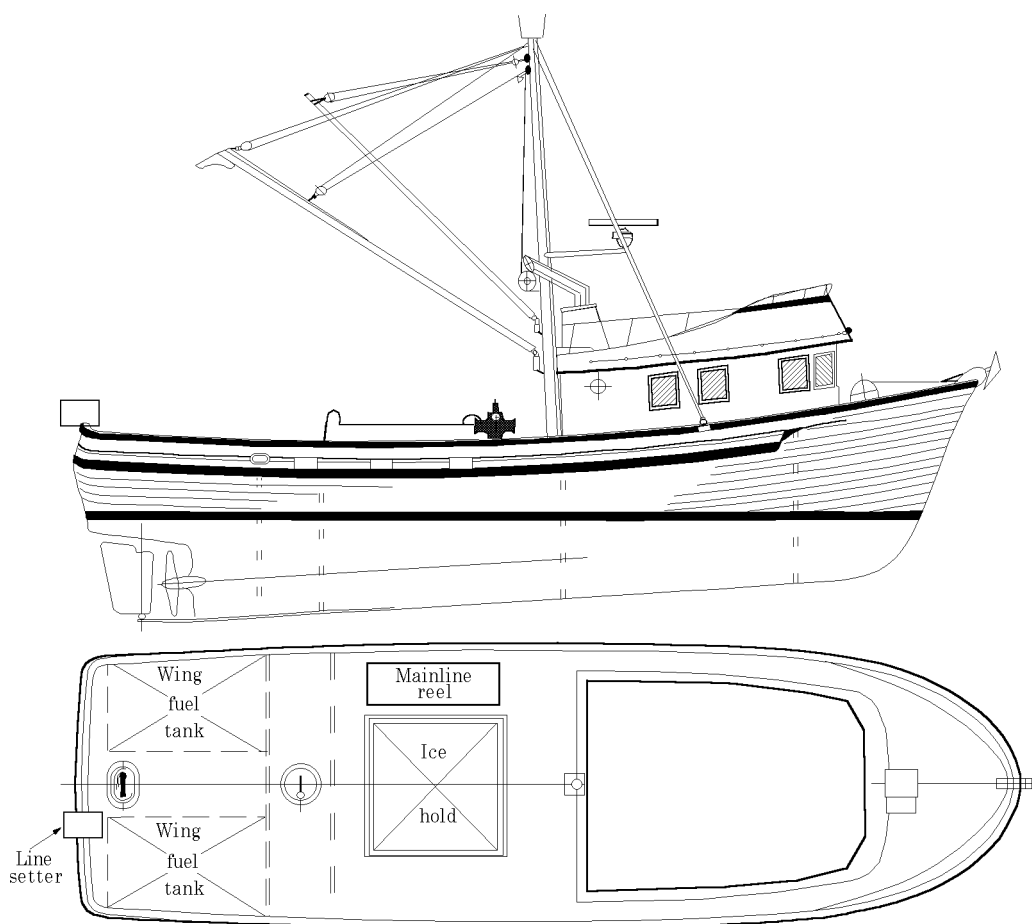


Figure 3: Delta Marine 16 m (53 ft) longline vessel

The main fish hold is designed for icing fish. It has a volume of 25 m³ or 25 t (914 cu ft) that gives it a holding capacity of only about 4–5 t of fish (it takes about 5 or 6 t of fish-hold volume to hold 1 t of iced fish). The main fish hold has a refrigeration system that cools the hold down to 0° C via bulkhead-mounted coils. The system runs on R-22 refrigerant. *NFC Waab* also has a bait freezer with a capacity of 5 m³ or 5 t (180 cu ft). The bait freezer can be cooled down to –18° C with the same R-22 system that cools the main fish hold.

¹ The survey report shows the fuel tanks as having only 1,600 gallons capacity but documents from the manufacturer state that the fuel capacity is 1,800 gallons.

NFC Waab and her sister vessels, *NFC Kosrae*, *Aryanne* and *Nien Weno*, were built in 1991–92 by Delta Marine Industries, Inc. of Seattle, Washington, USA. *NFC Waab* was surveyed on 25 February 1992, and subsequently delivered to Yap State, FSM. Appendix A outlines the main specifications of *NFC Waab*. The vessel began fishing out of Yap for Micronesian Fresh Tuna, which is a subsidiary of NFC.² Since 1992 she has fished out of Chuuk and Pohnpei as well.

2.1 PROBLEMS WITH *NFC WAAB*

Two sorts of problems with *NFC Waab* were encountered during the project. First, the vessel had been very poorly maintained, both in safety equipment and mechanically, and this was the same for other NFC vessels. Secondly, the Delta vessels had some limiting design features, mostly relating to dealing with size and range capabilities.

2.1.1 Safety equipment and machinery

On arrival in Pohnpei, the Masterfisherman found *NFC Waab* to be in a very poor state of repair and not seaworthy. The vessel required some extensive routine and general maintenance before it could put to sea on a tuna longline trip. Most safety appliances and devices were either out of date or missing. A list of these is provided in Appendix B.

There were many mechanical and other deficiencies on *NFC Waab* at the start of the project. These included problems with some of the electrical systems. They were mainly associated with a poor maintenance regime, and included most of the major pieces of machinery and equipment on the vessel. As the project progressed, additional problems were encountered and fixed where possible. Appendix C outlines the mechanical and electrical problems encountered, with some background information where known.

2.1.2 Limiting design features

The design of *NFC Waab* presents a few limiting features relating to tuna longline fishing and fishing on the high seas in the tropical Western Pacific. First of all, the relatively small size and the hull shape of FSM's Delta vessels render them probably less safe than larger vessels operating in FSM. *NFC Waab*, at 16 m (53 ft), could be classed as a 'mini' longliner. The small size makes the vessel uncomfortable, especially in rough weather. FSM lies in the tropical cyclone belt and there are few places for a vessel to run to during bad weather. In addition, *NFC Waab* has a rounded chine, which allows the vessel to roll much more than a hard-chine vessel would roll. It does, however, have rolling chocks, or bilge keels, but these are not very effective when the vessel is lying in the trough of the swell. During longline fishing, the usual practice is to shut the vessel down after the line has been set. Vessels naturally lie in the trough of the swell when not under way. A small vessel with a round chine rolls constantly under these circumstances.

The accommodation on *NFC Waab* is fairly comfortable but the engine room is small and cramped. The engineer has to literally crawl or stoop to get around in the engine room. This makes it very difficult to do any at-sea repairs or maintenance, especially in rough weather. The preceding problems are mostly a matter of comfort and could possibly be overlooked. The small size of the fish hold, fuel tanks, and fresh water tank, on the other hand, present the more limiting features of *NFC Waab*.

NFC Waab has a small fish hold for an 'ice' vessel. The hold has a volume of 25 t but it takes 5–6 t of volume to ice 1 t of fish.³ That means that *NFC Waab* can only hold about 4 to 5 t of fish maximum. During the project it was not unusual for some of the OTFCA vessels to land 10 t–15 t of tuna. Most of the OTFCA vessels use refrigerated sea water, or RSW systems for chilling their catch. The break-even point for a longline vessel operating in an export tuna fishery in FSM would probably be in the neighbourhood of 5–6 t. Based on fish-hold size alone, *NFC Waab* could never be a commercially-viable tuna longline vessel in FSM waters.

² *Waab* is the name for Yap in Yapese.

³ Icing is the process where fish are buried in layers in a bed of flake or crushed ice.

NFC Waab has two stern wing tanks (see Figure 3) that hold 3.4 t (900 US gallons) each or 6.8 t (1,800 gallons) total. *NFC Waab* consumes approximately 0.75 t of fuel daily. This means that she has an operating range of about nine days' steaming, or 1,620 nm. A typical longline trip lasts much longer than nine days. Usually 10–12 sets are made (one set per day) and the vessels steam for an addition of 5–10 days. It may take 2–5 days to get to the fishing grounds and another 2–5 days to return to port after fishing is completed. Also, the vessels spend some time searching for fish, and shorter moves are often made between sets. Therefore, a longline trip could last as long as 21 days. With an operating range of only nine days, *NFC Waab* would rarely be able to do enough fishing to fill the fish hold.

Lastly, *NFC Waab's* fresh-water tank holds only 320 US gallons (1.2 t) of fresh water. A crew of six can easily consume 50 gallons (0.175 t) daily. *NFC Waab* would run out of fresh water in six or seven days. As it was, the crew had to take spare water jugs and heavily ration the fresh-water supply as a matter of routine.

2.2 REPAIRS AND MAINTENANCE WORK CONDUCTED ON *NFC WAAB*

During the first five weeks of the project, repairs and maintenance work were carried out on *NFC Waab*. *NFC's* port engineer, who is normally stationed in Chuuk, came to Pohnpei for the express purpose of repairing the generator. New parts were ordered from the USA and the work was completed by the third week. The generator worked after these repairs were done, but not at 100 per cent efficiency. Besides the problem with the timing gear, the generator set had several other problems. The engine was leaking oil from almost every seal. The oil-pressure gauge and oil-pressure alarm did not work. As a result, oil level had to be constantly monitored by checking the dip stick. The crew would tend to overfill the oil sump, as the engine needed topping up with oil on a daily basis (up to one gallon US). This further aggravated the problem with the leaking seals. The engine room typically had a fine mist of oil in the air and covering most surfaces. This not only created a mess but was probably a fire hazard as well. By the end of the project the generator was completely out of service and needed a total rebuild. It broke down after the third set of the second trip and *NFC Waab* had to return to port.

Most of the other work was carried out by the Masterfisherman with assistance from one or two of the crew, and this work is listed in Appendix D. Some of the repairs and maintenance conducted were specific to the mechanical problems identified in Appendix C, which included the main engine starter motor, alarm systems, pumps etc. Other repairs included the installation of new quartz lights on deck and on the davit (Figure 4); the replacement of the transfer switch for engine controls; moving the Wagner jog steering switch; and installing a new control valve for operating the reel to the station outside (Figure 5). While repairs were being done, most of the crew worked on constructing new replacement fishing gear.

3. Fishing Operations

3.1 EXISTING FISHING GEAR

The existing fishing gear on *NFC Waab* consisted of an LP 182 cm x 91 cm (72 in x 36 in) Super Spool, hydraulically-operated monofilament longline reel (Figure 6). The reel has a capacity of 75.85 km (41 nm) of 4 mm (0.16 in) monofilament mainline, but it had only about 28 km (15 nm) of the original line left. The three branchline bins each have a capacity of 440 branchlines (1,320 total capacity), but *NFC Waab* had a total of only about 700 branchlines, and these were in poor condition.



Figure 4: Quartz light mounted on davit to light up the line-hauling area at night

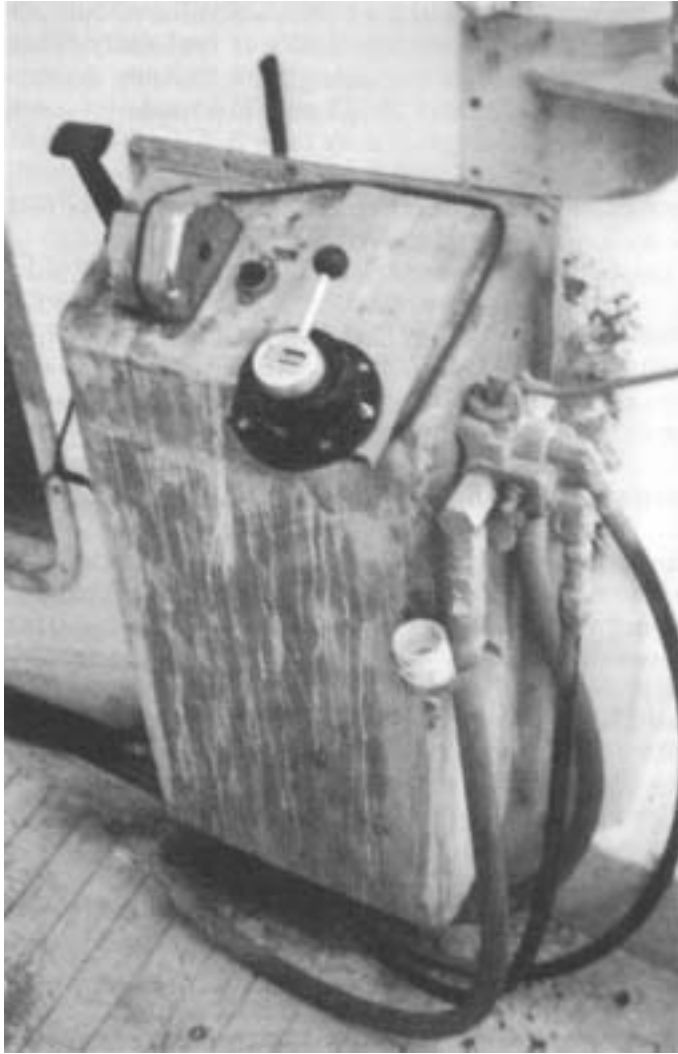


Figure 5: New mounting for the Wagner jog steering control and control valve for operating the LP reel

The branchlines were 14 m (7 fathoms) long and were made up of 2.1 mm (0.085 in) monofilament. Some had leader wires and some did not. Many of the leader wires were rusted and many of the monofilament branchlines were kinked and tangled. The floatlines were made up of either 4.0 mm (0.16 in) tarred kuralon or 4.0 mm (0.16 in) monofilament (same as the mainline). These were stored on a hydraulic leader cart which was inoperable. The length of the floatlines varied from 20 m (10 fathoms) to 40 m (20 fathoms). There were sufficient 360 (15 in) plastic floats to set about 1,100 hooks in 20-hook baskets, but not enough branchlines or floatlines to set more than 700 hooks. There were four radio buoys, but two of these were inoperable. There were no light buoys.

The LP reel and the LP LS-3 shooter were in need of some general maintenance. The line shooter required a new drive wheel, line guides and all rubber parts replaced. The leader cart, however, was unrepairable as no parts were readily available. In any event, leader carts are not in general use in the tuna longline fishery, so a decision was made to remove it from the vessel. Floats would be pulled in by hand and floatlines hand-coiled as is done on most longline vessels.



Figure 6: LP reel with new monofilament mainline installed

3.2 NEW FISHING GEAR

To ensure that *NFC Waab* was properly equipped for fishing operations, many components of the longline gear needed to be replaced. NFC spent around US \$15,000 on the purchase of new fishing gear and spare parts during the course of the project.

3.2.1 Mainline, floatlines and light buoys

To start, 37.5 km (20 nm) of 3.6 mm (0.15 in) mainline was purchased and wound onto the LP reel (Figure 6). This was necessary to allow adequate hooks to be set to increase the catch and catch rate.

The crew of *NFC Waab* made up 80 new floatlines. These consisted of 30 m (15 fathoms) of tarred 6.4 mm (0.25 in) kuralon (the same type of line used in Japanese basket gear). An eye splice was put in one end of each line and a 9/0 swivel snap was spliced into the other end. The eye splice was for attaching floats during setting and the snap was for snapping the floatline to the mainline (9/0 refers to the size of swivel on the snap). These floatlines were stored on *NFC Waab's* deck in large plastic rubbish bins that were secured to the rail (Figure 7).

The Masterfisherman and the crew also made up four light buoys (Figure 8). These consisted of a 3 m (10 ft) fibreglass pole stuck through an inflatable light buoy float. Two 0.5 m (20 in) lengths of 19 mm (0.75 inch) steel rebar were clamped onto the lower end for counter balance, while a strobe light and a longline flag were attached to the top end. Reflective tape was added to improve visibility. These light buoys were attached to the mainline during setting, in between the radio buoys.



Figure 7: New floatlines stored in plastic rubbish bins secured to the rail

3.2.2 Branchlines

A few years ago several Hawaiian vessels in the 'Korean' fleet began to use a different-style branchline with their monofilament systems. Instead of using monofilament they used 3.0 mm (0.12 in) tarred red polyester three-strand line for branchlines. This was actually an adaptation of one element of the older 'basket' gear to fit with the more modern 'monofilament' gear. It took a while for the rest of Hawaii's fleet to notice, but now several more vessels are switching to this style of gear.

The branchlines are constructed from 8–12 m (4–6 fathoms) of tarred red polyester line that has a swivel snap tied to one end and a swivel tied to the other end. Tarred red polyester line needs to be burned with a hot knife or an electric line cutter, so that the ends do not fray and unravel. The swivels can be barrel swivels, bullet swivels or leaded swivels. Leaded swivels come in a variety of weights ranging from 38 to 75 g (1.14–2.25 oz). A 1 m (0.5 fathom) stainless steel 1 mm (0.04 in) leader wire with hook is attached to the swivel to complete the branchline. Hooks are usually Japanese-style tuna hooks with rings, but some fishermen

prefer circle hooks. The knot used to tie the tarred red line to the snap and to the swivel is a barrel knot or slip knot (Figure 9). Lastly, the bitter end of the tarred red line is tucked into the lay of the line to prevent the knot from slipping and to keep the end out of the way. This is done with a small Swedish fid (Figure 10).

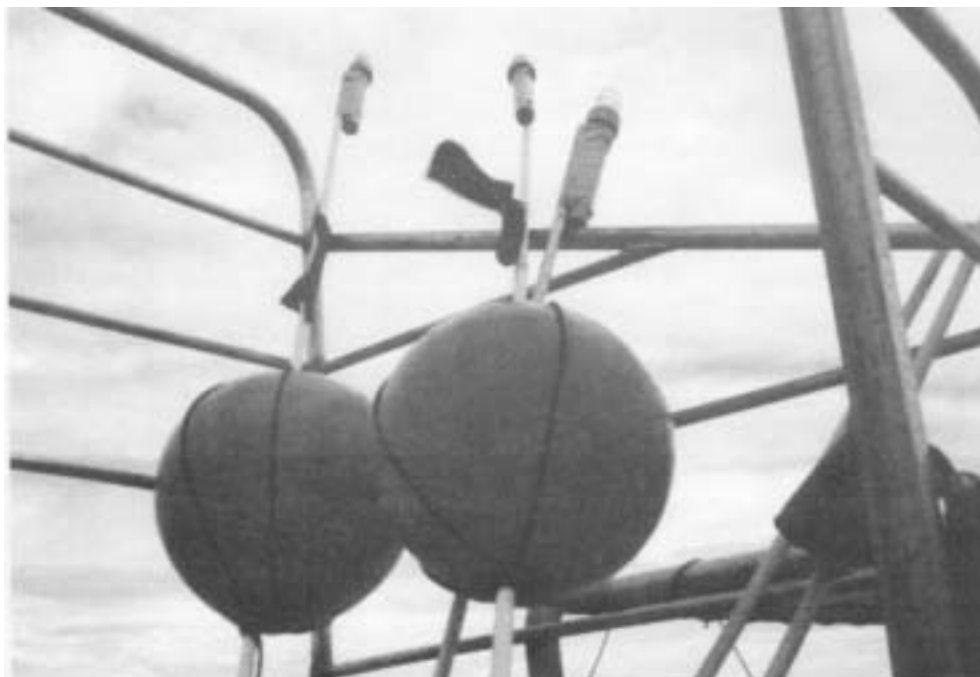


Figure 8: Light buoys made by the Masterfisherman and crew to go between radio buoys

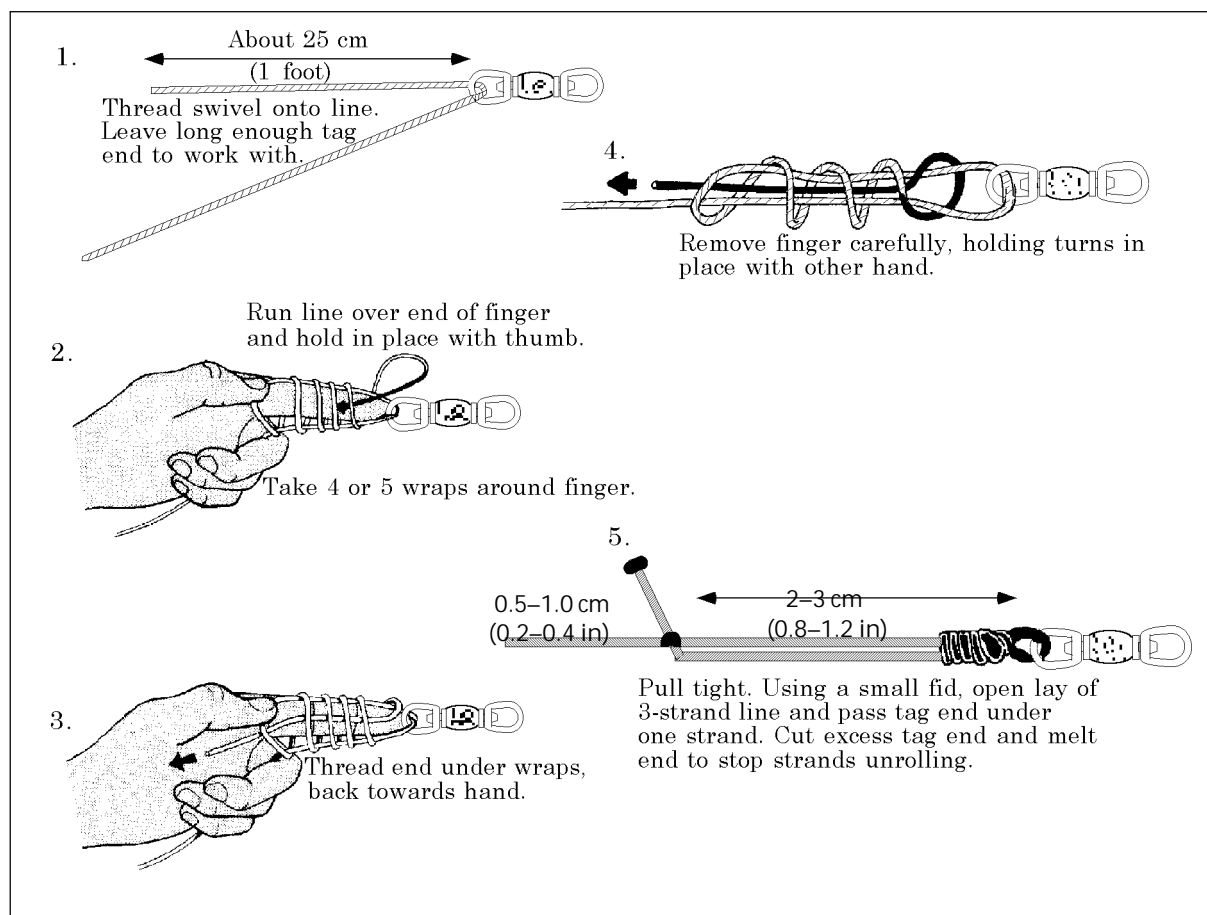


Figure 9: Tying a barrel or slip knot using 3-strand tarred red polyester line

Because knots are used on the tarred red polyester line, there is an initial savings of US \$200–\$300 (if 1,500 branchlines are made) as no crimps need to be purchased. However, this is offset by the increased cost of tarred red polyester line. Monofilament branchline (just the line) costs an average of US \$0.04/m, while the tarred red polyester line costs US \$0.11 m. Taking into account the money saved by not using crimps on the tarred red polyester line, it would cost about US \$800 more to gear up a vessel with this than with monofilament (1,500 hooks).



Figure 10: Using a Swedish fid to tuck the end of the tarred red polyester line back into the lay of the line

In the long run, however, longliners can save a substantial amount by using tarred red polyester line, as it tends to outlast monofilament. It is not unusual for longliners using monofilament branchlines to lose as many as 50 per set. This can add up to several hundred per trip. Most branchlines are lost due to shark damage or damage from small by-catch fish and discards such as snake mackerel, mahi mahi, oilfish, etc. Typically the snaps and even the hooks can be re-used, but the monofilament is usually discarded. Vessels in Hawaii using tarred red polyester line reported losing only 20–30 branchlines per trip.

Branchlines made from tarred red polyester line are easier to construct, are easier to set with fewer tangles, make it easier to pull in fish (especially large fish), and are easier to recoil while hauling. Both monofilament and tarred red polyester line are subject to sun damage from ultra-violet light and should be covered when not in use. However, monofilament is much more susceptible to sun damage and more likely to suffer from abrasion than tarred red polyester line.

The biggest benefit of using tarred red polyester line, however, is the ease of handling. Since it does not kink or twist like monofilament, it always lays back into the bin naturally during hauling. This makes the following set easier, as the lines leave the tub without twisting and tangling. Also, tarred red polyester line does not tend to wrap around the mainline as much as monofilament. Generally both setting time and hauling time are shortened when using tarred red polyester line. This means that more gear can be set, so fishing effort is increased or more time can be allowed for travel to new fishing grounds.

The best feature of tarred red polyester line is the increased gripping power that it has over monofilament. Monofilament is, by its nature, slippery. When pulling in a large, active fish it is not unusual for the fisherman to lose his grip on the line, which allows the fish to run. Often, the branchline will break when the fish reaches the end of its run and the line becomes tight. Three-strand tarred red polyester line has a fairly rough surface compared with monofilament, so there is much more friction between the fisherman's hands and the line. This allows the fisherman to maintain a stronger grip so that the fish can be brought up to the rail for gaffing as quickly as possible. Fewer fish are lost on tarred red polyester branchlines than from monofilament branchlines.⁴

During the project 1,320 new branchlines were made up for *NFC Waab* and stored in the three bins (Figure 11). Several things contributed to the successful fishing experienced in the two trips made during the project (including a better maintenance regime and improved

⁴ This statement is based on the personal experiences of the Masterfisherman and on information related to him by other fishermen from the longline fleet in Hawaii. How much better tarred red polyester line actually is compared to monofilament is a question that needs to be investigated further.

fishing strategies), but the introduction of new tarred red polyester branchlines also had some bearing on the fishing results. The Masterfisherman was able to instruct the crew of *NFC Waab* in constructing new branchlines in just a few hours, and within about a week, the crew of three had completed the task. By the time they had finished making 1,320 branchlines they were experts. The crew had been having difficulties with monofilament branchlines, not so much with construction—which is relatively easy and takes about the same amount of time—but with fishing. After using tarred red polyester branchlines on two trips, they were all convinced that this style of gear was a vast improvement.



Figure 11: The new tarred red polyester branchlines stored in the three bins

3.3 SETTING THE GEAR

Before fishing operations started each day the deck had to be laid out properly. This included stringing the mainline from the reel back aft to the line shooter where the baiting took place, and arranging all buoys, floatlines, radio buoys and branchline bins in their proper places. The right number of bait boxes had already been taken out of the fish hold.

After the vessel was under way in the setting zone on the desired course and speed, the first radio buoy was thrown over. As the mainline went out over the stern through the line shooter, floatlines and baited branchlines were clipped on at appropriate intervals. The spacing used was usually about 40 hooks per mile (20 hooks per kilometre), and 20 hooks per basket. At 40 hooks per mile, the interval between hooks is about 25 fathoms (50 m). The branchlines need to be far enough apart so that they cannot tangle with each other, and so that during hauling, one can be coiled before the next one comes up.

The line was deployed just to the starboard side of centre (Figure 12 shows the position of the line shooter), the baited hooks were thrown off the port side (Figure 12), while the floatlines were thrown off the starboard side (Figure 13). The branchline bins were positioned between two crewmen at the stern. One man, the baiter, removed a hook from its snap, baited it by piercing the hook down into the body of the baitfish just in front of the dorsal fin going from the left to right side, and then threw the baited hook at the proper interval. The species of bait used during the fishing operations were Maro Aji (*Decapterus spp.*) and Iwashu (*Sardinops melanosticta*).

The baiter set the pace. The other man, the snapper, then snapped the clip, which he had removed from the rack, onto the mainline.

It was important for the snapper to snapp just the clip as the baiter threw the bait. To avoid tangles, branchlines were thrown so that they would lie perpendicular to the mainline.

Figure 12: Setting the tuna longline using the line shooter on NFC Waab— branchlines being set off the port side



When the desired number of the hooks had been thrown, the last radio buoy was attached and thrown over. The boat was stopped for this and a loop was tied into the mainline. Positions at the start and finish of the set were taken from the GPS, and were written down or marked on the chart. In addition, current, boat drift and wind direction were always noted. This helped in locating the line after 6–7 hours of soaking. The signal from the radio buoys was always checked.

3.4 HAULING THE GEAR

After a soak of 6–7 hours the line was recovered. The deck had to be rearranged somewhat and tools laid out before hauling commenced.

The first radio buoy was then recovered and the end of the mainline detached and passed through the blocks and secured to the reel. If the mainline was cut at the end of the set, a blood knot was used to re-attach the two ends (Figure 14). Blood knots were also used if any bad tangles or shark-damaged sections of the mainline needed to be cut out. Once the line was secured to the drum, hauling commenced.



Figure 13: Throwing the float and floatlines from the starboard side during line-setting operations

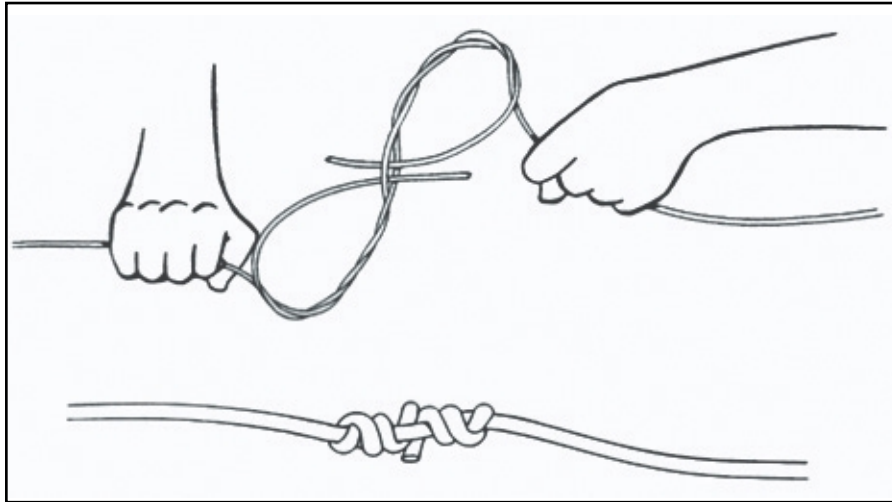


Figure 14: Blood knot: tying the knot and the finished knot after the ends have been trimmed

The main man on the deck was the roller man, who operated the control valve for the reel, engine controls, and steered the vessel (Figure 15). His job was to control the speed at which the line was recovered and to unsnap all branchlines and floatlines as they came up. Another crewman, the coiler, stood directly behind the roller man. His job was to take each snap from the roller man and coil the branchlines into the branchline bin in front of him.



Figure 15: Roller man operating the controls for the reel, throttle, and steering while unsnapping the branchlines from the mainline

Other crew stood behind the coiler (Figure 16). Their job was to assist the coiler with branchlines, or pull in floatlines, coil and stow the lines, and stow the floats. This whole process was done without stopping (until a branchline holding a fish was reached) as the snaps could be removed from the mainline while it was still moving. The roller man kept one hand on the line (this also allowed him to feel if a fish was on the line) and the other hand on the control valve. Another man tended to all fish; spiking, bleeding, cleaning and icing.



Figure 16: Other crew with branchline bins waiting to assist the coiler

When a fish was encountered, the roller man yelled 'fish!', stopped the vessel and turned to port (so the vessel would not go over the line). The coiler usually stood by with a gaff as the roller man pulled the fish in by hand. The snap was not removed from the mainline until the fish had been gaffed and was on board, unless a lazyline, or playline, had been used, as was necessary with a very active, large fish. After the fish was on the deck, hauling resumed. It was better to keep the vessel and line moving once hauling had started, as stopping the vessel for any length of time could have put enough tension on the line to break it or to twist the mainline, thus tangling the branchlines. After the final radio buoy had been hauled in, the end of the line was secured onto the reel.

3.5 HANDLING THE CATCH

As a tuna was pulled up to the surface near the rail, one or two men gaffed it and lifted it on board (Figure 17), taking care not to gaff the body or to injure the heart. The first gaff (if the fish was alive) would necessarily be somewhere in the head, while the second gaff could then be stuck into the open mouth. Tuna should not be gaffed in the lower jaw, as this tends to destroy the isthmus connecting the gills to the lower jaw, which gives the iced fish a distorted shape, and could damage the heart. As the gaffed fish was hauled aboard, a third man would grab the tail to enable the fish to be lowered gently to a waiting rubber pad.

If the landed fish was thrashing, two things could be done. If the thrashing was violent and likely to damage the fish or injure the fishermen, the quickest way to settle it down was to hit it with a firm blow to the top of the head with a wooden club or 'fish bat'. This blow only stuns the fish and does not kill it. If the fish was only moving slightly, covering the eye with a gloved hand would usually calm it down. The same club was then used to remove the hook. This was done by grabbing the branchline near the hook and pulling it tight, and then striking the ring end of the hook with the club.

After the hook was removed, the fish was spiked with a stainless steel 'tee spike'. A long screw driver would work just as well. The spiker straddled the fish with one foot on either side just behind the pectoral fins, with the fish on its belly, held firmly in place with the spiker's legs. The spike was inserted in the soft spot between the eyes and pushed back at about a 45 degree angle into the skull. The brain was then destroyed by stirring the spike around. If spiking was done properly, the fish shuddered violently and then went limp, with its mouth agape and its eyes not responding to touch. The skin colour changed from blue to grey.

The fish were bled by making cuts on either side of the fish in the pectoral fin recess. The cut has to be perpendicular to the body axis of the fish or the blood vessels are likely to be missed. After the blood vessels were seen to be bleeding a cut was made in the gill membrane on one side of the fish, at about the mid-line (Figure 18). Further cuts were made during bleeding, on either side of the tail between the third and fourth tail scutes.



Figure 17: Landing a fish using a gaff in the head of the fish



Figure 18: Bleeding cut being made in the gill membrane

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

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

By-catch species were handled and cleaned in a similar way, with marlin having their head removed as well (headed and gutted). Small fish were not cleaned, but iced in the round or whole. Live sharks were released by cutting the trace, while dead sharks had their fins removed and retained.

It was important to keep everything that came into contact with fish clean at all times. After each fish had been handled, all tools, including the gaff heads, spikes, knives, and mats, were rinsed with seawater. At the completion of each fishing trip, the fish hold was emptied and scrubbed with seawater and a mixture of soap and bleach. The soap and bleach were rinsed completely away after washing.

4. Results from Fishing Operations

Because of the length of time spent on vessel repairs and maintenance, and fishing gear upgrading, only two trips were made during the three-month project. On both of these trips *NFC Waab* experienced breakdowns and had to return to port early, so fishing effort was somewhat curtailed. However, a total of six sets were made, although on the first two sets of the first trip the line shooter was not working.

4.1 PROJECT CATCHES

Table 1 summarises the catch during the two trips undertaken on *NFC Waab* by the Masterfisherman, while Appendix E gives a more detailed breakdown of the catch and effort. The total retained catch for the two trips was 1,652 kg (64 fish), while the total effort amounted to 5,940 hooks being set. If only the third set of the first trip and all sets of the second trip are considered, a total of 1,539 kg (56 fish) of fish were retained with the effort being 4,260 hooks.

Table 1: Total catch retained and number of hooks set by *NFC Waab* during fishing activities for all species, yellowfin tuna and bigeye tuna

Trip and set number	No. of hooks set	No. of fish (all species)	Weight (kg) (all species)	No. YFT	Weight (kg) YFT	No. BET	Weight (kg) BET
1/1	840	3	16	0	0.0	0	0.0
1/2	840	5	97	2	38.0	1	50.0
1/3	1,000	21	476	15	343.0	3	120.0
2/1	880	4	102	2	45.0	0	0.0
2/2	1,210	20	627	18	541.0	2	86.0
2/3	1,170	11	334	10	295.0	1	39.0
Total for all sets on both trips							
6	5,940	64	1,652	47	1262.0	7	295.0
Total for Set 3 of Trip one and all sets on Trip two							
4	4,260	56	1,539	45	1224.0	6	245.0

1. YFT = Yellowfin tuna; BET = Bigeye tuna.

2. By-catch was not recorded for Sets 2/2 and 2/3.

The totals have been split in this way because on the first two sets on the first trip, the line shooter was not working and the crew were getting accustomed to the new gear and the setting method being used by the Masterfisherman. These first two sets were therefore considered to be 'shake-down' sets while everyone got used to the new routine.

Table 2 summarises the catch per unit of effort (CPUE) for the main species. The overall CPUE for the total retained catch was 27.8 kg/100 hooks (61 lb/100 hooks) or 0.278 kg/hook (0.61 lb/hook). For yellowfin tuna, the total CPUE was 21.2 kg/100 hooks (46.8 lb/100 hooks) or 0.212 kg/hook (0.46 lb/hook), while for bigeye tuna it was 5.0 kg/100 hooks (11 lb/100 hooks) or 0.05 kg/hook (0.11 lb hook). If the first two sets of Trip 1 are removed, the CPUEs increase to 36.1 kg/100 hooks (79.5 lb/100 hooks) or 0.361 kg/hook (0.79 lb/hook) overall, 28.7 kg/100 hooks (63.3 lb/100 hooks) or 0.287 kg/hook (0.63 lb/hook) for yellowfin tuna, and 5.8 kg/100 hooks (12.8 lb/100 hooks) or 0.058 kg/hook (0.12 lb/hook) for bigeye tuna. The combined CPUE for yellowfin tuna and bigeye tuna is 45.3 kg/100 hooks (100 lb/100 hooks) or 0.453 kg/hook (1 lb/hook) for Set 3 of Trip 1, and 51.8 kg/100 hooks (114.34 lb/100 hooks) or 0.518 kg/hook (1.14 lb/hook) for Set 2 of Trip 2.

Table 2: CPUE percentage of catch and average weight for all species, yellowfin tuna and bigeye tuna

Trip and set number	CPUE all (kg/100 hks)	CPUE YFT (kg/100 hks)	CPUE BET (kg/100 hks)	YFT (%) by wt.)	BET (%) by wt.)	Ave. wt. (YFT kg)	Ave. wt. (BET kg)
1/1	1.9	0.0	0.0	0.0	0.0	0	0.0
1/2	11.5	4.5	6.0	39.2	51.5	19	50.0
1/3	47.6	34.3	12.0	72.1	25.2	22.9	40.0
2/1	11.6	5.1	0.0	44.1	0.0	22.5	0.0
2/2	51.8	44.7	7.1	86.3	13.7	30.1	43.0
2/3	28.5	25.2	3.3	88.3	11.7	29.5	39.0
Total for all sets on both trips							
6	27.8	21.2	5.0	76.4	17.9	26.9	42.1
Total for Set 3 of Trip 1 and all sets on Trip 2							
4	36.1	28.7	5.8	79.5	15.9	27.2	40.8

1. By-catch was not recorded for Sets 2/1, 2/2 and 2/3.

As can be seen from Table 2, the overall average weight for yellowfin tuna was 27 kg (59.5 lb)(gilled and gutted), while for bigeye tuna it was 42.1 kg (92.9 lb). Overall, these two species represented over 94 per cent of the total catch. However, the percentage would have been slightly lower if the by-catch had been recorded on the last two sets.

Unfortunately, both trips that the Masterfisherman undertook were cut short due to mechanical failures on the vessel. On the first trip, the main engine starter motor started smoking, the engine room was getting very hot and the generator set kept shutting off and eventually would not start. On the second trip, the generator set stopped at night during hauling (no lights), so the mainline had to be cut and released with a radio buoy attached. The remainder of the line was hauled at first light and *NFC Waab* headed for Pohnpei with batteries getting weaker (and running out on the way in), with no way of charging them.

On both trips, the catch rates were improving as the better fishing grounds and fish were being located. If this factor is taken into consideration, it is likely that the catch rates achieved could have been higher on additional sets, which would have increased the overall CPUE for both trips.

4.2 COMPARISON OF CATCH RATES

One of the main aims of the project was to increase the catch rates for the two Delta Marine vessels, *NFC Waab* and *NFC Kosrae*. When the Masterfisherman arrived in Pohnpei, the catch rate for these vessels was around 18 kg/100 hooks or 0.18 kg/hook for the target species yellowfin tuna and bigeye tuna combined. As can be seen from Figure 19 (provided by NFC's Operations Manager), the catch rate for these two vessels was about half that obtained by the Japanese-style vessels, *NFC Pohnpei* and *NFC Chuuk*. NFC staff also stated that the CPUEs for the Delta Marine vessels have been somewhere between quarter and half those obtained by the DWFN fleet.

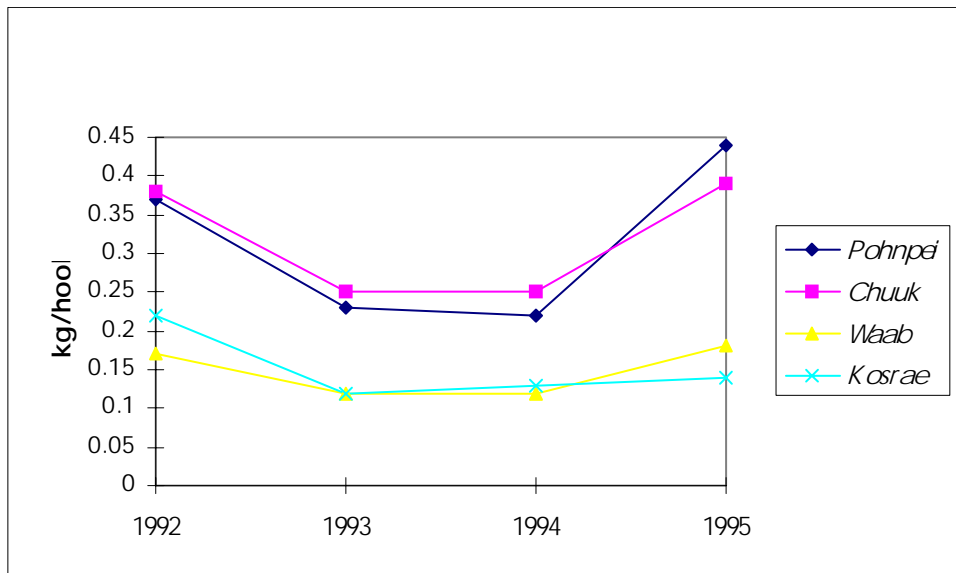


Figure 19: CPUE for yellowfin tuna and bigeye tuna combined for four NFC vessels, 1992–1995

The CPUE that NFC management is striving to achieve and maintain is 50 kg/100 hooks (110 lb/100 hooks) or 0.5 kg/hook (1.1 lb/hook). Given the historical catch rates for the *NFC Waab* and *NFC Kosrae*, the project CPUE for yellowfin tuna and bigeye tuna combined (overall 26.2 kg/100 hooks (57.5 lb/100 hooks) or 0.262 kg/hook (0.57 lb/hook), or 34.5 kg/100 hooks (76 lb/100 hooks) or 0.345 kg/hook (0.76 lb/hook) excluding the first two sets on trip one) are a great improvement. On an individual set basis, CPUEs as high as 51.8 kg/100 hooks (114 lb/100 hooks) or 0.518 kg/hook (1.14 lb/hook) — Set 2 of Trip 2) were recorded. These catch rates should have been higher, but both trips were cut short, as explained in the previous section.

5. Conclusions

5.1 NFC WAAB

NFC Waab (and *NFC Kosrae*) are basically good vessels with fine gear. However, the small size of their fuel tanks (6.8 t or 1,800 gallons), fresh water tanks (1.2 t or 320 gallons), and fish holds 26 m³ (918 ft³) renders them unsuitable as commercially-viable tuna longline fishing vessels fishing in FSM waters. Fishing grounds are typically days away from port and search time adds even more days to a trip. Under these circumstances, the Delta vessels are only capable of fishing two to five sets in the area where the fish are during any one trip. If the maximum of 1,320 hooks is set with the target CPUE of 50 kg/100 hooks (110 lb) or 0.5 kg/hook (1.1 lb/hook), only 2–3 t of fish can be expected from the very best trip of five sets (two sets to locate fish and three sets on the fish).

NFC Waab came equipped with only one battery bank for the 12 volt system. Later a second battery bank was added. *NFC Waab* now has a total of four 8D 200 amp batteries. The

problem is that these batteries are laid out in two banks of two batteries each (as they should be), but the two banks are connected together (they should not be).

Inspection of the shaft and shaft alley on *NFC Waab* revealed that the Cutlass bearing was badly worn and needs to be replaced and that the intermediate shaft bearing also needs to be replaced. While changing the packing on the shaft gland it was discovered that the shaft had a sag to it. In other words, the gap at the bottom of the stuffing box (packing gland) is smaller than the gap at the top. This is caused by wear on the Cutlass bearing, which holds the shaft up just in front of the propeller. Additionally, most of the sea-cock valves were either frozen in the open position, or simply did not stop water in the closed position. This is potentially a very dangerous situation that could result in the vessel sinking. Nobody in the crew or management could remember when *NFC Waab* was last slipped.

Routine maintenance and lubrication of both engines and the generator set have not been a priority on *NFC Waab* and some things need to be attended to. In particular, the marine engine transmission (gear box) needs to be serviced. This involves changing the oil, cleaning the oil filter, cleaning the breather pipe, and greasing the shaft seal.

It was also discovered during the project that the store of spares on *NFC Waab* was very poor. This was built up, but was still inadequate. The Masterfisherman prepared a list of spare parts that should be ordered as replacements or as spares. This list of spare parts is presented in Appendix F.

5.2 VESSEL CREW

NFC Waab's core crew (Sirel [captain], Falerio and Aliwis) are all good seamen and capable fishermen. However, they lack most of the technical skills necessary to run and maintain a tuna longline fishing vessel. Generally they were unaware of most of the problems that the Masterfisherman found on *NFC Waab*, and they did not have the skills to do repairs on the problems that they were aware of. Also, the crew did not understand most of the systems on the boat and they were poor house-keepers.

5.3 FISHING GEAR

One of the questions that SPC sought to answer during this project was whether or not LP monofilament fishing systems are suitable for longline fishing in FSM waters. Although the fishing effort during the three months that SPC was in Pohnpei was minimal (six sets total during two trips), the CPUEs were substantially better than those reported in the past. This would indicate that the LP gear works fine in FSM waters if used properly. However, the design limitations of the Delta Marine vessels (fuel, fresh-water and fish-hold capacity), poorly-maintained gear and lack of technical and fishing skills on the part of the crew, limited the catches in the past.

The upgraded fishing gear was well received by the crew of *NFC Waab*, and contributed to the increased catch rates achieved. The crew were able to fish 1,200 hooks easily using this new branchline gear as they found it easier to work with fewer gear losses.

5.4 NFC MANAGEMENT

Management, including vessel captains as well as middle managers and upper management, should be a team with the same goal in mind: operating a profitable business venture safely. In order to accomplish this goal, vessel captains and middle managers (operations) need to have a sound knowledge of all technical aspects of the vessels they are working with. This is probably NFC's weakest point. Although the captains are quite good at driving a boat from one point to another and are well versed in navigation, the captains and engineers are generally not very knowledgeable in vessel maintenance and do not possess the necessary technical skills to keep all the systems on a vessel operating smoothly. As a result, all NFC's vessels are either broken down and out of service or in need of minor or major repairs at any given time.

The middle management team at NFC is very capable when it comes to basic vessel support: arranging for bunkering, bait, ice, provisions and manning. However, proper operation and maintenance of NFC's fishing vessels could be greatly improved if middle management had a better understanding of how a vessel works and what is required to keep it operational. Someone on the middle management team should have all the technical skills and knowledge required of a captain and engineer. This is not the case at NFC. Operations managers need to spend more time on the vessels if they are to understand the systems and problems.

Upper management at NFC is doing best to secure a capital base for operations, vessels, gear, planes, etc. and to negotiate deals such as the recent takeover of most of the main competitor's air-freight contracts. However, management is probably weakest in terms of selecting people who possess the necessary technical skills to operate vessels and to manage vessel operations and in monitoring the activities of the middle management team. Overall, NFC's strengths have definitely been in developing domestic transshipment facilities, air-freight services, and marketing.

Safety at sea is an area that both vessel captains and operations managers need to be more aware of. In one instance, the *KSVI 2* was drifting somewhere close to Ant Atoll and was in need of fuel and a pump to move fuel to its service tank (her generator was down and fuel could not be pumped). *NFC Waab* took on extra fuel in drums, rigged a hand pump, and took on stores for two or three days sea time. At about 1400 hours Friday *NFC Waab* left to rescue *KSVI 2*. Both vessels returned safely to port the same evening at about 2000 hours. NFC management were not aware of this and made no attempt to contact the vessels either by radio or by visiting the wharf during this time.

6. Recommendations

Based on the Masterfisherman's experiences during the three months spent in Pohnpei working with NFC and on the *NFC Waab*, it is recommended that:

- (a) The two battery banks be isolated so that one bank starts the engines (main and generator set) and the other bank supplies the wheelhouse 12 volt system (radar, radios, autopilot, GPS, lights, etc.). The engine starter bank should then be charged by the alternators on the two engines, while the other bank should remain on the generator powered charger;
- (b) All NFC's vessels be slipped at least once every two years, (although once per year would be better), to allow the hull to be water-blasted and inspections made to zinc anodes, keel coolers, cutlass (shaft) bearing, pintle (rudder) bearings, echo-sounder transducer, etc;
- (c) The sea cocks on each vessel be checked when slipping occurs and serviced or replaced as necessary;
- (d) Both the main engine and the auxiliary engine be fully serviced every 1,000 hours or every six months, whichever comes first;
- (e) NFC keep a stock of spare parts for all its vessels, such as the spares for *NFC Waab* listed in Appendix F;
- (f) The crew work under the watchful eye of an experienced tuna longline captain/engineer for at least several months more so that they will be able to run the vessel on their own with confidence;
- (g) A good marine engineer be included in the crew, and NFC management closely monitor the vessels on a regular basis to ensure that they are being properly maintained and kept clean;

- (h) That NFC seriously consider putting LP gear on the KSVI vessels if it plans to re-gear these vessels in the future;
- (i) NFC management purchase enough gear to ensure that their vessels are fishing with the maximum gear possible, to assist in increasing their catch rates;
- (j) NFC seek out and hire a suitable, qualified, expatriate operations manager who is also an experienced captain, engineer and fisherman;
- (k) A practically experienced operations manager train NFC's current team of managers in hands-on vessel management;
- (l) Managers spend more time on the vessels, getting to know the systems and the people, so that they understand the fishing operations as well as the vessels themselves;
- (m) NFC explore the possibility of divesting itself of its fishing fleet by chartering the vessels out to another entity, such as Micronesian Longline Fishing Company (MLFC), and concentrate its efforts on what it does well: packing, transshipping, and marketing of fish;
- (n) Whenever vessels are at sea, and especially during an emergency, the operations manager have a roster of staff on standby and in regular radio contact with the vessels seven days per week;
- (o) The Delta Marine vessels be used as training vessels for NFC captains and engineers, using expatriate captains/engineers retained on salary, with revenues from fish caught being used to offset operational costs.

7. References

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LIST OF SAFETY EQUIPMENT EITHER OUT OF DATE OR MISSING

- Liferaft out of service by 3 years.
- EPIRB (emergency position indicating radio beacon) battery out of service by 5 months.
- No life rings.
- No hand-held flares.
- No rocket flares.
- No smoke signals.
- All fire extinguishers (4, dry chemical) were empty except for the Halon system over the main engine.
- Hydrostatic launching devices on life raft and EPIRB were out of service by 2 years.
- No first aid kit or medical kit on board.

Note: NFC management had previously ordered a new liferaft at the Masterfisherman's request but it had not arrived by the start of the project. While in Guam, the Masterfisherman had purchased a life ring, hand flares, rockets flares and smoke signals, on behalf of NFC.

MECHANICAL AND ELECTRICAL DEFICIENCIES ENCOUNTERED ON *NFC Waab*, WITH BACKGROUND INFORMATION WHERE KNOWN

- Generator had broken down. As *NFC Waab* was steaming from Chuuk to Pohnpei for the start of project operations, the timing-gear for the injector pump on the Isuzu auxiliary engine came loose and a 2.5 cm (1 in) square hole was broken out of the timing-gear housing cover. The crew told the Masterfisherman that this was the second time this had happened recently, and was the result of the wrong part being used (the nut that holds the gear in place). Parts had to be ordered from USA and repairs took some time as *NFC*'s port engineer had to be flown in from Chuuk. This was considered a fairly major problem as *NFC Waab* could not fish without a generator. All deck lights are 120 or 220 volts, as are the main seawater circulation pump and the galley stove.
- The main engine had starter motor problems. In order to start the engine, the engineer had to disconnect the two 200 ampere starting batteries and jump-start the engine. As it turned out, a 24 volt starter had been installed on the vessel in December 1995 when the old starter malfunctioned. *NFC Waab* was set up with a 12 volt system, including starter motors for both engines. The 24 volt starter had been supplied by a Guam company which insisted that it was the correct replacement part. In addition to discharging the battery bank rapidly, the 24 volt starter was probably responsible for burning up the alternators on both engines and damaging some of the other wiring as well.
- Both fuel tanks were contaminated with water and dirty fuel.
- The fresh-water system had a leak, so water ran out sooner than usual on a trip.
- The lazarette was flooded. Water was coming in through the packing gland on the rudder post and through the water-tight hatch on deck which had a faulty gasket. The drain pipe for the lazarette (to the engine room) was plugged and this water could not be removed except by bailing or with a portable pump.
- The bait freezer was not operational and was also taking on water through a faulty gasket on the water-tight hatch. The suction pipe going to the seawater manifold in the engine room that is used for pumping out the bait hold was plugged up; thus the hold could not be pumped except by bailing or with a portable pump.
- The refrigeration system for the two fish holds was not working. The condenser pump for cooling the refrigerant was frozen up and the system had a freon leak. This pump also had the function of supplying water to the heat exchanger for the hydraulic system. Without the pump the hydraulic system ran very hot, up to 200° F (93° C).
- The stuffing box, or shaft gland, for the main shaft was leaking. The engine room was constantly taking on water as a result of this. After the generator broke down there was no way to pump out the engine room except with a portable pump run from a portable gasoline (petrol) generator.
- The 12 volt bilge pump was not working.
- The autopilot was not working. This was a result of the lazarette flooding; the rudder-angle- indicator sending unit, or rudder follower, in the lazarette was flooded and inoperable. The autopilot will not function without a signal from the rudder follower.
- Wheelhouse gauges did not work. Main engine and generator oil pressure and water temperature, gear-box oil pressure, and engine RPM could not be monitored from the wheelhouse, or from the engine room.
- The main engine could only be started from the wheelhouse and stopped from the flybridge station. The start-stop buttons in the engine room did not work, the stop

button in the wheelhouse did not work, and the start button on the fly bridge did not work.

- Alarms did not work. None of the alarms, including main-engine oil pressure, main-engine water temperature, generator oil pressure, generator water temperature and bilge high water, worked. Some of them were malfunctioning and some had merely been disconnected.
- The engine room blower did not work (*NFC Waab* did not come from the factory with an engine room exhaust blower. It had been installed in FSM at a later date, but was not working).
- The hydraulic steering system leaked in the engine room.
- The colour video plotter was off the boat and in a shop for repairs. The crew reported that it had been sent away several months previously.
- The galley refrigerator did not work. Perishable foodstuffs had to be stored in the fish hold on ice.
- The galley stove worked on only one of four burners and the oven did not work.
- The wheelhouse air conditioner needed servicing (charging).
- Deck lights did not work. The port side navigation light was out.
- The anchor winch did not work and there was no anchor or any way to anchor the vessel.
- The boom winch did not work. All hydraulic fittings to the boom winch were badly corroded and none of the blocks in the boom rigging worked.
- The leader cart for storing floatlines did not work. All hydraulic fittings on it were corroded and some were missing.
- All hydraulic fittings and hoses going to the LP reel needed replacing. In fact, the entire hydraulic system on deck needed an overhaul. There were several metres of monofilament mainline wrapped around the shaft on the reel. If left, this would have eventually ruined the main seal on the reel motor.
- The line setter needed several new parts, including drive wheel, line guides and all rubber parts.
- The outside steering station on the main deck (used during line hauling) was inoperable. The engine control and the remote steering did not work.
- There was only one large-scale chart of FSM waters in the wheelhouse, and this had fallen into the engine room bilge and was oil-stained and unreadable.
- There were no instruction or parts manuals for the main engine, generator set, or refrigeration system. These manuals were not on file at NFC's office.
- There were not many spares (engine parts, nuts, bolts, hose clamps, packing, etc. on board and the spares that were present were in disarray and not easy to find. This was true of tools also.
- The general appearance and condition of the vessel indicated that routine maintenance, including cleaning, had not taken place for at least a year and probably longer. The condition of the wheelhouse was such that it was a bordering on being a health hazard to those living on board. The wheelhouse and galley were badly infested with cockroaches and flies and there were rats living on deck. The engine room, too, had not been cleaned for some time. Oil leaks from the generator, main engine and steering system had coated almost every surface in the engine room with oil. There were oil-soaked rags on the floor boards, on the shelves, and in the bilge.

REPAIRS AND MAINTENANCE WORK CONDUCTED OR SUPERVISED BY THE MASTERFISHERMAN

- Pumped out lazarette and repacked rudder post. Cleaned out drain pipe to engine room. Replaced gasket on water-tight hatch.
- Replaced rudder follower in lazarette. Autopilot worked after this but fluxgate compass in wheelhouse needed to be re-mounted and adjusted.
- Repacked shaft gland.
- Replaced 24 volt main engine starter motor with proper 12 volt motor. The first time this was done a second-hand motor that was taken from *NFC Kosrae* was used. It malfunctioned during the third set of the first fishing trip and *NFC Waab* had to return to port. A new starter motor was installed before the second trip was made. (This was done by a local engineering company.)
- Installed new 12 volt submersible bilge pump.
- Repaired seawater manifold in engine room. All check valves were removed and new hoses added. The main fish hold and the bait freezer could now be pumped.
- Repaired engine room exhaust fan and re-installed it in outside stack.
- Installed new float switch for bilge high-water alarm.
- Repaired alarm system.
- Replaced leaking fresh-water pressure tank in engine room.
- Installed new quartz lights on deck and on davit.
- Installed new side lights (red and green navigation lights) on wheelhouse.
- Installed new gaskets on water-tight hatches going to bait freezer, and shaft tunnel in fish hold.
- Repaired small hatch (access) on fish hold with foam and fibreglass.
- Repaired outside station. Replaced transfer switch for engine controls and moved Wagner jog steering switch from wheelhouse.
- Replaced all hydraulic hoses and fittings on deck going to reel, including a new control valve for operating the reel.
- Removed non-functioning hydraulic leader cart, anchor winch and boom. Blanked off all unused hydraulic ports.
- Installed temporary seawater hose to heat exchanger for hydraulic system.
- Gave boat a thorough cleaning and organising, including repairing numerous small items, such as cupboard doors, stove elements, lights, etc.
- Organised all parts drawers, inventoried all spares and tools and purchased replacements as necessary.
- Replaced all safety equipment as needed, including life raft, etc. and fire extinguishers.

- Replaced first aid and medical supplies, as follows: bandaids, surgical tape, sterile gauze pads and rolls, antiseptic wipes, suture kits, butterfly bandages, elastic bandages, scissors, tweezers, thermometer, eye patches, eye wash, antiseptic ointment, anti-fungal ointment, antiseptic solution, antibiotics (doxycycline), pain killers (Panadeine), triangular bandages, and hydrogen peroxide.
- Replaced wheelhouse chart with large-scale chart of FSM (North Pacific Ocean. Micronesia. Trust Territory of the Pacific Islands. [1969]. Chart no. 525. Prepared and published by the Defence Mapping Agency Hydrographic/Topographic Center. Washington, D.C. USA). This chart was used as a reference for project fishing operations.
- Additional items were purchased for the wheelhouse including binoculars, pens, pencils, compass dividers, notebooks, torch, cutlery, dishes, pots and pans, and padlocks for security.

**LIST OF SPARE PARTS THAT NEED TO BE MAINTAINED BY NFC
FOR *NFC WAAB***

- Remote steering for Comnav Marine 2001 Autopilot (211 Remote)
- Wagner jog stick
- Rudder angle indicator for Comnav 2001 Autopilot
- Medium-duty rudder follower for Comnav 2001 Autopilot
- Modutec hertz meter for AC panel (55 hz 120 volts)
- Two 25 x 1300 mm (1 in x 52 in) hydraulic hoses with female JIC swivel fittings at each end for oil cooler and gear box on the main engine
- Fuel pump for main engine (lifting pump)
- Fuel lines for main engine (injector lines)
- One set of injectors for main engine
- Starter for main engine (part no. 8C3593, Delco-Remy no. 1993807 12/CW 91L18)
- Alternator for main engine
- Spare belts for alternator
- Coolant circulation pump for main engine (water pump)
- Oil pressure sender and gauge (electrical) for main engine
- Tachometer sender for main engine *

* When ordering parts for main engine be sure to include all engine numbers:

- 3406B Caterpillar,
 - serial number 4TB03087,
 - modification number PL 4856–07,
 - arrangement number 4W 3810,
 - performance specifications 0T4481, 322 horse power.
- Spares for new generator set motor should be similar to those for main engine: starter, water pump, fuel pump, injectors, injector lines, alternator, belts, and oil pressure and water temperature gauges. When new generator set motor arrives, all numbers should be recorded and kept on file for future ordering of parts.
 - Spare belt and diaphragm for fresh water pump
 - Switch and knob for oven
 - Sea-surface temperature monitor (the one on *NFC Waab* is malfunctioning and should be repaired or replaced.)
 - Colour plotter (one year is too long to wait for a repair or get a new one.)
 - Anchor capstan (catalogue [Anon., undated] has one it calls a 'hydraulic gypsy winch', p. 50). This could be connected to existing hydraulic lines on the bow, which would be

less expensive than repairing the old anchor winch. An isolation valve would have to be put into the line as on the line setter and LP reel.

- Anchor, anchor chain and anchor rope. The boat at present has no anchoring system.
- Freeman 0.375 m (15 in) round hatch (this hatch is for inspecting the intermediate shaft bearing. One clamp on it is broken and it does not seal).
- Spare seawater pump for deck wash down (similar to new pump for refrigeration condenser but a bit larger, two to three horse power constant duty, three phase with 50 mm (2 in) suction and discharge ports).
- User manuals for all equipment on boat including main engine, generator set, refrigeration, hydraulic steering, and all electronics.
- New battery for 406 EPIRB or new EPIRB (emergency position indicating radio beacon).

Filters

NFC Waab now has a complete set of filters* to last for the rest of the year, but the filter numbers should be kept on file so that replacements can be ordered easily. Filter numbers are as follows:

Main engine

- oil – Fram PH-3335
- primary fuel – Racor 2040 or Fleetguard FS-1207
- secondary fuel – Fram P-3376
- air filter element – 4N0015 UMNKDR*
- crankcase emission filter – Nelson-Winslow 88365A*, gasket no. 098403*
- breather pipe filter – 9Y2988*

* Assuming that the above four items were ordered as requested.

Generator set (old numbers – new engine should be checked to be sure if they are the same or equivalent)

oil – Fram PH-3567
primary fuel – Racor 2040 or Fleetguard FS-1207
secondary fuel – Napa 3386

Hydraulic steering

- Fram P-1653A

Hydraulic system

- Fram PH-3587

