OBSERVATION REPORT ON TUNA PURSE SEINE FISHING OPERATION IN EASTERN INDIAN OCEAN ONBOARD R/V NIPPON MARU

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TD/RES 104

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INTRODUCTION

Tunas frozen are one of the major imported marine fish in the Southeast Asia region. More than 400,000 tons, cost 550,000 U.S. Dollar, had been imported in 1997 (Fisheries Statistic Bulletin of South China Sea region, SEAFDEC 1997). Almost of them are raw materials for fish cannery industry. Two countries in South China Sea, Taiwan and the Philippine, have potential to harvest tuna resources in Pacific Ocean. Even though the trend of the import has no sign to rapidly increase, but the quantity is remain high. In order to reduce maintain long term supply for frozen tunas from foreign vessel, establishment of tuna fishing fleet is necessary for this region. As well as the development on tuna purse seine fishing techniques included with fishing ground information and studying of new tuna resources are very important.

Indian Ocean is one of the top fishing ground in the world tuna fishing. Fishing ground is not too far for countries in the Southeast Asian region to try for tuna fishing. The search and study of tuna and skipjack abundant in Indian Ocean shall be advantages for the tuna fisheries regional development plan in the future.

Southeast Asian Fisheries Development Center (SEAFDEC) is the international organization that takes the lead for high sea fisheries promotion. In 1992 SEAFDEC has constructed new training/fishing vessel for tuna purse seine from Japan, under supported from Japanese government. She delivered to SEAFDEC/TD in 1993. Before the arrival of M/V SEAFDEC, Japan Marine Fisheries Resource Research Center (JAMARC) and Southeast Asian Fisheries Development Center (SEAFDEC) started to set up the collaboration program. The objective of program is, to develop SEAFDEC purse seine technician staffs by assign a staff to observe/train on board R/V Nippon Maru in 1993. Detail is appeared in the Observation Report on Tuna Purse Seine Fishing Operation around Seychelles Waters onboard R/V Nippon Maru (Aussanee Munprasit and Isara Chanrachkij, 1993)

The second establishment of the collaboration between JAMARC and SEAFDEC has been done since 1999 by Mr. Sumio Hirogawa under supervise by Mr. Kazuo Shima President of JAMARC and Mr. Shogo Sugiura, The deputy Secretary General of SEAFDEC. The first activity of the collaboration was conducted in October 2000. Fishing operation assistant by R/V Nippon Maru was done, to set 5 pieces of SEAFDEC Payao in Indian Ocean. The second activities has been included the fishing information transfer and staff development program. The collaborations are conducted by R/V Nippon Maru, the research/fishing vessel. The vessel had operated skipjack and tuna purse seine in Indian Ocean. Period is from 28 December 2000 to 19 April 2001. The fisheries information exchanging was established between M/V SEAFDEC and R/V Nippon Maru during fishing season, from the end of January to the end of March. The staff development programs were initiated by two sections.

1. Fishing technology improvement. This activity was conducted from 28 December 2000 to 28 February 2001 by assigning a fishing gear staff to train/Observe the fishing operation in R/V Nippon Maru. SEAFDEC/TD assigned Mr. Isara Chanrachkij, assistant master fisherman to train under supervise by Mr. Takehiko Akiyama, fishing master and Mr. Michiro Imai Captain of R/V Nippon Maru.

2. Marine engineering technology improvement. Activities were conducted from 6 March to 19 April 2001 by assigning an engineer staff had trained/Observed onboard R/V Nippon Maru. SEAFDEC/TD assigned Mr. Wirote Laongmanee, 2nd engineer of M/V SEAFDEC to train under supervise by Mr. Takehiko Akiyama, fishing master and Mr. Mutsuo Abe Chief Engineer of R/V Nippon Maru.

This report is comprised with the daily activities, important and key information of tuna purse seine fishing techniques particulary during period from 28 December 2000 to 28 February 2001. Although some informations and techniques are not able to describe by the dialogues, the experience from training in R/V Nippon Maru shall be tools for M/V SEAFDEC in order to achieve the smooth and safety operation in the future.

ACKNOWLEDGEMENT

Authors would like to express sincerely appreciation to Mr. Kasuo Shima, the president of JAMARC who kindly approved on the requesting of SEAFDEC/TD for these training/observation, Mr. Sumio Hirogawa, Director of 2nd Division of Department of Development, who kindly arrange the training schedule and General Manager of Far-sea Purse seine Fishing Co., Ltd. to approve SEAFDEC staff training onboard company's vessel.

The special citation has been presented to Mr. Shogo Sugiura, The Deputy Secretary General of SEAFDEC who established and mobilized the cooperation with JAMARC and thank you Mr. Panu Tevaratanamaneekul who full-support this program. The truly appreciation has also expressed to Mr. Aussanee Munprasit, SEAFDEC/TD fishing expert on tuna purse seine who is the pioneer trainee onboard R/V Nippon Maru. He had informed authors, how to live onboard purse seiner in 60 days without any port of call and Mr. Pratakphol Prajakjitt who illustrated the net diagram of this report.

Isara Chanrachkij (1)
Wirote Laongmanee (2)
Masao Ishii (3)

Figure1: Authors, i.e. Isara Chanrachkij (Right) Wirote Laongmanee (Left)

(1) Fishing gear technologist, Capture Fisheries Technology Division, SEAFDEC/TD
(2) 2nd Engineer (Retired) of M.V.SEAFDEC, SEAFDEC/TD
(3) JICA expert on tuna purse seine fishing operation, Master fisherman (Retired) of Taiyo Fisheries Co., Ltd.

PURSE SEINER R/V NIPPONMARU

R/V Nippon Maru is a modern purse seine fishing and research vessel. She is American purse seine type, port side (left-side turned) surrounding style. She was constructed in Miho shipyard, Shimizu, Japan and delivered in same year, 1986. Her owner is Japan Far-sea Purse seine Co., Ltd., Japan. She is a 1,788 GT vessel, 78 meters in length, 14.0 meters in breadth and 8.27 meters in depth. Her draft is 5.5 meters. The maximum speed is 17 knots and service speed is 14 knots. The propelling power is transmitted from a main engine, Asasaka 3800 PS and 2 electric generators with 900 P.S. each. The accommodation space is available for 22 people. On this cruise, 20 members were attended onboard, under the commanding by Fishing Master Mr. Takehiko Akiyama, Captain Mr. Michiro Imai and Chief Engineer Mr. Abe Mutsuo. R/V Nippon Maru is one of the highest efficiency purse senier in Indian Ocean. She is completely equipped with powerful deck machinery, modern navigation and fishing aid instruments,

1) DECK EQUIPMENT

1.1) One skiff boat installed with Main engine Yanmar 650 PS.

1.2) Two working boats with main engine Mitsubishi 360 PS, equipped with VHF transceiver and a Tele-Echo sounder system

1.3) One main mast has installed with a double steps crow's nest at the top. Main mast is installed with a main boom. A power block with net gripping system is installed at the tip of main mast. Three winches are set at main boom. The first is double winch. It is 8 tons pulling force winch. It is used for hauling skiff boat and bunt part of purse seine net if there are fishes more than 80 tons in the bunt net. The second is single block winch. It is 3.5 tons pulling force winch. It is used for bunt part if there are fishes about 50 tons in the bunt net. The last one is cargo winch. It is 2 tons pulling force winch. It is used for hauling the bunt part if there are fish less than 20 tons in the bunt net. This winch usually uses as utility winch, fish unloading and loading some equipment from shore to ship. There are two fishing booms, starboard side and port side. Each fishing boom has a cargo winch installed. The cargo winch has 2 tons pulling force. It is used for hauling the bunt part together with the cargo winch at main boom. This winch also uses to be utility winch, fish unloading and loading some equipment from shore to ship. There are other six accessory booms with a cargo winch installed at each boom. Cargo winch has 2 tons pulling force and used from utilities work e.g. unloading catch, heave up Payao, etc.

1.4) One system of Mitsui-Marco power block with grip, pulling force 5.5 tons, is installed to be main net haulingdevice.

1.5) One system of float shifter (Aba-flex), is installed for arranging the float at the float space. The using of float shifter can reduce numbers of crew to handle for the float arrangement.

1.6) One system of Mitsui-Marco, is installed for hauling purse line and towing warp. Uurse winch comprised with three drums, 2 main drum of purse winch has 14 tons pulling force. The towing warp drum has 6 tons pulling force.

1.7) One Purse davit with three sheave blocks and one auxiliary winch for releasing the double roller purse rings form the purse line.

1.8) Three Mitsui-Marco capstan winches, a fore deck capstan with 3 tons pulling force is used for handle and secure the float line at fore deck. The other two capstans are installed at the working deck. Each one has 4 tons pulling force.

1.9) Two Mitsui-Marco choke-winches, each winch have 4 tons pulling-force. Both of choke winches are used for pulling the bunt up before scoop the fishes and secure the skiff boat at the slipway while vessel is encountered strong gale and rough sea during the navigation.

1.10) The skiff boat towing warp winch, which has 3.5 tons pulling force and towing line storing drum, which has 2 tons pulling force. Skiff boat towing warp winch is used for adjusting warp during purse seine operation. The towing line drum is used for storing towing rope. They are installed at foredeck part.

1.11) One hydraulic skiff boat release hook, used for launching skiff boat while fishing operation is started. The modern purse seiner has not employed and crews to hit a hammer at the stopper for launching skiff boat.

2) NAVIGATION INSTRUMENT

2.1) Gyro and Magnetic compass

2.2) Auto pilot system

2.2) Navigation RADAR range 64 NM. (Furuno)

2.3) G.P.S. system (Furuno GD-500, GD-70Mk2)

2.4) Satellite Navigation System (Furuno FSN-70 with course plotter Furuno FP-170)

2.5) Navigation plotter display CD-141 with controller GD-2200

2.6) Navtex receiver system (JRC-NRC-300A)

2.7) NOAA Weather Satellite Image Receiver for weather forecast (Furuno)

3) RADIO COMMUNICATION AND GMDSS

3.1) SSB transmitter and receiver

3.2) VHF radio transceiver

3.3) Satellite communication system (Telephone and facsimile)

3.4) Two radio direction system for detecting radio direction signal from radio buoys. (Koden and Taiyo Munsen)

Figure 2: Navigation-aid instruments on the bridge of R/V Nippon Maru
(Left to right: NOAA satellite receiver display, Navigation radar display, JRC bird radar display, Furuno bird radar display, Color plotter display)

4) FISHING AID INSTRUMENT

4.1) Two bird-Radar (Furuno FR-830DS, JRC JMA-7736)

4.2) Two scanning Sonar (Furuno CSH-81-94 High frequency, 94 kHz, CSH 20-4 Medium frequency, 40 kHz.)

4.3) One Color Video Sounder (Furuno FE-1500)

4.4) One paper Video Sounder with Dual-frequency mode 28/50 kHz (Furuno FE-822S), is used for receiving fish school images from echo sounder of working boats transmitted through the radio signal.

4.5) Two tele-paper echo sounder (Furuno TS-32 Mk-3)

4.6) One Doppler current indicator (Furuno CI-30)

4.7) One Net sonde (Furuno FNZ-Mk3),

5) RESEARCH and OCEANOGRAPHIC INSTRUMENT

4.1) Oceanographic winch driven by Hydraulic system

4.2) STD (Salinity, Temperature and Depth sensors)

4.3) Expendable Bathythermograph (XBT)

4.4) Expandable Conductivity Temperature ands Depth sensors (XCTD)

6) ENGINE SYSTEM

6.1) Main Engine

R/V Nippon Maru has installed a main engine is Akasaka Diesel engine Model AH40AKD

Output:	3800 PS
Revolution:	340 RPM
Type:	4-stroke cycle engine, direct injection
No. of cylinder:	6 cylinder
Cylinder bore:	400 mm
Cylinder stroke:	640 mm
Cooling type:	Indirect cooling Injection pressure 250 kg/cm^2
Piston velocity:	7.25 m/s

Fuel oil consumption 141 g/psh at 85% load (referred from operation manual)

Injection firing order 1-4-2-6-3-5

Main engine has installed with a set of Turbo-charger of IHI model VTR354-11 L 141 /TO 11 and marine reduction gear of NICO model MGN 12042Z-46 ratio is 2.44/2.66.

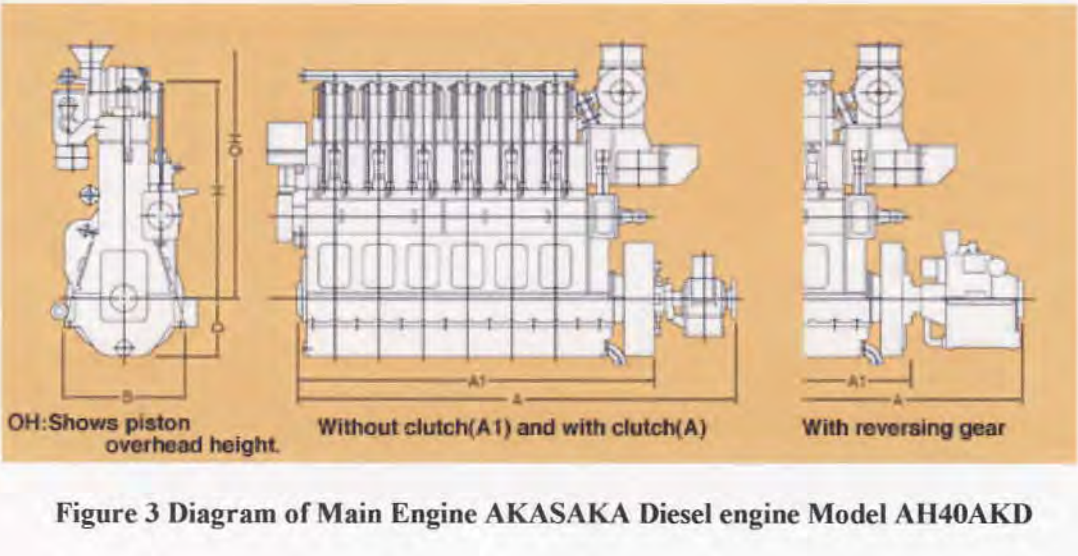

Figure 3 Diagram of Main Engine AKASAKA Diesel engine Model AH40AKD

6.2) Auxiliary Engine and Generators

R/V Nippon Maru had installed 2 sets of auxiliary engine and generators as Yanmar diesel engine, model M-200AL-ET.The specification of auxiliary engines is

Output:	900 PS
Revolution:	900 RPM
No. of cylinder:	6 cylinders
Engine type:	4-stroke cycle engine, direct injection cooling type,

Indirect cooling water system

Injector pressure:	280 kg/cm^2
Cylinder bore:	200 mm
Cylinder stroke:	260 mm
Piston velocity:	7.80 m/s
Displacement:	49.01 liters

Most of auxiliary engines are installed with Turbo charger IHI-BBC model VTR 161. Specification of generators

Brand name:	SHINKO ELECTRIC CO., LTD
Model:	TVLI-A-806
Output:	750 KVA 445 Volt
	973 Amp 60Hz, 3

Phases

Revolution: 900 RPM

The two set of generators should operate parallel together when fishing operation time or when refrigerator running for brine cooler. During the cruise, two of these auxiliary engines and generators were daily maintenance and period maintenance

Figure 4: YANMAR DIESEL ENGINE, model M-200AL-ET6.3

6.3) Refrigeration Compressor

The refrigeration system is very important for any range fishing vessel, almost of developing country still using ice and salt for fish storage and food stuff, which often spoil because of less taking care and inappropriate technique. R/V Nippon Maru had installed refrigerators for fish handling, provision handling and air conditioner. There are 2 types of refrigerator for fish handling had installed on R/V Nippon Maru

Figure 5: Screw type compressor

6.3.1) Screw type compressor

A screw compressor is a positive displacement machine that using a pair of intermeshing rotors instead of a piston to produce compression. Rotors compose of helical lobes affixed to a shaft. One rotor is called "male rotor" and it will typically have four bulbous lobes.* The other one is "female rotor", this has valleys machined that match the curvature of the male lobes. Typically the female rotor has six valleys*. This means, one revolution of the male rotor, the female rotor will move to 240 degree while male rotor must rotate one and half cycle for completing one female rotor cycle.

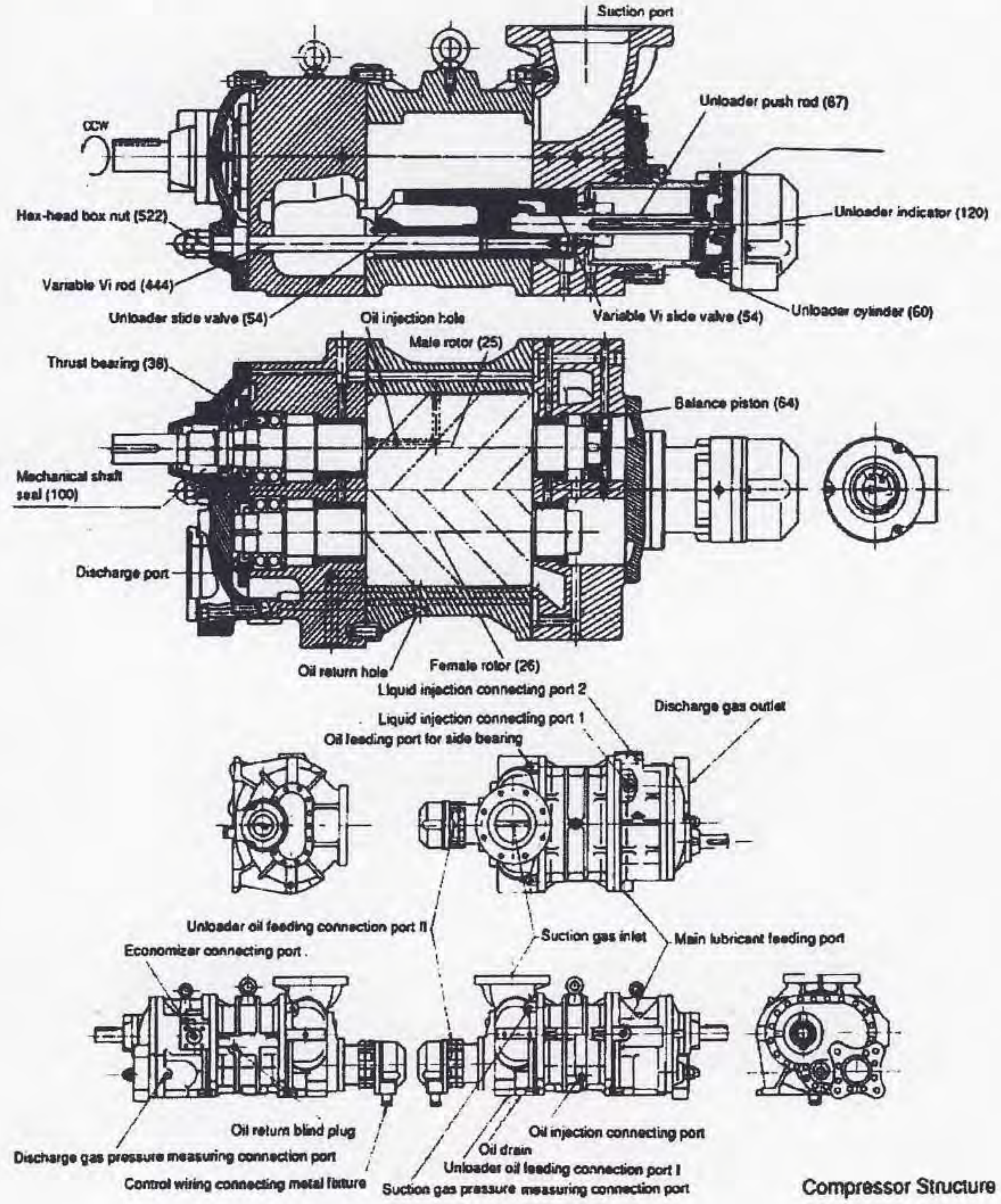

Figure 6: Diagram of compressor

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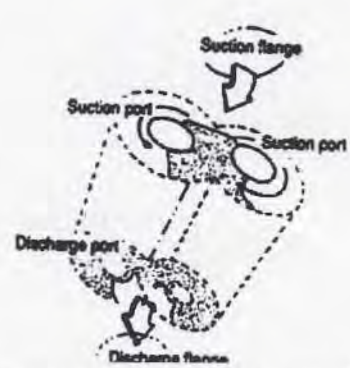
*The number of lobes on the male and female rotor is various from one compressor manufacturer to the other. However, the female rotor will always have numerically more valleys than the male rotor has lobes. The male rotor is driven by either an electric motor or an engine. Because of the number of male lobes, there are four compression cycles per revolution which means, the resulting compressed air has small pulsations compared to a reciprocating compressor. By the time that the compressed air leaves the package, it is to all intents and purposes pulsation free.

Compression Mechanism Suction Stage

As shown in Fig. A and Fig. B, the rotors of different lobe shape mesh and the clearance between the M rotor lobe, F rotor groove and compressor casing increases gradually from the suction side as the rotors turn. When the clearance reaches the maximum as the rotors rotate further, this is sealed by the walls at both ends of the rotor and becomes independent



Rotor rotation &Compression cycle

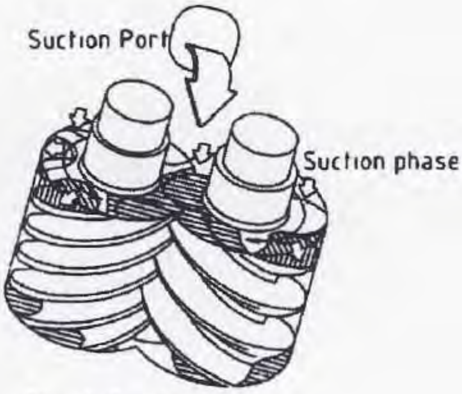


Fig .A Suction stage

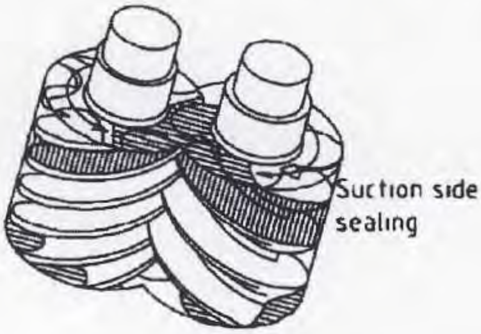
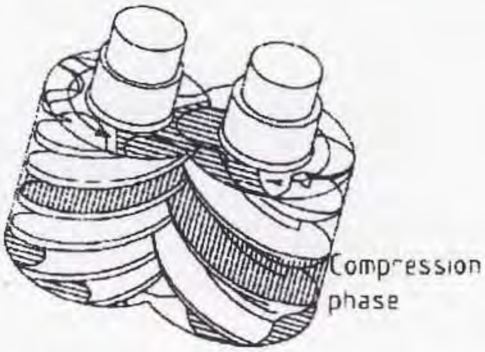
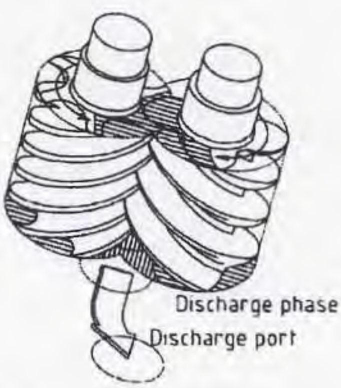


Fig .B Suction side sealing

Compression Stage

As the rotors turn further, the volume between the lobes is decreased, compressing the trapped gas, while the sealing line moves toward the discharge side.





Discharge Stage

The volume between the lobes is decreased to the designed Vi, the clearance between the discharge port and rotors is linked and the gas is pushed out to the discharge side. Specification of screw type compressor onboard R/V Nippon Maru

Brand name	MYCOM of Mayekawa MFG.CO., LTD.
Model	F-160LUD-M
Revolution	3550 RPM
Capacity	745 m3/h 60.9 JRT (TC/TE = 35/-25) 113.8 BKW

Motor 140KW x 440V x 2P x 60Hz x 3550RPM

Main proposes for screw type compressor is cooling down brine cooler because of the high capacity and easy to operate and maintenance. The screw type can also operate for fish storage if necessary.

6.3.2) Reciprocating compressor type

A reciprocating compressor is a positive displacement machine that uses a piston contained within a cylinder to produce compression. The piston is traditionally round shape, because it is easier to manufacture round things than square things. The piston traverses the cylinder, sucking in atmospheric air at one end of its stroke, and then compressing the air when it reaches the other end of its stroke. Reciprocating compressors may have more than one stage of compression (single stage), the other case they are called two stages, three stages or the like. R/V Nippon Maru has installed 2 sets of reciprocating compressor. Specification of each set as follow;

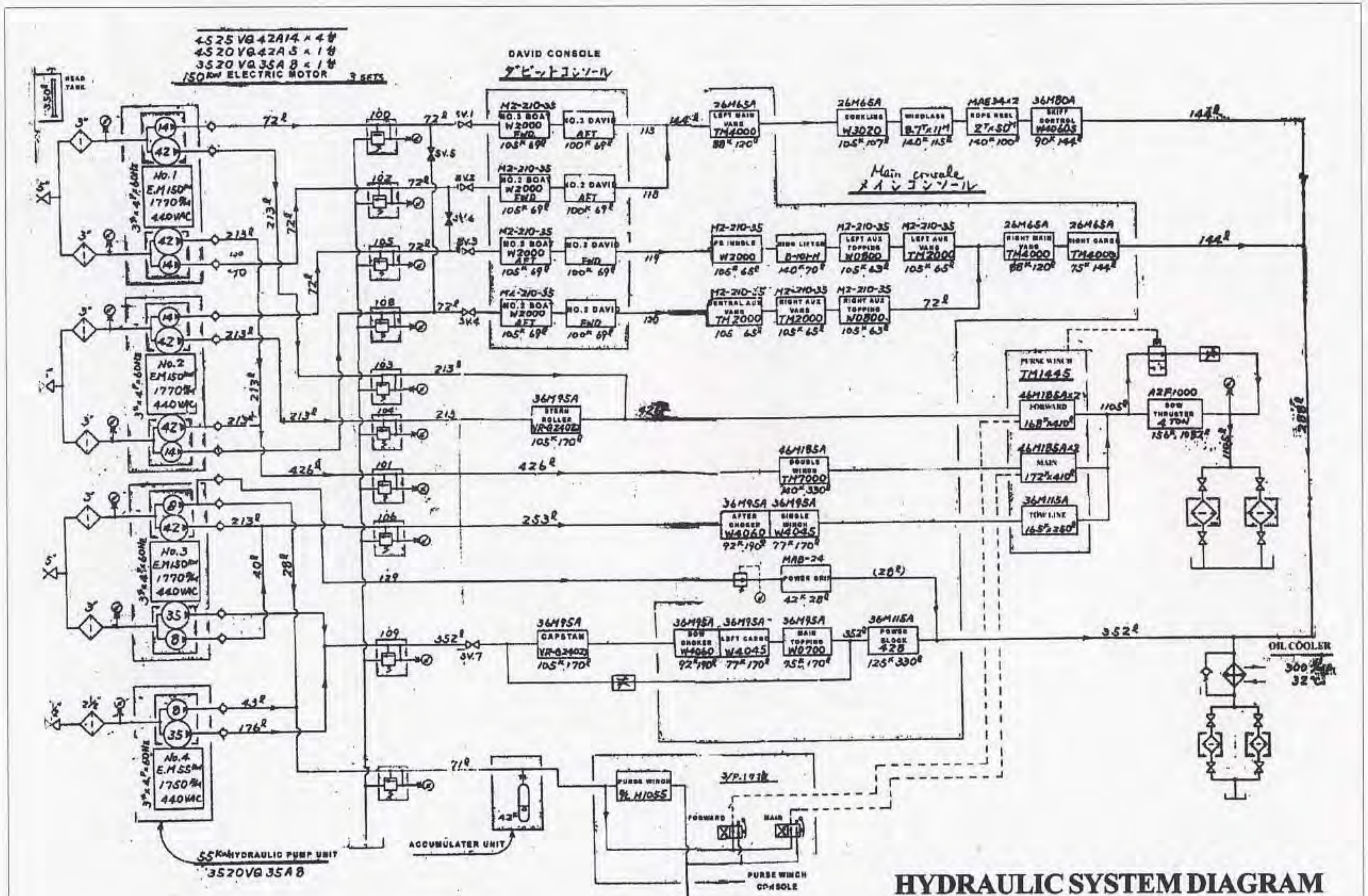
Brand name	MYCOM of Mayekawa MFG.CO., LTD.
Model	F62B
Revolution	1200 RPM
Capacity	764.5 m^3/h 46.6 JRT 88.8 BKW
Motor	130KW x 440V x 6P x 60Hz x 1200RPM and

Brand name	MYCOM of Mayekawa MFG.CO., LTD.
Model	KM62B
Revolution	1200 RPM
Capacity	16.2 JRT 50.1 BKW
Motor	75KW x 440V x 6P x 60Hz x 1200RPM

According to amount of catches in fish holds and brine tanks, engineers will be considered which machine should be run. Sometime a machine is under maintenance status, another has to be operated in stead to keep fish with the appropriate temperature.

Figure 7: Mycom Compressor for Refrigerator System

http://mycomcanada.com



HYDRAULIC SYSTEM DIAGRAM

Table 1: Detail of R/V Nippon Maru

Ship owner	Japan Far-sea Purse seine Fisheries Co.,Ltd
Port registry	Tokyo
International Maritime Organization Registry	8603755
Call sign	JAWT
Gross tonnage	760 GT
International tonnage	1788 GT
Net tonnage	657 GT
Date of launch	June 1968
Date of delivery	August 1986
Place of birth	Miho shipyard, Japan
Length (m)	78.0
Breadth (m)	14.0
Depth (m)	8.27
Main engine (PS)	
1 × Diesel engine AKASAKA	3800 ×380 rpm
Reduction Gear Ratio	2.44:1
Propeller 5 blades	
Diameter (m)	4
Pitch (m)	3.93
Service speed (Kt.)	15.1
Maximum speed (Kt.)	17.0
Fish hold (Ton)	1508.88
Fuel oil tank (Ton)	701.71
Fresh water tank (Ton)	78.97
Lubrication oil tank (Ton)	31.51
Completement (person)	22

Figure 8: R/V NIPPON MARU in Indian Ocean
(Photo by I. Chanrachkij, 1996)

Figure 9: Deck Equipment and Machineries on R/V NIPPON MARU I

1. Skiff boat towing warp drum
2. Anchor winch
3. Capstan winch
4. Skiff boat towing warp winch
5. High bridge deck
6. Remote control wheel console
7. Fishing instrument boom
8. Fishing gear space
9. Inmarsat dome
10. Funnel
11. Sea crane for Payao
12. Upper deck
13. Derrick boom
14. Working boat
15. Craw nest
16. Main control console
17. Capstan winch
18. Purse davit
19. Ring holder
20. Purse winch
21. Fish hold
22. Working deck
23. Hopper
24. Main boom
25. Choke winch
26. Towing warp guide roller
27. Net space
28. Skiff boat holder
29. Power block
30. Float line shifter
31. Skiff boat
32. Slip way
33. Cargo boom

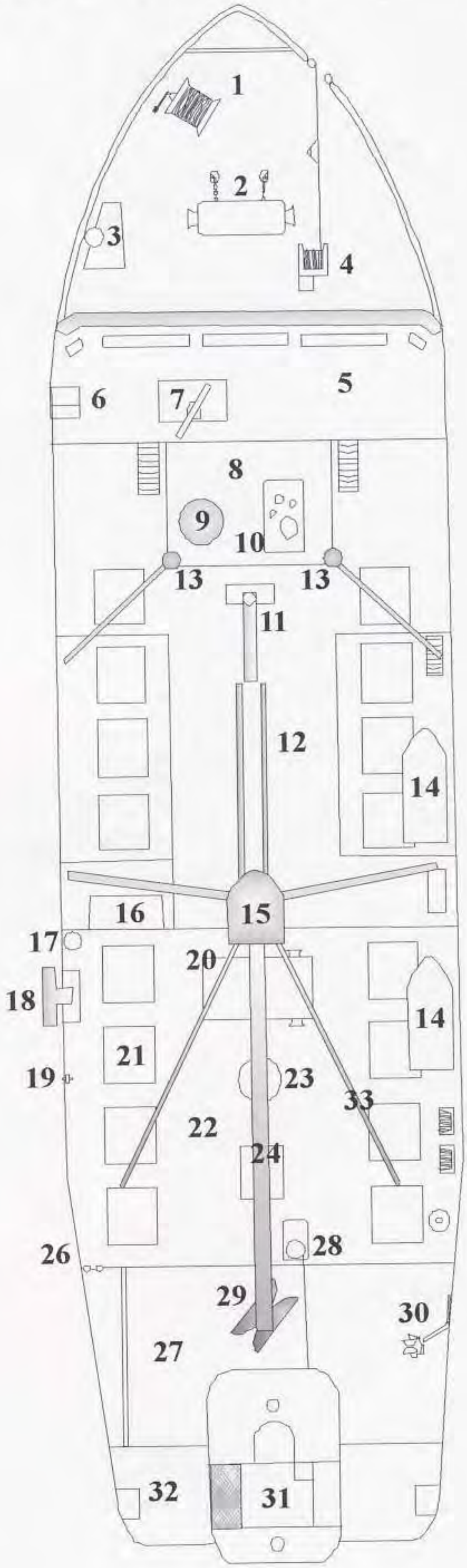


Figure 10: Deck Equipment and Machineries on R/V NIPPON MARU II

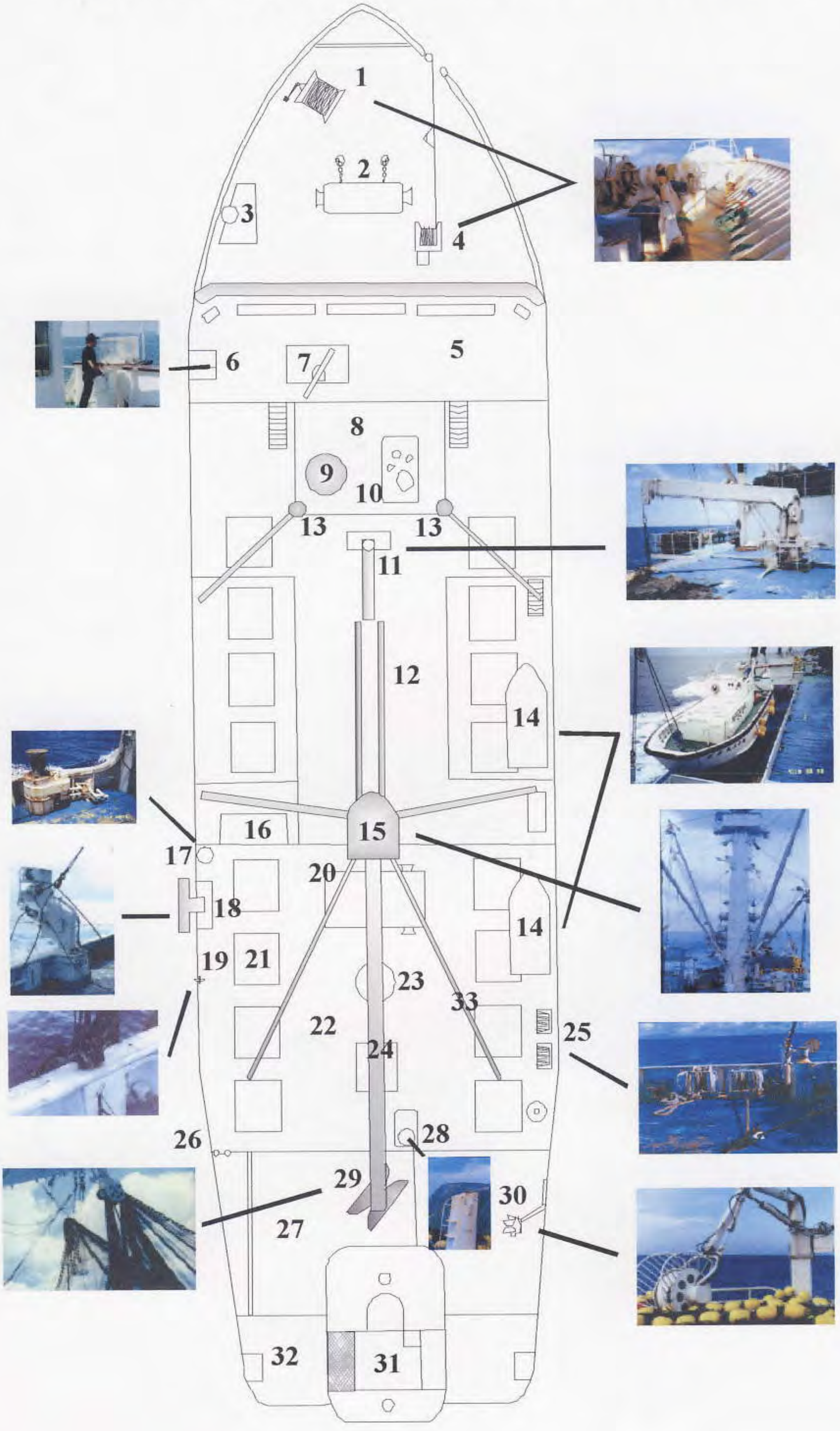


Figure 11: Deck Equipment and Machineries on R/V NIPPON MARU III

Top left: Purse davit
Middle left: Main mast with craw's nest
Low left: Skiff boat releasing hook
Top right: Purse winch
Middle right: Utilities Capstan winch
Low right: Float shifter (Aba flex)

Figure 12: Deck Equipment and Machineries on R/V NIPPON MARU IV

Top left: Working boat
Middle left: Control of working boat winch
Low left: Skiff boat towing warp
Top right: Working boat with davit
Middle right: Choke winches
Low right: Utility crane

PURSER SEINE NET

R/V Nippon Maru has a tuna & skipjack purse seine net. The purse seine net is constructed by Teito Seiko Co., Ltd. Japan. The length of float rope is 1505 m. the length of sinker is 1748.7 m. The maximum net depth after hanging is about 220.5 m. Material of the main body net is nylon knotless net and tetrolon knotless net. The Hi-dex (Polyethylene) net is assembled for the selvage part. The thick twine of nylon net sheets is used for sub-selvage part. The float line material is Dan line (Polypropylene), fixed with synthetic fiber floats. The sinker line of tuna purse seine is galvanized chain. There are various sizes of chain constructed. The net construction is described follow:

Float and float rope

Purse seine net of R/V Nippon Maru is fixed with 2 sizes of float, the EVA-M-700 (Buoyancy force 7000 g.) and EVA-M-500 (Buoyancy force 5000 g.) EVA is synthetic material, stands for *Ethylene Vinyl Acetate*. EVA floats are selected because float must be served the high compression from the power block with power grip and float line shifter (Aba flex). However the pressure resistant of EVA material is lower than other materials, e.g. ABS: *Acrylonitrile ButadieneSstyrene* (Pressure resistant is up to 300 m) EVA floats are deformed by pressure if the floats submerse under sea surface more than 100 m. Total numbers of floats are 4,991 pieces with 25 tons buoyancy force. Details of float fixed with purse seine net are described by portion as followed;

From rim of net, triangle net parts (Side selvage) to portion No.1, is fixed with EVA M-700 (Buoyancy force 7000 g) 10 floats are tightened with float line length 3.02 meters. Total numbers of floats are 50 pieces (Float length of this part is15.0 m.)

Portions, No.1 to No.6, are fixed with EVA-M-700 (Buoyancy force 7000 gram). 9 floats attached within float line length 3.02 meters. Total numbers of floats are 630 pieces. Net portions, No.1 to No.2, are served as bunt part so that it needs very high buoyancy force to prevent the net submersible during bunt hauling and fish scooping. Portions, No.1 to 6, are constructed by the big size of twine net so the weight is heaviest, compare with the other net portions.

The other trouble found at net portions No.1 to No.6 are occurred by float submersible during purse line hauling. Same trouble as net portions No.1 to No.6, net portion No.23 to No.26 are fixed with EVA-M-700 as well. Net portion No.23 to the end of net has always trouble from float submersible during purse line hauling and towing warp hauling.

Net portions, No.7 to No. 9, are attached with the highest frequency of float compare with the other net part. There are six EVA-M-700 floats fixed in 1.5 m. Total numbers of floats in three portions are 630 pieces. R/V Nippon Maru always shoot the net follow current direction. After complete the net circle, these portions, No.7 to No.9, are the wall to against the current flow. These portions are easy to submerse during purse line hauling or when the current is fast. That is the characteristic So that these three portions have highest buoyancy force per portion of the complete net.

Net portion No.10 and No.11 is fixed by float EVA-M-500 same number as Net portions No.7 to No.9, 630 pieces. But buoyancy force is lower than net portion No.7 to No.9 because float is EVA-M-500 (Buoyancy force 5000 gram) These portions also required high buoyancy force because they have change to submerse under surface by sea current. Total float numbers of portion No.10 and No.11 are 455 pieces.

The main body of net, from portion No.12 to No.22 is fixed with EVA-M-500. The total float numbers are 2275 pieces. From net portion No.10 to No.22 is the longest part of the complete net. The floats, EVA-M-500, can reduce the cost of the net and more convenient for arrangement during fishing operation. The net panels, which fixed at net portions No.12 to No.22, are light weight. Net material is made from the small twine size and big mesh size (details in main net part). So that high resistant from current flow does not impact to these net portions.

Figure 13: Synthetic fiber floats EVA-M-500 (Buoyancy 5000 g) with Dan line float rope (Polypropylene) with selvage (Photo: Nitto seimo Co., Ltd advertising document)

Net Portion No.	Float Size	Float line length (m)	No. of Float (Piece)	No. of float /1 Ken* (Piece/K)
Side selvage – No.1	EVA-700	15.0	50	5 pcs/1 K (1.52m)
No.1 - No.6	EVA-700	360.0	940	9 pcs/2 K (3.04m)
No.7 - No. 9	EVA-700	180	630	6 pcs/ 1 K (1.52m)
No.10 - No.11	EVA-500	120	455	5.8 pcs/ 1K (1.52 m)
No.12 - No.22	EVA-500	660	2,275	4.9 pcs/ 1 K (1.52 m)
No.23 - No.27	EVA-700	300	488	2.4 pcs/1 K (1.52 m)
No.27 – Side selvage	EVA-500	117	36	5 pcs/1 K (1.52 m)
Total		1,698	4,991	

*ken: Japanese measurement Unit =1.52 m.

Table2: Details of Float

The float line material is Polypropylene rope: PP (Commercial name: Dan line) Dan line rope is more suitable than Polyethylene rope: PE (Commercial name: Hi-dex) for float line because elongation characteristic of Polyethylene rope is less than Polyethylene rope (Commercial name: Hi-dex). There are three sizes of Dan-line used for float line. Net portions, No.1 to No.8 and No.23 to No.27, are fixed with 48 m/m diameter Polypropylene rope. Net portion No.9 to No.22 fixed with 36 m/m diameter Polypropylene rope. The triangle net near bunt part is polyester (tetrolon) rope 40 m/m diameter and the triangle net near wing part (Portion No.27) is nylon single braid rope 40 m/m diameter. Total length of float line is 1,698 m.

Sinker and Sinker Line

Heavy sinker is standard used for weight the lower part of purse seine net Purpose of sinker is to bring net panel rapidly sinking down under sea surface, to block fish school. To prevent escapement of fish school, net panel have to purse at sinker line and bring haul on the deck as fast as possible. Success of fishing operation is depended on how fast of net setting and purse line hauling.

Sinker and sinker line is the same part, performed as ground rope of tuna purse seine net. Sinker or sinker line for assembling tuna purse seine net is usually made by metal chain. There are various kinds of chain material, i.e. Alloy, Iron zinc-plate or Carbon steel. Metal chain is suitable for making the net sinker because;

1. The chain is strong enough for the high tension during fishing operation. Tuna purse seine net is hauled by power block with high tension more than few tons force. Sinker line made by chain is stronger than rope. Strong characteristic is the most important for

2. The chain weight is heavy enough for sinking speed requirement. If the chain is too light small, the lower part of purse seine net can not sink down to the proper depth when current condition is strong. The small size of chain makes the net panel submerse too slow. Fish school can escape by swimming under the foot chain. The small size of chain is not strong enough for the strong pulling force during purse line hauling. If the chain is broken, it will make the net broken. That will be the very serious damage for the purse seine net. The portions of net, where bear with heavy tension or heavy load, are fixed with the big size of chain.

There are few sizes of chain employed for fixing as the foot chain. Chain size at the bunt (Portion No.1 to No.2) is 13 m/m diameter. Portion No.3 to No.4 and No.24 to No.27 require the strongest foot chain because these portions bear the highest tension during surrounding operation. To prevent the net broken during purse line hauling and let the net sink down as fast as possible, portion No.3 to No.4 and No.24 to No.27 are fixed with chain size 16 m/m diameter. Portion No.5 to No.23 is the longest part of net and they do not bear high tension during purse line and net hauling. So that they are fixed with the smaller chain, size 12 and 11.2 m/m because it is costly. Total length of sinker chain is 1,720 m

Figure 14: Foot chain 13 m/m diameter with the bridle chain joint (Photo: Nitto seimo Co.,Ltd advertising document)

Bridle rope is also made by galvanize chain, size 10 m/m diameter. Bridle chains are triangle shape, one leg of bridle chain is jointed with the purse ring and the other two legs ends are jointed with foot chain. Total bridle chains of R/V Nippon Maru purse seine net are 107 pieces. Legs of bridle chain, which are attached at purse rings, are different in length according to location of setting to the net part. Length different of each bridle chain is described as;

1) The first bridle chain length is 10.5 m. It is under net portion No.1 (the bunt part)

2) The second bridle chain length is 9.75 m. There are 2 pieces, under net portion No.2 and No.3 (bunt part) and the net portion No.27 (wing part)

3) The third bridle chain length is 9 m. There are 2 pieces, under net portion No.3 and No.4 (wing part) and net portion No.26 (wing part)

4) The forth bridle chain length is 8.25 m. There are 2 pieces, under net portions No.5 and No.25 (wing part)

5) The fifth bridle chain length is 7.5 m. There are 2 pieces, under net portions between No.5 and No.6 (main body net) and the net portion No.24 (wing part).

6) The sixth bridle chain length is 6.75 m. There are 2 pieces, under net portion No.7 and net portions between No.22 and No.23 (wing part)

7) The seventh bridle chain length is 6 m. There are 2 pieces, under net portions No.8 and No.21 (wing part)

8) The eighth bridle chain length is 5.25 m. There are 4 pieces, under net portions No.7 to No.13 (wing part)

9) The ninth bridle chain length is 4.5 m. There are 90 pieces, under net portions (No.14 to No.20)

Purse Ring

The purse rings are used for pursing the lower part, foot chain, of net in order to impound tuna into net circle. They made by Iron galvanized steel or stainless. R/V Nippon Maru use double roller purse ring type (or snap type). Double roller purse ring is widely popular in tuna purse seine fishing more than the traditional oval ring. This ring type is found more safety and able to reduce time for ring transfer than the circle type. However double roller type is more expensive then traditional one. Number of purse ring is equal number of bridle chain, 107 purse ring fixed with the net.

Figure 15: Right: Traditional round shape purse ring (right) and double roller purse ring (left) Left: Double roller purse ring (left) open the ring when release from purse line (Photo by Audio Visual Section, SEAFDEC/TD, 2001)

The advantage of double roller purse ring is described, i.e.

1. Double roller is more safety than the traditional oval purse ring. Handling of oval purse rings is required a special center piece of purse line. This central piece of purse line is steel wire 6×19, galvanize wire length 33 m and 25 m/m diameter It is used for hanging all rings together after finish purse line hauling. During purse line hauling, it is necessary to adjust the purse line hauling speed. And speed adjustment is able to make the central piece of purse line turn to be loop or kink. The kink or loop of purse line is dangerous for crew. Oval purse rings require 2 pieces of connection joints to join between the special piece of purse line and the other parts purse line. These connections can made the purse line damage when store all purse line in the drum. Connection joints can be broken or loose itself when store in the drum. That causes the purse line hauling trouble. The reducing of connection joint can reduce the eye loops of purse line at least

four pieces. So that the risky of purse wire broken at the loop will be reduce as well. No purse line hauling adjustment will save the time and easy to handle.

Double roller ring does not require any special canter piece of purse line. Double roller rings are able to be use with traditional purse line, steel wire 24 m/m and diameter 600 m in any places of the purse line length. That can save the money for purchase the central piece of purse line and reduce the supply spare for this part.

2. Save the time for re-twist activity. Because of no adjustment of purse line hauling speed, so that the purse line does not get heavy twist. The deck preparation does not necessary to make re-twist activity. That can save more time. For the professional fishing boat, it is very important. The fishing gear preparation time is reduced. So the next operation will be started faster.

3. The transferring of oval purse rings to ring striper take the long time and it is very dangerous especially during rough sea condition. The removal of the ring striper can provide more space for bunt hauling activities.

4. To reduce the cost for the wire cramps. During purse line hauling operation, traditional purse rings require a pair of wire cramp and a safety cramp. The price for a pair of cramp is about 350000 Japanese yen. However purse wire cramps have to spare for any emergency cases.

5. To reduce some corrosive of purse rings and purse wire. During purse line hauling operation, there is abrasion between traditional purse ring and purse wire. The abrasion makes to the purse rings and purse line corroded, and life span of both accessories become short. The double roller purse ring has 2 small rollers at upper and lower part of ring and they can reduce the abrasion between purse ring and purse line.

Purse line

In order to close the bottom of purse seine net while hauling operation, a purse line will be inserted through the purse rings and pull at the both side of purse line by purse winch. Purse line must be strong, untwisted and uncurl. Re-twisted procedure has to do after finish every fishing operation. The purse line of R/V Nippon Maru is steel galvanize wire type (dry type) construction of strand is 6 ×19 Fc (Jis)

There are few sizes of steel wire, comprised to be complete purse line. The main drum of purse winch is 19 m/m 1,500 m. long spice with 22 m/m 400 m., long spice with 26 m/m 400 m., long spice with 22 m/m 400 m. and the last long spice with19 m/m 400 m. Total length of purse line is 3,100 meter.

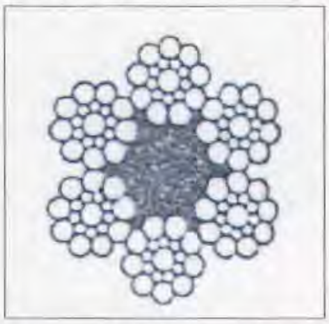


Figure 16: Steel wire structure 6/19 (1+9+9) Central heart of fiber core.
Example use: For Purse wire, trawler sweep line, running rigging
Flexibility: Poor to average

Diameter (m/m)	**Diameter of One stand (mm)**	**Area (Sq. m/m)**	**Safety working load (ton)**		**Weight (Kg/m.)**
			Galvanize type	**Normal type**	
19	1.50	170	20.0	22.2	1.54
22	1.65	2.6	24.2	26.9	1.87
26	1.94	287	33.7	37.5	2.61

Table 3: Specification of wire for purse line (Source: Teisan wire specification handbook, Japan)

Construction of Purse seine net

Bunt part

Bunt part is one of the important parts of net. All catches must be impounded before brailing into the fish holes. In order to serve high tension from fish weight and corrosive with ship hull and net panel, bunt part is always assembled with the big twine, small mesh size and sometime composed from double net sheet. The bunt part of R/V Nippon Maru is composed from 2 portions (Portion No.1 and No.2). The material of bunt part is nylon knotless. The nylon 230, 210, 180, 160, 140,120 ply are used for constructing the bunt.

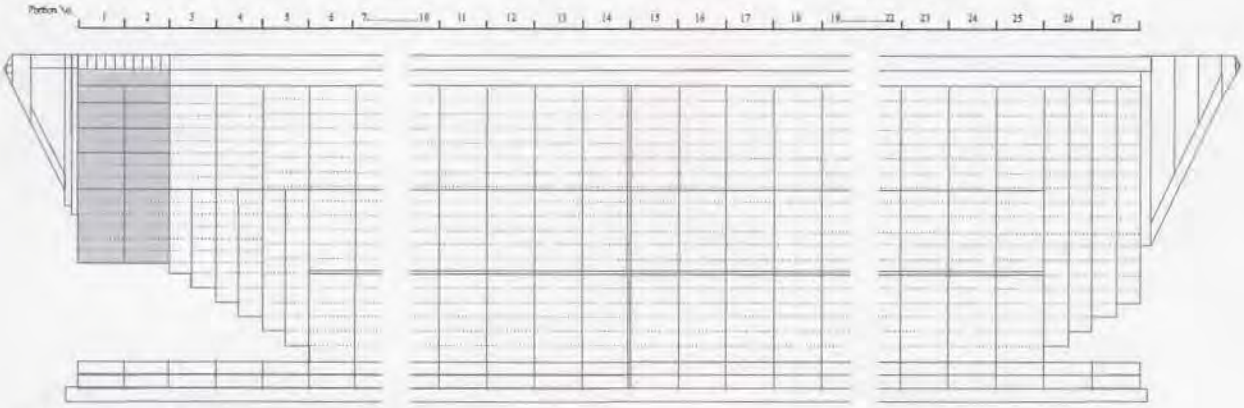


Figure 17: Bunt part (Shadow zone) of tuna purse seine net, portion No. 1 and No.2 (Illustrated by Pratakphol Prajakjitt)

Each net portion of bunt part is vertically comprised by 25 net sheets. Total net sheets for complete bunt part (Net portion No.1 and No.2) are 50 pieces. Each net portion is comprised of various net material and size, i.e.

1) The top net panel is ultra-cross net 230 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m. in stretch length. There are 2 net sheets complete in a net portion so that total net sheets (net portion No.1 and No.2) are 4 pieces. This part of bunt always takes highest weight when scooping and hauling all fishes, 2-3 tons, on the deck after finish scooping.

2) The second layer net panel is nylon 210 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m stretch length. There are 2 net sheets complete in a net portion. Total net sheets (net portion No.1 and No.2) are 4 pieces. The red twine is fixed between net sheet 230 ply and net sheet 210 ply that easy to recognize how much the net has already hauled up.

3) The third layer of net panel is nylon 180 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m stretch length. There are 2 net sheets complete in a net portion. Total net sheets (portion No.1 and No.2) are 4 pieces. The blue twine is fixed between 210 and 180 ply net sheet.

4) The forth layer of net panel is nylon 160 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m stretch length. There are 2 net sheets complete in a net portion. Total of net sheet (portion No.1 and No.2) are 4 pieces. The green twine is fixed between 180 and 160 ply net sheet.

5) The fifth layer of net panel is nylon ultra cross net 140 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m stretch length. There are 3 net sheets complete in a net portion. Total of net sheets (portion No.1 and No.2) are 6 pieces. The yellow twine is jointed between 160 and 140 ply net sheet.

6) The sixth layer of net panel is nylon ultra cross net 120 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m stretch length. There are 5 net sheets complete in a net portion. Total of net sheets (portion No.1 and No.2) are 10 pieces. The green twine is jointed between 160 and 140 ply net sheet.

7) The seventh layer of net panel is nylon net 120 ply. Mesh size is 90 m/m with 100 meshes depth and 75 m. in stretch length. There are 7 net sheets complete in a net portion. Total of net sheets (net portion No.1 and No.2) are 14 pieces.

Float line length of bunt is 100.50 m. with contraction 33%. Sinker line length of bunt is 120 m. with contraction 20%. This part need to hang with highest contraction, compare with the other part of net, because bunt is gather the large amount of catches so the net is necessary bulky.

Wing part

The wing parts of R/V Nippon Maru purse seine net are comprised of net portion No.3 to No.5 and No.26 to No.27. Net portions No.3 to No.5 are located between the bunt and main body part and net portions No.25 and 26 are located between the triangle net (or side selvage net) and main body part. The main purposes of wing part are,

1) To prevent any damages to main body from heavy weight of bunt part during fish brailing operation.

2) To increase sinking speed at the lower part of purse seine net for protecting the fish school escape from the net circle when net surrounding and net hauling operation.

The net material for assembling wing part is always smaller twine size than bunt part. However mesh size of wing part is bigger than bunt part, because wing part necessary to reduce the water-resistant. Wing parts have net panels which stronger than main part because wing parts must prevent main part of any damages cause by heavy weight of bunt with catches. Net panel can be described portion by portion, i.e.

Net portion No.3 wing net panel of is assembled by 210d 90 ply, mesh size is 105 m/m. This portion is divided into 2 main parts.

1) The upper part has 9 pieces, vertical fixing. One piece of net sheet has 100 meshes in depth and 75 m stretch length.

2) The lower part has 23 pieces, vertical fixed. One piece of net sheet has 100 meshes in depth and 37.5 m. in stretch length

Net portion No. 4 has same float and sinker construction as portion No.3, 30% contraction at float part and 18% contraction at foot chain part. Construction is almost same as net potion No.3The upper part of wing net panel is same as No.3 The different design is appeared at number of net sheets at lower part of wing net, 27 pieces. Mesh size is 105 m/m. One net sheet has 100 meshes in depth and 37.5 m stretch length.

Net portion No.5 is constructed by 2 types of material. The upper wing net is comprised by 8 net sheets of nylon 210d 60 ply. Mesh size is 105 m/m. One sheet of panel has 100 meshes in depth and 75 m. in stretch length. The lower main net has 23 pieces of nylon 60 ply. Mesh size is 105 m/m. One piece of panel has 100 meshes in depth and 37.5 m. in stretch length. The lowest part comprised by 8 net sheets above foot chain selvage. Material is nylon 210d 90 ply. Mesh size is 100 mm. 1 net sheet has 100 mesh width and 37.5 m stretch depth. Net portion No.5 is 28% contraction at float part and 16% contraction at foot chain part.

Net portion No.26 and No.27 has same construction, comprised by only material, nylon 210d 90 ply. Mesh size is 150 m/m. One sheet of panel has 100 meshes in depth and 37.5 m. in stretch length. Net portion No. 26 has 33 net sheets and Portion No. 27

has 28 net sheets. Net portion No.26 and 27 has same contraction as 28% at float part and 16% at foot chain part.

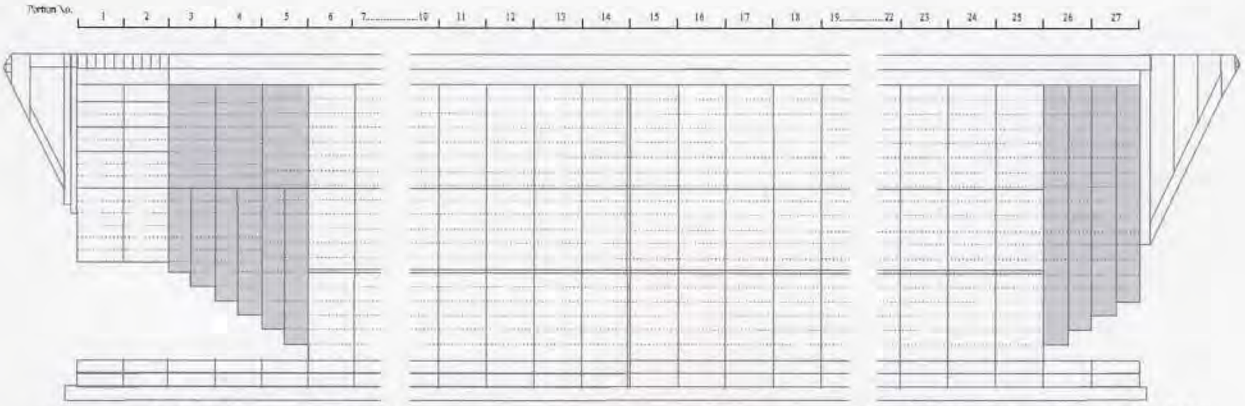


Figure 18: Wing part (Shadow zone) of tuna purse seine net, portion No.3 to No.5 and No.26 to no.27 (Illustrated by Pratakphol Prajakjitt)

Main part

The main part is the largest part of purse seine net covered from potion No. 6 to No.25 This part is very important for surrounding the fish school so that the most important characteristic of main net is fast sinking, to prevent the fish escape by diving under the sinker. By this reason, polyester: PES (tetrolon) is the most suitable material for assembling main part of tuna purse seine net. The tetrolon has higher specific gravity than nylon, 1.38 and nylon is 1.14 however the tetrolon is more expensive than nylon. In order to save cost, only lower part of purse seine net is constructed with tetrolon. With sinking force characteristic tetrolon material, purse seine net can be reduced the size of sinker chain to be smaller. Net panel of main part is designed to use biggest mesh size but smallest twine, to reduce resisting against the current during operation. Main part, portion No.6 to No.25 is 28% contraction at float part and 16% contraction at foot chain part. The net panel of main part can be separated into 4 net vertical layers. The material and construction are followed;

1) The top main net of portion No.6 to No.25 is 160 net sheets (8 sheets per a portion) of nylon 60 ply. Mesh size is 105 m/m. One piece of net sheet has 100 meshes depth and 75 m stretch length.

2) The second layer of main net has 100 net sheets (5 sheets a portion) of tetrolon 80 ply. Mesh size is 180 m/m. One piece of net sheet has 100 meshes depth and 75 m. in stretch length.

3) The third layer of main net has 20 net sheets (1 sheet a portion) of tetrolon 2/180 ply. Mesh size is 105 m/m. One piece of net sheet has 5 meshes depth and 75 m. in stretch length.

4) The forth layer of main net has 100 net sheets (5 sheets a portion) of tetrolon 80 ply. Mesh size is 180 m/m. One piece of net sheet has 100 meshes depth and 75 m stretch length.

5) The fifth layer is sub selvage of main net, comprised by 20 net sheets (1 sheet a portion) of Nylon 210d 2/120 ply. Mesh size is 150 m/m. One piece of net sheet has 20 meshes depth and 75 m stretch length.

Three special selvage net panels have been assembled between portion No.7 to No.8, portion No.14 to No.15 and portion No.21 to No.22 Each net panel is tetrolon

2/180 ply. Mesh size is 105 m/m. One net sheet of panel has 5 meshes in width and 360 m. in stretch depth.

Figure 19: Main part (Shadow zone) of tuna purse seine net at portion No.6 to No.25 (Illustrated by Pratakphol Prajakjitt)

Selvage part

This part is same as the frame of net to prevent the net body from the damage during fishing operation. Selvage net is one of the strongest parts of the all type of fishing net. Selvage for purse seine net is divided into 3 main parts i.e., upper selvage part, lower salvage part and the side selvage. Selvage material is described;

Side selvage

The side selvage or triangle net panels are secured at the both sides of purse seine net, the bunt side and the wing side (figure 22) Material of Side selvage or triangle net is Polyethylene (Hi-dex) 450 denier. Mesh size is various according to the position of side selvage

Side selvage attached at the bunt side is consisted by 2 main net.

1) The rim of side selvage is Polyethylene (Hi-dex) 450d. Mesh size is 300 m/m 5 meshes are at the float part. 30 meshes are fixed with iron triangle (figure 21) and 45 meshes are attached with the second part of the side selvage net.

2) The second part side selvage net at bunt side can separate in 3 vertical net layers.

2.1) Top part is Polyethylene (Hi-dex) 450d. Mesh size is 150 m/m. One piece of panel has 5 meshes in depth and 22.5 m. in stretch length.

2.2) Second layer is (Hi-dex) 480d. Mesh size is 300 m/m. Upper side, attached with float line, has 70 meshes. Side which is attached with the rim piece (2.1) is 130 meshes and the opposite side is 200 meshes. Between second layer and bunt part has 3 special net sheets. First net sheet is nylon 210d 2/300 ply. Mesh size is 100 mm. 1 net sheet has 20 mesh width and 106.4 m stretch depth. Second net sheet is nylon 210d 2/300 ply. Mesh size is 100 mm. 1 net sheet has 20 mesh width and 152 m stretch depth.

2.3) The lowest layer, attached with sinker rope, is Hi-dex 450d. Mesh size is 150 m/m. One net sheet has 5 meshes in depth and 30.4 m stretch length.

The side selvage at the wing part (net portion No. 27) is comprised of 2 net portions, same as bunt part but the size is different.

1) The rim of side selvage is Polyethylene (Hi-dex) 450d. Mesh size is 300 m/m 5 meshes are at the float part. 30 meshes are fixed with iron triangle (figure 21) and 45 meshes are attached with the second part of the side selvage net.

2) The second part side selvage net at bunt side can separate in 3 vertical net layers.

2.1) Top part is Polyethylene Hi-dex 450d. Mesh size is 150 m/m. One piece of panel has 5 meshes in depth and 54.7 m. in stretch length.

2.2) Second layer is Polyester (tetrolon) 250d, 2/600 ply. Mesh size is 300 m/m Upper side, attached float line, is 180 meshes. Net panel which is attached with the rim piece is 120 meshes and the opposite side is 300 meshes. Between second layer and wing part has special net sheet nylon 210d, 2/180ply, mesh size 150 mm. 1 net sheet has 50 mesh width and 152 m stretch depth

2.3) The lowest layer, which attached with sinker rope, is Hi-dex 400d, 2/450 ply. Mesh size is 150 m/m. One net sheet has 5 meshes in depth and 77.5 m stretch length.

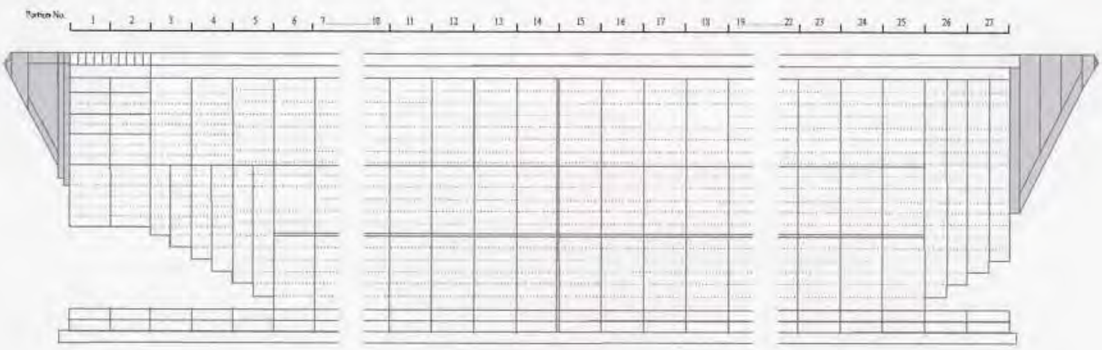


Figure 20: (Top) Triangle iron bar with the end of side selvage or triangle net (Photo: Nitto seimo Co.,Ltd fishing gear catalogue)
(Down) The construction of side selvage or Triangle net (Shadow zone) of purse seine net (Illustrated by Pratakphol Prajakjitt)

Upper selvage The upper selvage is the part that attached between float line and main net body. Because it serves the high tension among the net and floats, this part need to be the strong. The main upper selvage is different between the bunt part (portionNo.1 and No.2) and other (portion No.3 to No.27)

The upper selvage of bunt part (net portion No.1 and No.2) can be separate in 3 layers, which are different in material. Selvage of bunt part is comprised of 3 vertical layers of net and described at Selvage item.

1) The top is Polyethylene (Hi-dex) 400d 2/630 ply. Mesh size is 210 m/m and 1.5 mesh depth.

2) The second net layer, below the top layer, is a piece of nylon net, twine size is 9 m/m diameter. Mesh size is 150 m/m and 5 meshes depth.

3) The third layer, below 1) and 2), is a piece of nylon net, 2/300 ply. Mesh size is 100 m/m and 20 meshes depth. The horizontal stretch length of net is 157.5 m, covered bunt part, net portion No.1 and No.2

Upper selvage from portion No.3 to No.27 can be separated into 4 layers, which are different materials. Net portion No.3 has four layers selvage net, which different materiel, i.e.

1) The top selvage is polyethylene (Hi-dex) 400d 2/630 ply. Mesh size is 210 m/m and 1.5 meshes in depth.

2) The second layer is polyethylene (Hi-dex) 400d 2/450 ply. Mesh size is 150 m/m and 5 meshes in depth.

3) The third layer is a net sheet of polyethylene (Hi-dex) 400d 2/180 ply. Mesh size is 120 m/m. A net panel has 50 meshes in depth and 75 m. in stretch length.

4) The forth layer is a net sheet of Polyethylene Ultra-cross net 120 ply. Mesh size is105 m/m. A net panel has 50 meshes depth and 75 m stretch length.

The special selvage at main part of purse seine net (portion No.6 to No.25) is nylon net 90 ply. Mesh size is 105 m/m. One piece of panel has 100 meshes in depth and 75 m. in stretch length.

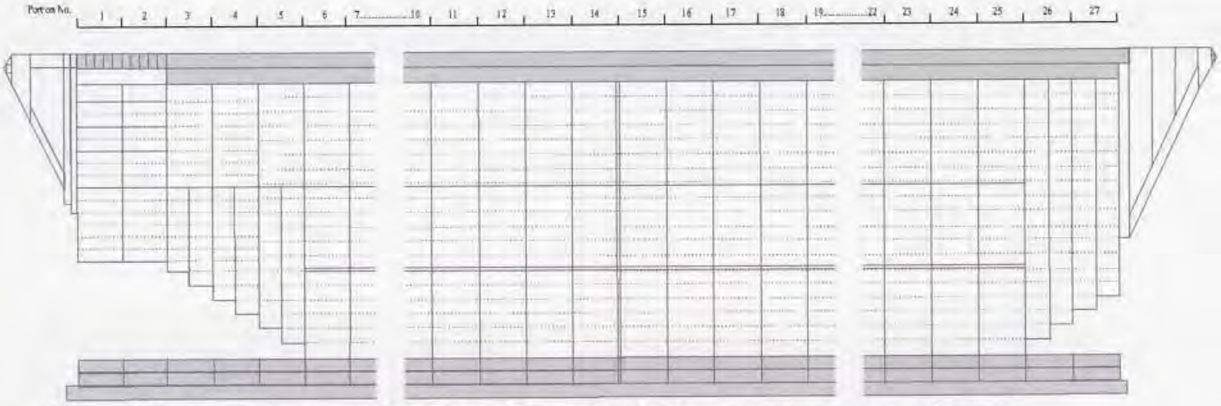


Figure 21: The location of Upper and Lower (Shadow zone) of purse seine net (Illustrated by Pratakphol Prajakjitt)

Lower selvage The lower selvage is the part that attached with the foot chain. It serves high tension especially during purse line hauling. High abrasion between foot chain and net, purse line and net is happened when fishing operation also.

The ordinary lower selvage from portion No.1 to No.27 can be separated into 3 layers, which are different materials.

The lowest layer is Hi-dex 400d 2/450 ply. Mesh size is 210 m/m and 5 meshes depth. The horizontal stretch length of net is 2025 m.

There are 2 net stripe attached between side selvage and bunt part. The first is a piece of nylon net 210d 2/300 ply. One piece of panel has 10 meshes in width and 105 m. in stretch depth. The second is a piece of nylon net 210d 2/300 ply. One piece of panel has 10 meshes in width and 150 m. in stretch depth.

Table 4: Specification of Nippon Maru purse seine net and the accessories

Item	Details	Specification	Remark
Length of cork line (m)		1698.12 m	
Length of foot chain (m)		1720.0 m	
Net Length	No. of strips	27	Exclude 2 triangle net
	Stretch (m)	2025	
Net Depth	No. of strips	27	Include selvage net
	Stretch (m)	306.3	
	Hung (m)	220.5	Depth after Hanging
Thickness & mesh size	Central body	Nylon 60 ply, Tetrolon 80 ply	
	Bunt (sack)	Nylon 230, 210, 180, 160, 140,120 ply	
Largest mesh size		180 m/m	
Smallest mesh size		90 m/m	
Depth & cork line ratio		0.15	
Accessories	Float	25.7 tons	Total buoyancy
	Purse ring	Double roller purse ring	
	Chain	16 m/m at wing section	
		13 m/m bunt section	
		11 m/m, 12 m/m, 13 m/m at body net	
	Purse line	Dia. 19 m/m Length 1900 m	
		Dia. 22 m/m Length 800 m	
		Dia. 26 m/m Length 400 m	
Other	Power block	Margo 5.5 tons	
	Purse winch	Margo 14 tons	

Figure 22: R/V Nippon Maru Purse seine Net Plan partI (Portion No.1 to Portion No.13)

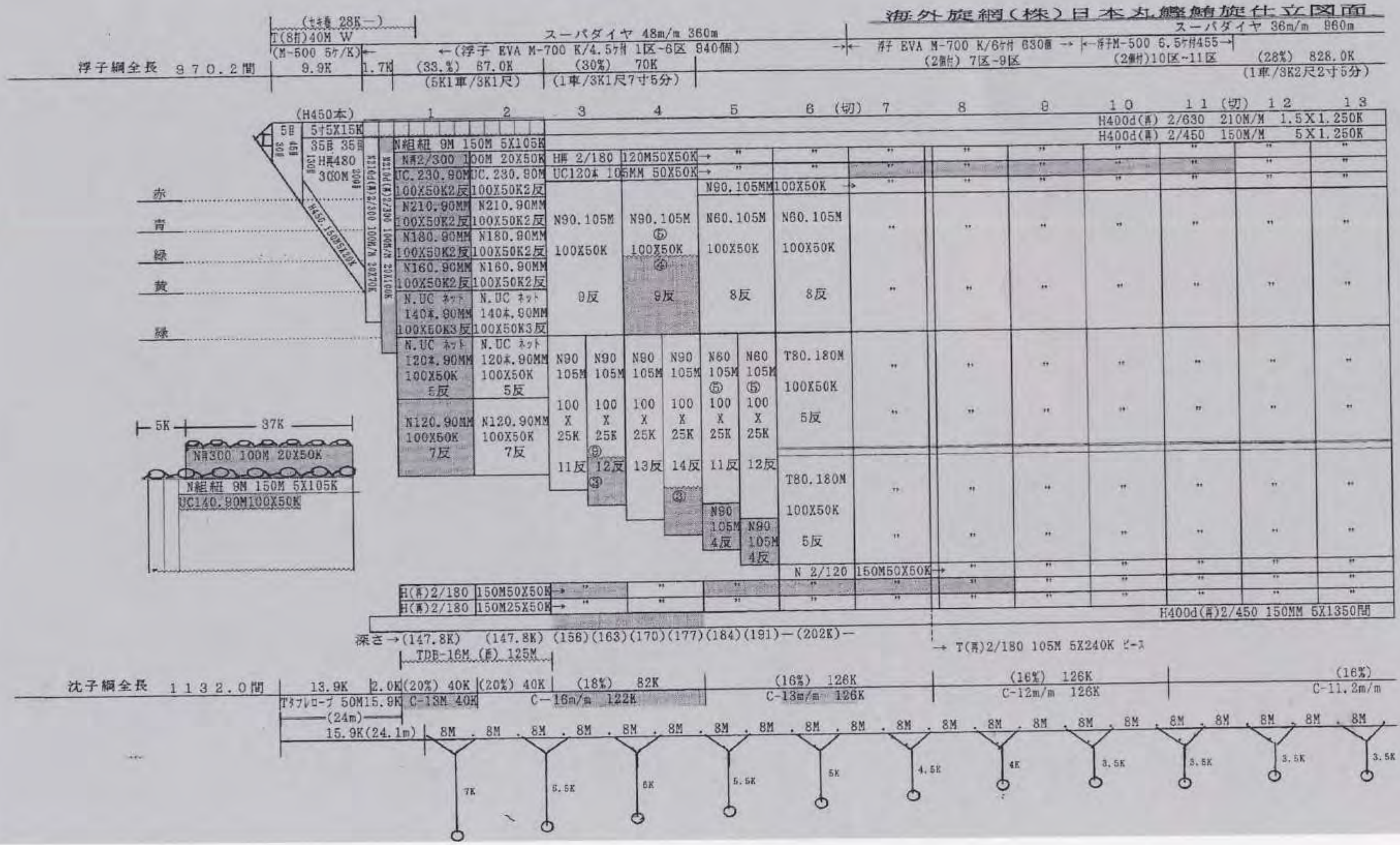
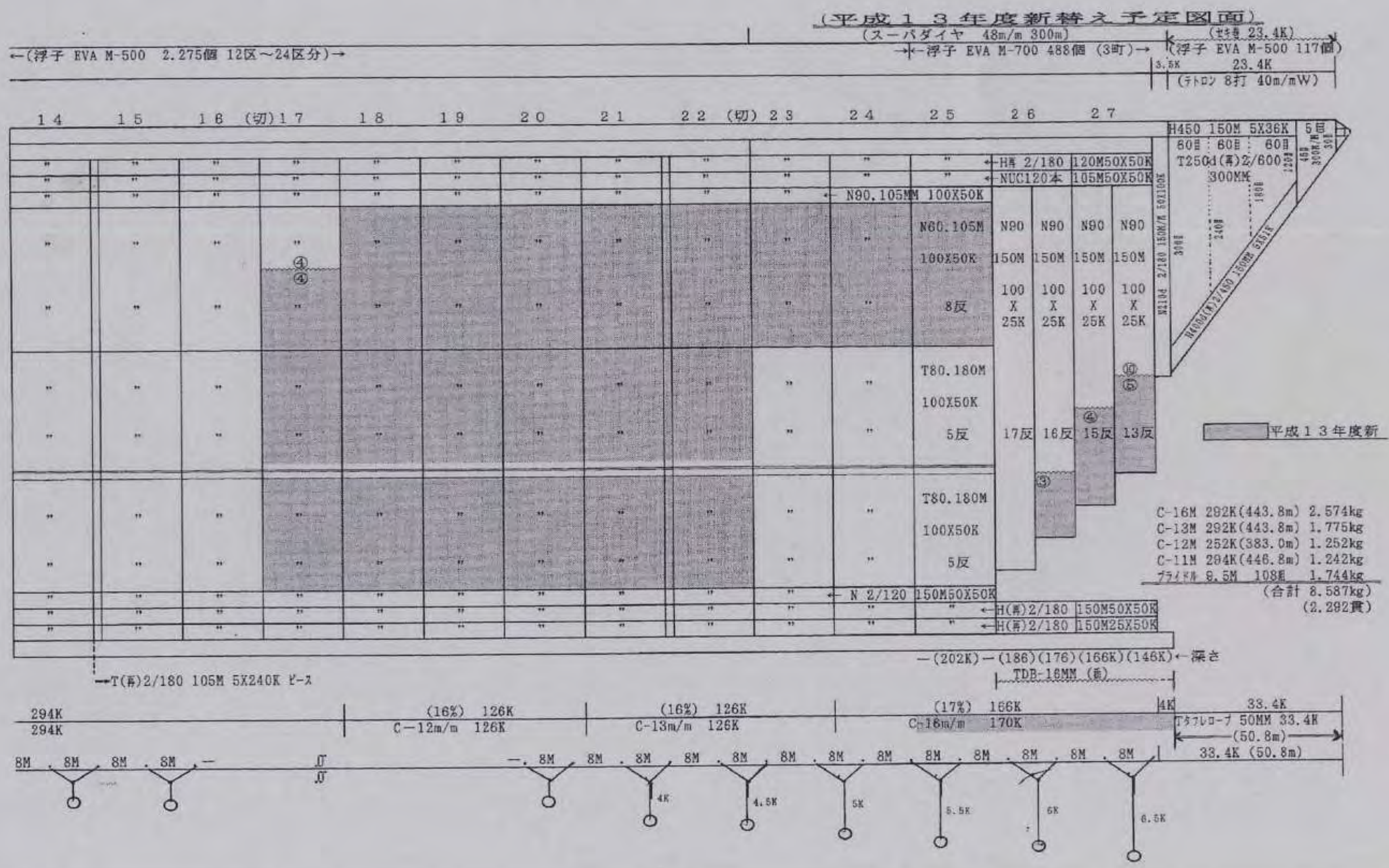


Figure 23: R/V Nippon Maru Purse seine Net Plan partII (Portion No.14 to Portion No.27)



FISHING OPERATION part I:
SEARCHING ACTIVITY and FISH AGGREGATING DEVICE

SEARCHING ACTIVITIES

Searching the fish school and some drifting objects is important stage of the purse seine activities. There is 2 majority type of fish school searching.

1. Direct method

This method is searching to the fish school directly. By this method, fishermen use binocular for searching, chasing and intercepting fish school jumping, boiling and breezing.

1) Fish school jumping is the fish behavior that the fish jump over the sea surface. Fish school boiling is the phenomenon that fish become hot to chummy natural live-baits which are boosted by the fish school to the sea surface.

Fish school breezing is the phenomenon that simple to the gentle breeze ripple at the sea surface. It also means that the fish school overcome wave and create calm with moving densely on the certain direction just under the sea surface. The phenomenon of the breeze varies to depend on the density and water depth of the fish school. Therefore, this breeze can, clearly or not so clearly, be seen time to time.

Boiling and the breeze caused by fish schools are lifted a little bit from the sea surface when the fish school is dense enough, or feeding activities are too strong. By this tuna behavior, sea water is become turbulence and long distance observable.

Figure 24: (Up) Crew members are searching for fish school and bird flocks after detection by bird Radar (Photo by I. Chanrachkij, 2001)
(Down) Fish school is jumping in Indian Ocean (Photo by I. Chanrachkij, 1997)

**Figure 25: (Left) Drifting log was discovered by searching (Photo by I. Chanrachkij, 2002)
(Right) Fish school searching by echo sounder (Photo by I. Chanrachkij, 2001)**

The fish school under the water can search by the fish finder. This method is checking fish school, directly by acoustic equipment. This method is used to detect the fishes which are underwater. Now a day, fish finders have been developed and utilize to presence the fish school. Now a day 2 types of fish finder are widely used for fishing, i.e. echo sounder and sonar.

2) Porpoise schools closely associate with yellowfin tuna. The association of tuna with porpoises is best known and well documented. Searching of porpoise schools for catching tuna is very popular along the west coast of America, in Eastern Pacific Ocean region (EPO) particularly in the area around tip of Baja, California and offshore of Chimbote, Peru. The most important dolphin from the point of view of tuna fishermen in EPO is Spotted Dolphin (*Stenella graffmani*) and the second most important is the Spinner dolphin (*Stenella longirostris*). Both species are often found in mixed herds. (Gorman, 1995)The common dolphin is another through less important species. Tuna schools are often gather around whale and whale shark also but this association is found worldwide. The trouble of tuna fishermen in EPO from the very beginning of tuna purse seine fisheries was that the by-catch of dolphin taken incidentally with the targeted tuna. The "sets on porpoise" technique when fishing for tuna particularly on yellowfin tuna have for many years caused massive incidental death of these animals. Massive has been declared, therefore, endangering the survival of the porpoises and the US government has set an annual quota on these kill. A major research effort participated by tuna fishery and US government and Inter-American Tropical Tuna Commission (ICCAT) technicians resulted in the development of dolphin saving techniques. Purse seining fishers were compelled to apply these measures and after for a few years, the dolphin mortality was reduced tenfolds and their population recovered. Nonetheless, under the pressure of "pro dolphin" lobbied a law was enacted on the US requiring of "Zero Kill" of dolphins, and food supply ceased of tuna cannery marketing caught with "setting on porpoise" technique. Consequently, this technique is abandoned at least by purse seiner (Ben-yami, 1995).

The important breakthrough technique for preventing the death of porpoises by purse fisheries is started in 1971 while Captain Harold Medina replaced the normal 4.25 inches stretch mesh sizes in backdown area to on his purse seine with 2 inches stretch mesh. This prevented dolphin from entangling their snouts flukes and flipper. This important modification was quickly adopted by other fishermen and soon become known as "Medina panel".

There were further technology advance during the 1970's that greatly reduce the number of dolphin killed by purse seining.

- The Medina escape panel was progressively enlarged
- The stretch mesh size in the Medina panel was progressive reduce to 1.25 inch.
- Refinements in breakdown procedure
- The introduction of inflatable rafts for dolphin rescue during purse seine setting.
- Development of additional uses of speed boat for ensuring the safety of dolphin in the purse seine.
- Increased understanding of the purse seine dynamics

The number of dolphins killed during night set was recorded over three times the rate for observed during the day. Provided there are no delay the back down maneuver can usually be completed in about an hour after net has been set. However gear malfunction, break down and weather condition can caused delays. Consequently set made close to sun down are like to be complete as night set. During 1977-1988, night sets accounted for 9.3% of all sets but resulted in no less than 25.6% of all recorded dolphin deaths. In 1981, typical lighting system for night set back down on most purse seiner was simply a rail mouthed or hand-held spotlight used to light up specific areas of backdown channel. Some vessel did not use any lighting.

At this time chartered San Diego based purse seiner several light systems and determine that the most effective was commercial made 1000 watt, high pressure Sodium-vapor floodlight with 140,000 lumen output. This is the type of light of commonly used in large parking lots and sport stadiums. It provides a soft light over entire back down channel, and the amber light does not dazzle the fisherman stationed in the area of the channel. The Inter-American Tropical Tuna Commission lent several of lights to purse seiner for more extensive trials. Subsequently during 1982 and 1983, a further 19 United State vessels were so equipped.

Starting in mid 1986, all us vessels were require by law to fit a light with 140,000 lumen outputs and most but not all of the other nations now have similar legislation.

While the use of these lights has resulted in a signification reduction in dolphin deaths on night sets, the death rate is still significantly higher than for they sets indicating that increase lighting alone will not resolve the problem of the higher death rate during night sets. Therefore, as of 1 January 1989, All US vessels had to complete back down maneuver not less than 30 minutes after sundown. Only vessel that had an established night set death rate equal to or less than the US fleet day rate were eligible to apply for a waiver for exemption (Gorman, 1995).

2. Indirect method

The tuna purse seine activities always search flock of sea bird for locating the fish school. This activity is indirect method of the fish detection. The most of pelagic fish school are accompanied with more and less a flock of bird. Therefore, lookouts to detect fish school always try to find out a flock of sea bird above horizon through the binoculars in fishing ground. The birds flying the steady manner and in a certain direction are not following fish school but only moving from place to place. The birds flying horizontally and vertically in the various directions are mostly attached to the fish school.

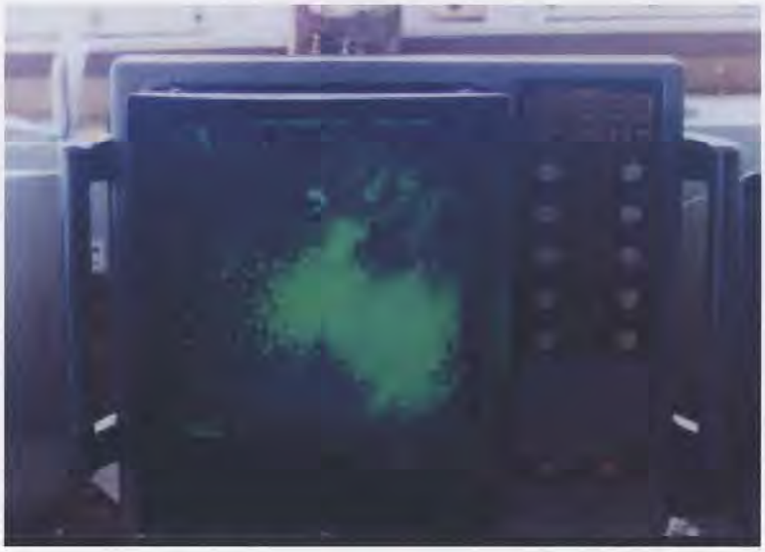


Figure 26: Flock of bird in the Bird radar display
(Photo by I. Chanrachkij, 2001)

The fish school mostly eats natural live-bait. The natural live-baits are pursued with and preyed on both of bigger size of fish and the birds. When the live baits free from the fish, they sink from the surface to deeper layer. At the same time, the fish school also chases after the bait and the flock of bird behaves in following manner:

1) The birds suspend their feeding activities and sit down to wait for the next chance of feeding on the sea surface.

2) Some of birds abandon to bite the baits and move to detect the other baits from here to there.

3) Some of birds do not abandon to attach the baits and soar to the sky up to several hundred meters to widen area of bait detection and they fly around there slowly watching with a vigilant eye sea surface, where once the bait school sunk will appear on the near surface to be boasted by fish school.

Different from the western Indian Ocean, the eastern part of Indian is rarely to find fish school jumping. So that members of the R/V Nippon Maru do not have any duties of eye-searching by binocular every day. Searching by binocular was conducted during the vessel stay in the EEZ of British Territory of Indian Ocean: BTIO (Chagos Archipelago) only.

The main equipment for searching fish school is the bird Radar. R/V Nippon Maru installs 2 sets of bird Radar. The displays are set at the bridge and the other 2 displays (the same transmitter and antenna) are in the fishing instrument space on compass deck. During the ship was sailing to the Payao, a bird Radar was turned on. When the navigator can find some raster of bird flock in the Radar screen, the ship was adjusted ship course to that bird flock direction. Then crews started searching the flock of bird, fish school jumping and drifting object by binocular. When the ship closely approaches to the drifting object, master fisherman has to search some fish school by Sonar later.

R/V Nippon Maru installs 2 sets of sonar for searching fish school. One of the sonar is the medium range (40 kHz). It use for checking the fish school below the 600 m. The other is the close range (94 kHz) which is used for checking fish school below the 400 m. That is different from M/V SEAFDEC. M/V SEAFDEC installs low frequency sonar for detecting the fish school below 2000 m. range. After fishing master can locate the position of fish school, the ship is leaded above the fish school. The fish school is checked again by the Echo sounder. At here master-fisherman decides to do operation and estimate the amount and species composition of fish school. If there are a lot of fishes, a light buoy is attached at the drifting object or Payao for coming back to do fishing operation in the morning.

FISH AGGREGATING DEVICE (FAD)

Suggested by master fisherman, Indian Ocean has rarely fish school jumping as well as some natural logs drift along the ocean. Fish Aggregating Devices (FADs) is a kind of manmade object, constructed and launched into fishing ground aim to aggregate the fish school. Fish Aggregating Devices (FADs) has become one of the most important tools for gathering fish school in the Eastern Indian Ocean.

FADs have various designs depended on the fishermen and their fishing ground. FADs is always called Payao, are well known among purse seine fishermen. These FADs can be classified by 2 types of Payao.

1. Anchoring Payao

Anchor Payao is attached a kind of Payao. It is set with anchor to fix Payao in certain position. Anchor Payao is widely set by small scale fisherman and in the limited deep sea fishing ground, e.g., South Pacific Ocean, Philippine, etc. In general, Anchor Payao has four parts, a raft, anchor, anchor line and fish attractor. The materials of anchor Payao are followed;

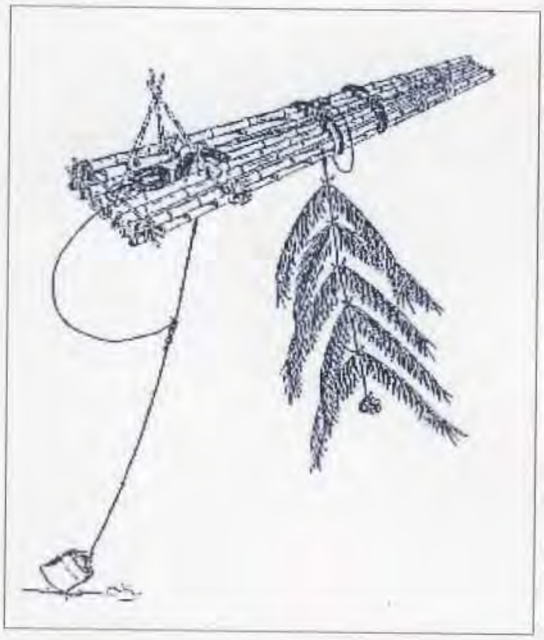


Figure 27: Anchor Payao (SPC, 1984)

1.1) Raft or buoy

The raft is made from Iron float or bamboo. Bamboo poles are tied in the raft. Shapes of rafts are triangle shape or cylindrical shape. It always attach with coconut rope. SEAFDEC anchor Payao is 8 m long, because it is triangle shape, maximum wide is 2 m and minimum wide is 1.2 m (See figure 24)

1.2) Anchor line

Anchor rope is made from Polypropylene or Polyethylene rope 18-22 m/m diameter. Because it is low cost, adequate strength and suitable characteristic for mooring. The length of rope more than sea depth is 1.5-2 times.

1.3) Sinker

Sinker can be made from heavy stones, pieces of rock oil drum fill with concrete or concrete blocks. M.V.SEAFDEC has sinkers made by few pieces of 200 liters oil drum, fulfilled with concrete are inexpensive and easy to deploy. It is widely used but the demerit is the limitation of the drag resistant is low. Sometime fishermen put some the iron bars to prevent sinker dragging. Some fishermen select concrete block (1000 kg) to be sinker. Concrete cubic block is very stable for anchor Payao but difficult to deploy particularly by the small boat.

At present, anchor Payao have not deployed at Indian Ocean because of few reasons. Firstlt, the fishing ground is far distant from shore. It is not convenient for Payao owner to keep maintenance those Payao. Secondly, Indian Ocean is very deep. The shallowest is around 1800 m. at Ninety East Ridge and deepest is about 4000 m. The setting of anchor Payao must spend large amount of anchor rope. In 1993, M/V SEAFDEC had deployed two anchors Payao in Indian Ocean. After 2 months, both of Payao were broken and abandon, only damage marking floats were found.

The development of the radio direction finders and radio buoys system are very fast. They are more convenient and reliable than previous system. Drifting Payao is more convenient and costly for tuna and skipjack purse seine fisheries in the world now.

2. Drifting Payao

Drifting Payao is sometime called DFADs. This type of Payao is proved itself, more suitable for the deep sea and vast fishing ground than the anchor Payao. However the set of these drifting Payao have to clearly understand on the pattern of oceanic current.

R/V Nippon Maru drifting Payao has 2 major designs. The first and standard design is look liked raft called *Raft type*. It is rectangular shape with dimension 3×3 meters. The frames of Payao are made from iron pipe diameter 2 inches. Supporting iron bars to main frame is made from iron pipes diameter 1 inch. There are 12 bamboo poles, to tight up together. There are 24 old purse seine floats fixed rectangular sides under the Payao. Floats are supported the buoyancy of Payao because fishermen prefer to reduce numbers of bamboo. The old net sheets, called skirt, are tightened under the Payao. It is used for aggregate some sessile organisms that attracts some fishes later. Many plastic sheets are attached at the skirt (see figure 25 and 31).

Figure 28: R/V Nippon Maru Drifting Payao Raft design

Other designed is called *Curtain type*. The floating part is made 5-6 bamboo poles, tight together. Bamboo pole length is 5-6 m. length and diameter about 10-12 cm. The drifting bamboo poles are support some buoyancies by 10-15 purse seine floats. The Payao is covered by sheet of nylon net and only sheet of skirt part is fixed under Payao.

Merits of Payao curtain design is easy, cheap and short time for construction. It was always constructed when Payao urgently required launching into the sea. However curtain designed Payao is shorter lifespan than raft design because there are not any iron bars to protect bamboo poles braking when launching Payao to the sea and heaving it up onboard.

Suggested by master fisherman of R/V Nippon Maru, that skirt of Payao should be selected big twine net. The big twine net has more surface area than the thin twine and sessile organisms have more chance to set themselves at the net twine. It made fishes is aggregated at the Payao in short period, faster than the Payao, which has thin net skirt.

Figure 29: R/V Nippon Maru Drifting Payao Curtain design (M/V SEAFDEC, 2002)

Mesh size is one of the key factors for increasing performance of Payao. Small preys are easily to enmesh at the net. And they are become foods for other fishes around Payao. It creates the new pelagic habitat of deep sea. Drifting objects, e.g. wooden log, or iron drum, has same aggregate mechanism as the Payao.

Figure 30: Some barnacles adhere with net twine at skirt of Payao

R/V Nippon Maru always sets 50-60 Payao during stay in fishing ground for 8-9 months every year. Some of them are lost during drift in the ocean. Most of Payao must be attached with a radio buoy. Radio buoys have been used by purse seiners since early of early eighties. Consequently they made sleeper that radio buoy transmits the HF radio signal, which signal can be received by the antenna of direction finder. The display of direction finder shows the direction from the ship to the radio buoy mean that the location of direction of Payao. By this method, the ship follows the direction in the display and the radio buoy can be found. In the early stage of this radio buoy were designed to emit signal continuously which made them too easy to be found by other purse seiner. Now a day, direction finder is developed to be selective-calling radio buoy. The selective-calling radio buoy, called Sel-called buoy, transmits the signal to the ship when the buoy receive the frequency with identification code signal only. That makes the Sel-call buoy can avoid the radio frequency scramble from another purse seiner, as well as to save battery power. However, in most fisheries, radio buoy and Payao or log stealing among fishing vessels is common occurred. One of Payao in the group is attached Argos buoy with the radio buoy. Argos buoy receives

Figure 31: Argos buoy

present position from GPS satellite and transmit signal with position via satellite to base station in France. The base station in France, send the drifting information of Argos buoy to JAMARC center in Tokyo, Japan. This information had been delivered to R/V Nippon Maru by Electronic mail via inmarsat communication system. By this method, R/V Nippon Maru knew the direction and drifting speed of the Payao attached with Argos buoy. This information is the reference direction and drifting speed for whole group of Payao. The estimation of the Payao attaches with radio buoy can be done with accuracy.

Selective-calling buoy transmit and receive signal

Selective-calling buoy receive signal and transmit signal with GPS data

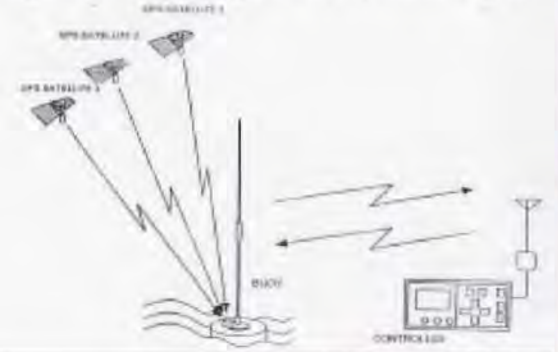


Figure 32: Function of radio beacon for tuna purse seine fishing operation

3. Aggregated school characteristic (Hallier, 1995)

Tuna schools associated with log and purse seine fishing on log school worldwide have similar characteristic. Intensive study conducted in EPO have clearly demonstrate that neither the size (for log greater than 1 m), nor the color, the shape, the nature or the time of the object at the sea has an influence on its attractiveness to tuna. Everywhere log school tunas are mostly skipjack (on average two third) follow by yellowfin tuna and big eye tuna. Almost everywhere bigeye tuna is generally more abundance in log school than free school.

Yellowfin tuna and Bigeye tuna are more dominant. On the average, log school catch per set are larger than catch per set from free school. However log school tunas are generally fetch the lower price than that of free school. Furthermore by-catch is larger on log school fishing. This by-catch mostly consists of the coastal fish which drift and associate with the log from coastal waters, minor tuna such as frigate tuna and kawakawa, wahoo, rainbow runner, dolphin fish (Dorado), shark and ray, leather jacket, billfish, etc. This by-catch involves extra work in cleaning the net and such sorting catch of unwanted species in limited time available before the catch in the net begins to deteriorate in high sea temperature.

Apart from a large catch on the average at log school, there are other advantages. For instance, hardly 10% of purse seine set on log schools yield no catches while 50%

of set on free schools are unsuccessful. As tuna biomass on under log is higher at dawn, most set are conduct early in the morning. Then, by mid-morning, the vessel can load its good catch, more of less saving its fishing day. The rest of the day can then be used to search for free school and other possible catch or find new logs for fishing next morning.

The same log can be fished around the several days in a row but of course catch per set tends to decrease but it is not rare that such log would several hundred metric tons of tuna.

This fishing techniques has undergone with several improvements as some purse seiners rely more and more on log school for their catch

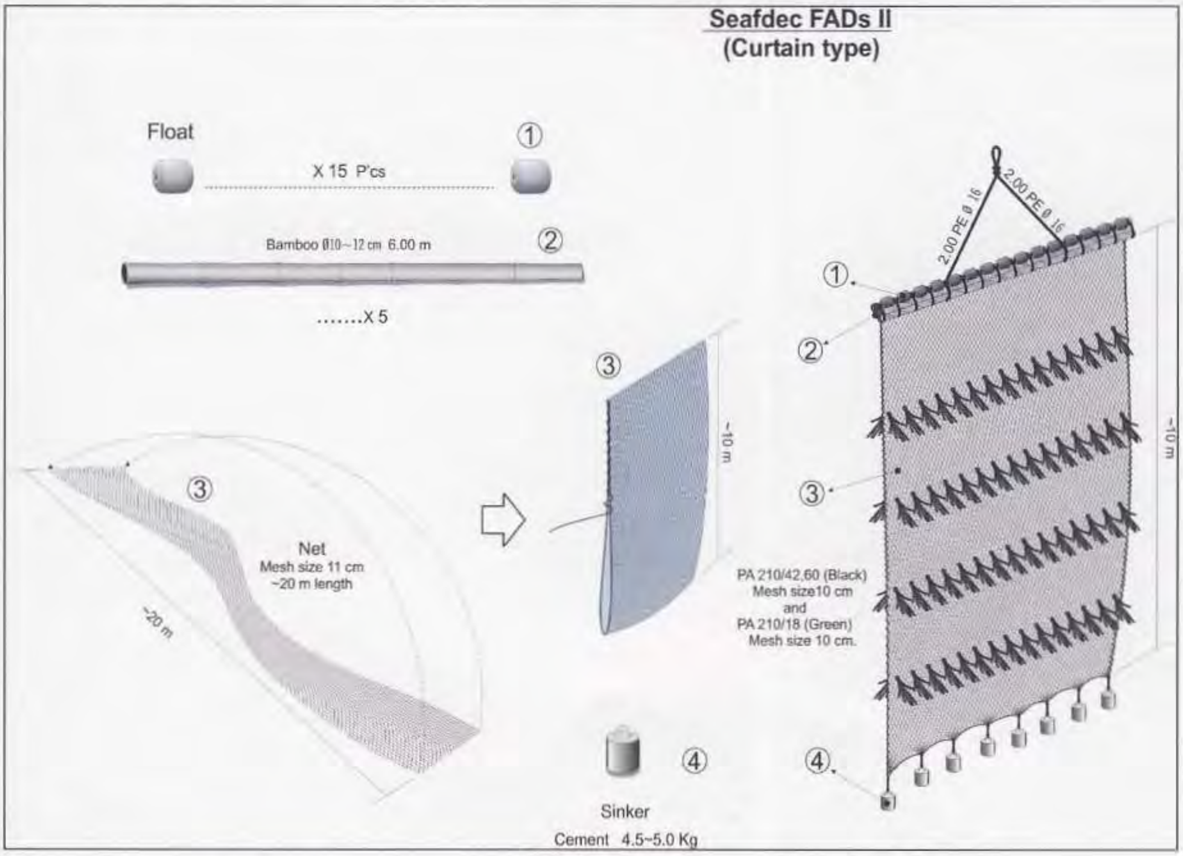


Figure 33 Design of R/V Nippon Maru Drifting Payao, Curtain Design

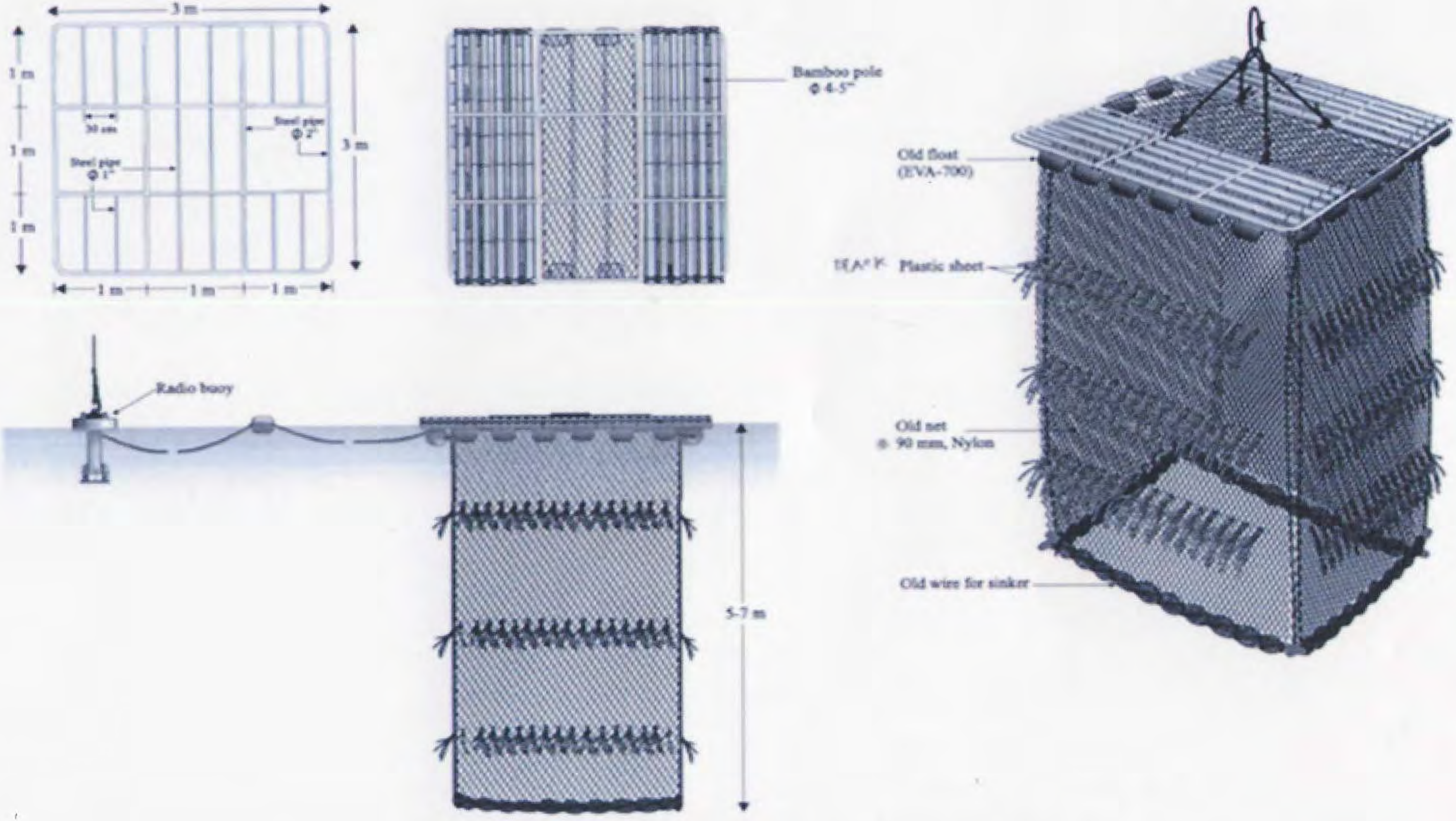


Figure 34: Design of R/V Nippon Maru Drifting Payao, Raft Design

4) Payao drifting pattern in Eastern Indian Ocean on fishing season 2000 to 2001

The setting of Payao is very important to successful gathering some fish schools. The location for Payao setting roughly decides by master fisherman experience. The direction and speed of oceanic current is very important as well. The accurate prediction of Payao position after drifting for 2 months can avoid the Payao drifting into some countries EEZ. Different from the roughly position, setting point is depended on the dense of fish. Master fisherman will set the Payao when he can find a drifting log, flock of bird or the school of prey. Payao condition will be proper for fishing after setting for 2-3 week.

R/V Nippon Maru set the Payao at the area of latitude from 01°40'S to 02°S and Longitude from 84°E to 86°E during the first navigation in August. The next navigation had been set at latitude from 04°S to 06°S and Longitude from 77°E to 78°E. The direction of the Payao in the end of year 2000 is south-western direction and the north-eastern direction in the early of year 2001. R/V Nippon Maru set these Payao within the group setting, 15-17 Payao a group.

August to October 2000

R/V Nippon Maru's Payao set the first group, six Payao around Lat. 02°S Long. 086-087°S in August 2000. After two months, in October 2000, all Payao drifted to SW/S - SW/W direction and average speed was calculated as 0.38 knot. (See figure 32)

The second group set on the same month, August 2000. Seven Payao were set around Lat. 01°S Long. 084°-085°S After two months, in October 2000, Payao drifted with varies direction. Two Payao drifted to E direction, two Payao drifted to NE/E direction and the others three Payao drifted to SW/S - SW/W (See figure) and the Payao No.7 was set with Argos buoy. It has shown the complete drifting track. (See figure 32)

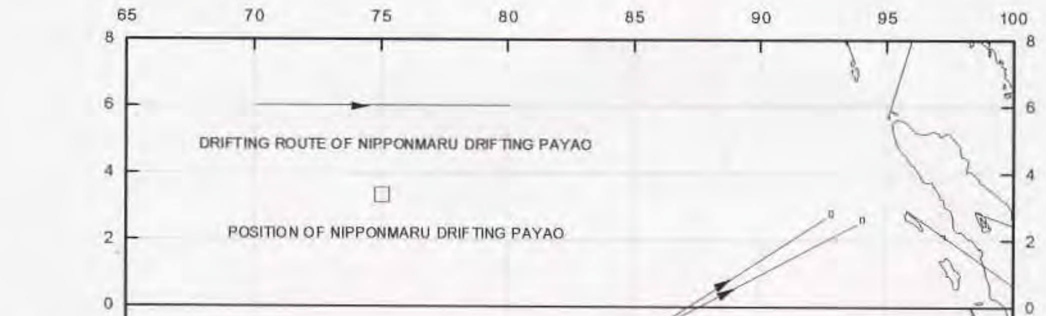


Figure 35: Drifting route of Nippon Maru Payao during August to October 2000

October to November 2000

Observation by 15 Nippon Maru drifting Payao, during October to November, drifting pattern of Nippon Maru Payao had shown the variations. 6 Payao drifted to north-east or east direction. 2 Payao drifted to south-east by east and south direction. 5 Payao drifted to west-north-west and west direction. (See Figure) Drifting speed is varied from 0.13 to 0.32 knot. The average speed of them is about 0.25 knot

It should be notified that During October to November, Payao drifted in non-constant direction. It seemed to drift from east to west and return back from west to east direction later. So that the average speed by calculation shown the speed is lower than other periods. The information can be collected by Argos buoy figure. (Figure 33)

November to December 2000

Observation from 27 times of 21 Nippon Maru Payao during November to December, the drifting pattern of all Nippon Maru Payao is the same direction. All Payao drifted to NE or ENE direction (See figure 34). Drifting speed of Payao was various from 0.4 to 1.3 knot. The average drifting speed on November to December was about 0.9 knots.

December 2000 to January 2001

Observation from 13 Nippon Maru Payao during December to January, the drifting pattern of Nippon Maru Payao were the same direction as drifting pattern during November to December 2000, from NE to E (See Figure 35) but drifting speed of Payao was slightly lower than November to December. Drifting speed had range from 0.4 to 0.8 knot. The average drifting speed on December to January was about 0.6 knots.

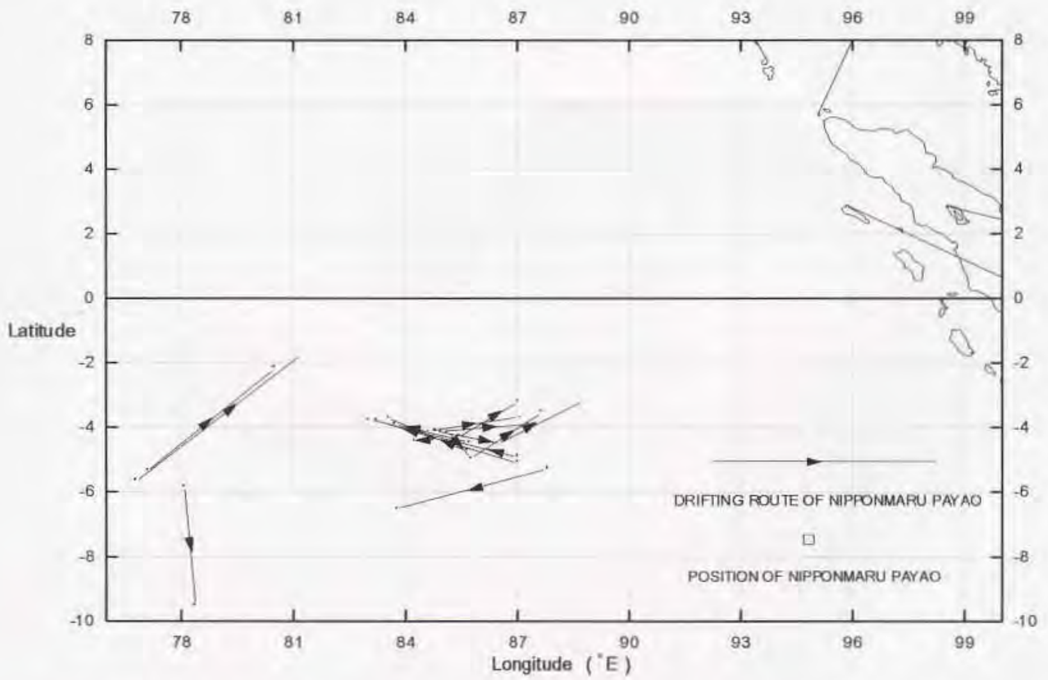


Figure 36: Drifting route of Nippon Maru Payao during October to November 2000

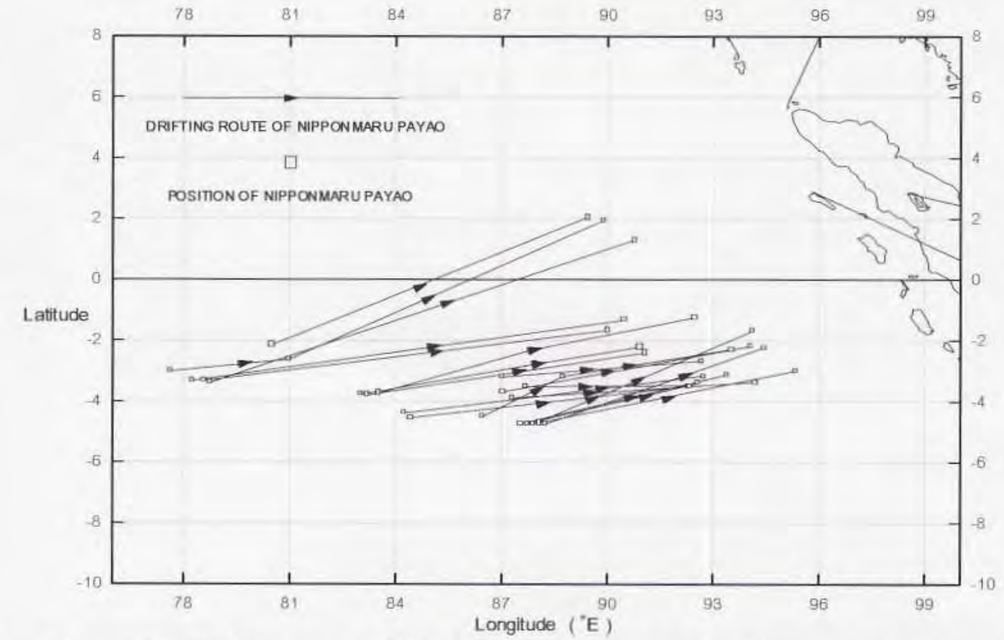


Figure 37: Drifting route of Nippon Maru Payao during November to December 2000

January to mid of February 2001

Observation from 17 times of 12 Nippon Maru Payao, during January to Mid of February, drifting pattern of 15 times of Nippon Maru Payao were found same direction, from NE to ENE (see figure 35). Drifting speed was slightly lower than previous period, from 0.4 to 1.0 knot. Other 2 Payao drifted and turned to ESE with speed about 0.2 knots. The average drifting speed of whole group on January to mid February was about 0.6 knots.

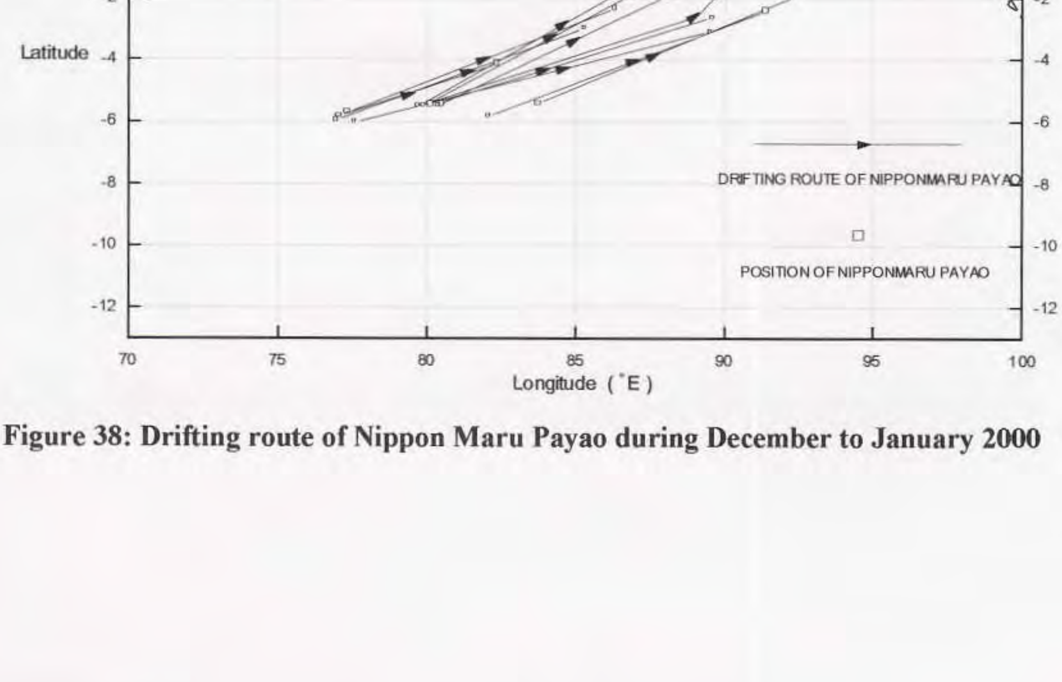


Figure 38: Drifting route of Nippon Maru Payao during December to January 2000

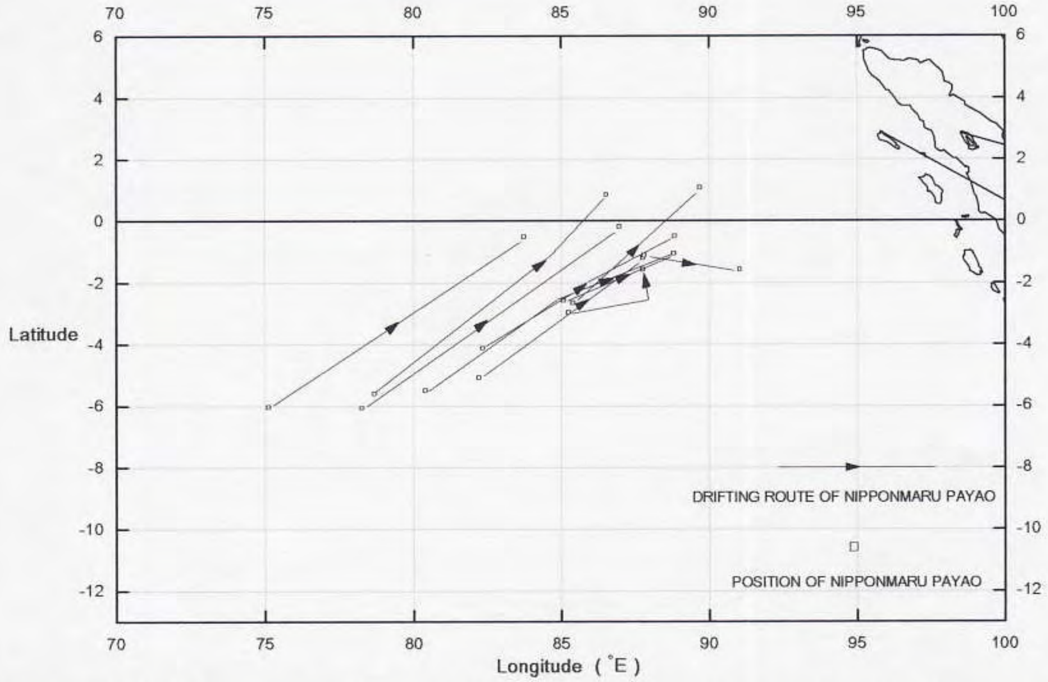


Figure 39: Drifting route of Nippon Maru Payao during January to mid February 2000

FISHING OPERATION part II: FISHING OPERATION

The continuing from the drifting object searching activities, a light buoy was attached when master fisherman decided to set the net at the drifting object. The ship was navigated against the windward to drift and wait until early morning. The distance between Payao and ship was depended on wind velocity in the area. R/V Nippon Maru usually spend half an hour for the weak wind condition and one hour for strong wind condition. Ship was blown back close to the Payao by the wind in the morning.

In the early morning, captain always navigated the ship approach to the Payao about 1-2 hours before fishing operation. The time was depended on the distance between Payao and ship after the drift at night. The distance for waiting before checking fish school was about 1200-1500 m. Crews woke up and took their breakfast about an hour before fishing operation. During the crew had their breakfast, captain navigated the ship to check fish school by Sonar and Echo sounder. The fish school, wind and current condition were kept into the consideration and decided to set or cancel the operation.

After checked fish school about 30 minutes or one hour before sun rise, the working boats were launched. A crew controlled each working boat, preceded to the Payao. When working boat arrived at Payao, two underwater lamps with 2000 watts were attached at Nippon Maru No.3. The lamps were set at the depth 10 m and 20 m. Nippon Maru No.2 was commanded to check the school around the Payao. Some operation the fish school did not stay under Payao. They sometime stayed far from Payao 100-200 m. During underwater lamps were switched on, both working boats were sending Echo sounder image via radio communication signal (call Tele-Echo sounder). Master fisherman can estimate amount, species and locate the position of fish school. He always spends 15-20 minute for luring.

Observation from the echo image, fish school near the Zero line (0-20m.) was school of bait, e.g. Rainbow runner, Leather jacket, Dorado and Indian mackerel. These two species have the different pattern. Rainbow-runner school always swim up and down, the vertical swimming of them are unstable. The Indian mackerel swim in the same layer as Rainbow runner but the vertical swimming character is stable. Upper line of Indian mackerel school in the echo-grams was usually found flat. The Skipjack tuna school was the same pattern as Indian mackerel but they stayed deeper and bigger image. In case of Indian mackerel big school or small school of Skipjack tuna, it is possible to confuse between Indian mackerel and Skipjack tuna. Tunas stayed in the deepest. The image was usually not big spot. It can be assumed that the tunas were fast swimming. It was not difficult to recognize the pattern of tuna images compare with skipjack.

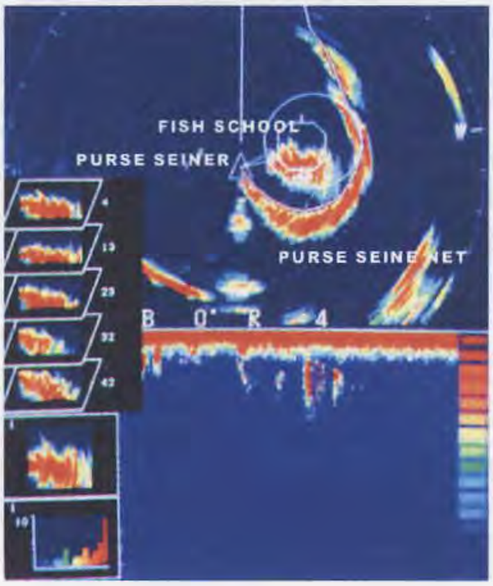
Figure 40: Echogram of Tele sounder from Nippon Maru No.3, Light boat

Shooting operation

When the ship was being approached to the target at distance about 1000 m., Radar was operated to check two working boat positions. By this reason it was important to know, where the fish stayed, at the underwater lamp or outside. Below 800 m., both of Sonar can detect the fish school. The speed of ship was increased up to 8-9-10 knots. The suitable distance between mother ship and target was always 350-400 m. While master fisherman order "*Let go*", Boatswain paid out hydraulic releasing hook. After releasing, the skiff boat was slip from the slipped way with the net end attached to the sea and mother ship full turned left. The first part was 45 meters towing wire after that the net is pulled down into the sea. Because R/V Nippon Maru is portside shooting, she always turns the left while shooting the net. Turning rate and speed of setting depend on behavior and location of fish school.

R/V Nippon Maru is portside net setting. She is necessary to keep the port side (left) while shooting the net. A crew at the main control console announced the length of net when the first buoy, the center of net and 350 meters before whole net was away from the deck. If the circle that can be complete with the net alone is too small, a larger circle can be made by letting out excess purse line and towing line. However master fisherman always let net away form board before ship makes a complete surrounding 100-200 m So that the towing line was necessary to pay out from the purse winch continuously until the mother ship reached at skiff boat. This activity is very important. The crew who maneuvered the purse winch must control the winch carefully. He must not to let the drum ran faster than the wire running out. So as to fouling the wire struck with the part of the wire in the reel. If the wire pay out get struck, Purse wire will be broken. All net will be sunk down and followed with a skiff boat. R/V Nippon Maru always spent 6-7 minutes for releasing whole net from the net space and spent the time about 8-9 minutes for complete the circle net.

Figure 41: Sonar Image on screen (Up) Net setting (Down)



Hauling operation

When mother ship reached the skiff boat, the skiff boat sent two guidance lines. The first was guidance line of purse line. It was hauled into the first drum of purse winch. The other was guidance line of the triangle stainless of triangle-bunt part. It was hauled by capstan winch and hung by a big pin near the winch after finish hauling. The hauling activities started from regaining the purse line, towing line and the triangle-bunt part of the net. Purse line was hauled from two ended parts to center. Purse wire from fore deck side was hauled into the front drum of winch. Purse line from Aft-deck side was hauled into the middle drum of winch. Both of lines were hauled back to the ship by a Purse winch. The towing warp was hauled into the rear drum of purse winch.

Before hauling back the purse line, purse winch controller spent 2-3 minutes for let the net sink down and 4-5 minutes when the strong current. The towing warp was finished when Stainless steel triangle shape of the wing part (portion No.1) was hung at the port side, stern deck. Time for towing warp hauling finishes and closes the circle of net was about 10-15 minutes. Nobody did allow to stays near the bulwark during towing warp hauling. The accident had been happened when the cover of sheave block of purse line or towing warp at the purse davit is opened. Some crews were killed from such event. The purse line hauling always took the time 25-30 minutes. The purse line hauling was finished when all rings were hung at the purse davit block.

The shooting position of net was concerned to the purse line hauling activities. During purse line hauling, the current or the wind direction was always same direction as heading of R/V Nippon Maru. If the current was strong, ship will be same direction as current. If wind is strong, ship will be same direction as wind. It meant that the actual shooing position was the real requirement degree (Heading direction during hauling operation) plus 30-40 degree.

Figure 42: Working boat is operating during the rough sea condition

Example that 20 knots wind blow R/V Nippon Maru from south to north and current was weak, the purse wire hauling heading was north. And the heading of start shooting was 320-330 degree. This concept was not constant because there were some more factors, e.g. current, fish school position and the characteristic of individual ship, etc. The start and finish shooting position can be read in the purse seine technical log.

Skiff boat was commanded to pull the mother ship to stern direction (5 o'clock) during towing line hauling. The purposes were, reducing the tension at towing line and tension between wire and its roller. After finish towing line hauling, skiff boat went to fore deck of mothership to get the other towing line for pulling mother ship from the net circle. Mothership was always turned her stern deck in to the net circle during purse line hauling. The heading was turned about 20-30 degree to port side or out of the net circle. A working boat was commanded to pull the net at the float line part away from stern deck (Slipway area), in order to prevent the entangling between net and rudder or propeller. The other working boat towed the Payao out of the net circle at stern area and tightened with the mothership at starboard side. During 15th fishing operation the working boat cannot tow the Payao pass the opening at stern deck. Working boat skipper kept the Payao towing rope as short as he could, and towed that Payao passed over float line with full speed. This method can prevent entangle between sinker of Payao and the net.

The net hauling was started after Payao was out the net circle. The Tuff-line rope was fixed with the triangle stainless frame. This frame was attached at the tip of triangle net and pulled by roller at purse winch. The net was passed through sheave of power block and compressed by power grip of power block. The power block has 5.5 tons pulling force with 20 meter per minute, running by hydraulic pressure. Because the floats is big size (EVA-M-500 and M-700) and reduce the numbers of crew, R/V Nippon Maru set a float shifter (Aba flex: Japanese calling) to shift the float from power block to the float space.

Figure 43: Net hauling (Left)
Float shifter or *Aba flex* (Right)
(Photo by W. Laongmanee, 2001)

Wind force always faced to the stern deck when crews were hauling the net. If the wind or swell face to the side of ship, ship will be rolled. The ship rolling makes the boom swing from side to another side. Master fisherman always selects this direction because he tries to avoid any dangers from the swing of all fishing booms. The other purpose is net handling is easily controlled circle formation. Net circle formation can let the fishes have area for swimming. It also reduces the catches damage from enmeshing.

Now a day, the American type purse seiners have already stopped to install ring striper and round purse rings for standard purse seine devices. They have developed the new technology for ring system call "Snap ring or Double roller purse ring. Double roller purse ring has been invented. The double roller ring can be open so that ring stripper is useless. The purse wire does not serve the heavy load during transfer the ring from the davit to ring striper. The purse wire can serve longer time than traditional ring system. Double roller ring system has been replaced the ring striper system in the world of purse seiner. The advantage of new system is the safety of crew and save the time.

Arrangement of crew working is important because the net is very large size. Fishing master manage the deck working by three crews arrange the floats and control the Aba-Flex system, two crews arrange the foot chain and seven crews arrange the net body. 1-2 crews take care of the double roller purse ring releasing. During hauling operation, researcher was only utility man. He measured the length and weight of fish and helped the crew by removing the fishes enmesh the net and marks the broken net.

Tuna purse seine net is big size. The stack of net was about 3 meters in high after arrange the net. To prevent the net falling or sliding, the net body is arranged by spiral or circle style. This method makes the net support each other of the net part. Master fisherman always controls the stern of ship against wind by skiff boat adjustment. The net is hauled until 6 last rings remained at the purse line. If there are not any trouble, hauling operation will take the time about 1:30 hours.

Figure 44: (Top) Tradition ring stripper was used in the previous (Photo by A. Munprasit, 1993)

(Left) Double roller purse ring is widely installed with purse seine net
(Right) A crew is hang purse ring at ring holder before hauling to net space (Photo by I. Chanrachkij, 2001)

(Right) Net hauling (Photo by W. Laongmanee, 2001)
(Left) Fishing-master controls all of activities during fishing operation (Photo by I. Chanrachkij, 2001)

When reached the bunt, the hauling device was change from power block to few hoists at the main boom and two fishing booms. The last 6 rings were pulled up on working deck by utility winch. After all 6 rings were removed from the bridle ropes and bunt hauling was done at working deck start from taking the foot chain up on board at working deck. Double braided rope was tightened at the net and that rope was pull up by hoists little by little. Skiff boat was tightened at the other side of net, open the net to be pond by assisting of Nippon Maru No.3 (see figure).

Figure 45: Bunt hauling by cargo hoists, double braid rope and crew

Nippon Maru No.3 conducted this duty until finish fish scooping to fish hold. If the weather condition was good, Nippon Maru No.2 was heave up on the mother ship before bunt part hauling. This activity spent the time about 40-50 minutes.

When reach the fish school that were died at the bottom of bunt, the giant scoop was used to take the fish up to the boat. The diameter of giant scoop is 1.8 m and scoop handle is made by Fiberglass 5 m length. Five crews must controlled handle of scoop in the skiff boat. Giant scoop was hauled by winches and a capstan at mothership and capstan at skiff boat. A full scoop can take a fish about 1.5 tons. If fishes were less than

2 tons whole bunt part will be pull up to working deck directly. During this period, Yellowfin tuna and Bigeye tuna, size 2 kg were tagged and release. It is a research program to study about life cycle and stock of tuna in Indian Ocean. All bunt part was pulled back by skiff boat into the sea after all fish take into the fish hold.

Figure 46: Activities continued by fish scooping from net to hopper and from hopper to fish dropped into fish hold through a conveyer

After transfer the catch from the net to the brine tank is complete the strapped down webbing is released and the cork line unlashed from the vessel and skiff rails, hauling and stacking is resume until all the webbing is out of the sea. Before end of the net pass through the power block, The cork purse line and breast line are release to their original attachment points, to the breast line and to the stainless steel triangle shape respectively, and the hoisting line is attached to the triangle so that it allows to pass over the for use during the net setting. After whole net is hauled up to the net space, skiff boat is pulling up to slip way and working boat is heaved up to the working boat space later. Before finish the activities, the crew have to arrange the guidance lines of purse wire and towing warp line. They are passed through the purse davit blocks and purse rings and set at the skiff boat. Some broken parts of net are repaired.

From the operation, fishes less than10 tons spent approximately 3 hours for operation and catches 50 tons spent 4:30 hours.

According to the fishing results the captain will take one of the following decisions;

1) Left DFAD or drifting object away and resumed searching for new school.

2) Retrieved DFAD onboard with the ideal of locating it in another appropriate area where tuna can be expected under the object

3) Attached radio beacon to DFAD of object with ideal of retuning to it at some future time and resume searching for another drifting object.

4) Remain next to the object so that it can not be used by other vessels and proceed to fish again at the right moment generally at dawn.

Payao can also heave up onboard when current drive them near coast particularly into shallower water area than 1000 m or the territory waters as no any licenses or permissions available. Purse seiner, have net with the depth up to 200 m and 1800 m length, is not able to operate with in the fishing ground less than 1000 m according to safety of the operation and purse seine net, therefore R/V Nippon Maru can not fish in these limited waters.

Figure 47: Fishing gear maintenance and preparation after finish fishing operation

Set on Porpoise

Even though fishing operation by R/V Nippon Maru has not conducted purse seine fishing operation by surrounding porpoise, the technique should be understand because this technique is quite sophisticate. The describe of the set on porpoise is quoted from Green, 1971;

The operation is started by searching activity. The fishermen spot the porpoise schools at the horizon with high power binoculars (up to 20 powers) some time mounted on swiveling rack on the bridge. Most of boats carry two such set of binoculars. While the boat is on the tuna grounds, a constant, "spotting watch" is kept during daylight with crew man rotating the duty. In addition, a look out with less powerful binoculars is posted on crow's nest.

Feeding schools often can be detected over the horizon by sighting the birds (Terns, bobbies and frigate birds) which gather over them. When the school of porpoise is sighted, the mother boat runs up on it while the lookout scans it for sign the fish. If the lookout spot numerous "jumper" (feeding fish breaking the surface), "shine" (flashes of reflected light from fish below the surface) or see a "blackspot" (dense school of fish below the surface) the mother boat prepare to set the purse seine net.

The mother boat stops engine, and the chaser-skiffs (also call "Speedboat" or "Pongos") are lower overboard. These boats herd and direct the porpoise slow them down if they are swimming and tighten up to school. Most large purse seiners use two *chaser-skiffs. A popular combination of skiff and engine is a 4.8 m FRP tri-hull using an outboard motor 85-105 hp. Skiff sailors are strapped in their seats and wear crash helmets.*

The master-fisherman directs the chase and set from the mast. He has radio transceiver contact with both chaser-skiff drivers.

Making a good set on porpoise is a fine art, and good "fishing skippers" are in high demand in tuna fleet. The fishing master directs and uses his chaser-skiff like shepherd does his dogs. When the school is headed properly, master-fisherman set his purse seine net.

When pursing is complete, the fish can no longer escape. Now the problem remains of separating the unwanted porpoise from the valuable tuna. For the porpoises, fishermen have developed an operation called "backing down". At the front end of the net (the end which goes overboard first, attach to the skiff boat) are several 30 fm length of line strung through 10 cm rings attached to the cork line by 0.9 m bridles. As soon as the front end of the net is picked up at the completion of the set circle and secure to the purse ring davit, the man in the cork tender passes three or four of these cork lines to the deck and they are pulled with the bow winch and secured.

This action caused the corks to bunch and a "balloon" to form in the bag of the net. The net is then dried up (take abroad) to approximately "half net" (further if the catch is small). The net is strapped down, the rings are secured and "backing down" begins. When the fish are near the net and the porpoise at far end of the net, master-fisherman signals, and the boat backs down, opening the net, and at the same time singing cork at the far end.

Most of the porpoises are spilled over the cork line. The tuna tend to swim up current into the balloon formed by bunched corks. Great care must be taken to avoid loosing the fish as well as the porpoise. If the fish head toward the end of the net, master-fisherman signals, and engine are immediately put into forward allowing the cork line to rise to surface. The cork tender is stationed at the end of the net to assist porpoises over the cork line.

After the backing down, the net is dried up to the bunt (reinforce section at the back of net). The bunt id "sacked up", this is, webbing in excess to that needed to hold the fish gathered up from the bottom and tied down. The skiff boats come alongside, and the cork-line on the side of the "bag" opposite the mother boat is secured to the skiff boat's rail. A portable rack is hung on the skiff boat and a crew man stand on the rack and assist the remaining porpoise over the cork line. The back is sack up farther, and the fish are bailed onboard.

Gorman, 1995, also confirms that porpoise will only be release safety and efficiently during backing down if the safety panel is of adequate size, properly installed and maintained, and correctly aligned to the backing down channel. Between 1979-1988, the death rates in sets in which the safety panel

FISH HANDLING BY REFRIGERATED BRINE

One of the important processes on fishing boat is how to handle fish quality after caught before deliver to canning plants or other post harvesting. R/V Nippon Maru has installed brine tanks, brine coolers and refrigerators for high quality fish handling.

Specification

Brine tanks volume	1500 m3
Fish holds volume	450 m3
Total volume	1950 m3
Maintained temperature	-40°c
Brine cooler	3 sets
Dimension	1300 mm diameter x 3100 mm long
Cooling area	170 m2
Flow rate	300 m/h
Refrigerated brine temperature	-17°c

On this cruise, brine tank no.6 at port side and starboard side were selected to dissolve salt or brine solution. Salt, 30 tons, was dissolved with seawater by using portable pump to stir water until well mixed situation which we call "brine solution". The brine solution should be kept at 24 to 25 brume scale concentration. Brine solution was possible to cool down by a screw type refrigerator to -16°c. Engineer conducted the same procedure for other two brine tanks, No. 6 port side and No.6 starboard side.

In the morning before starting purse seine operation, one from five refrigerated brine will be transferred to brine tank which was planned to load fish. After finished fish loading, brine tank need to a closed and temporary locked by small rope then pump refrigerated brine into loaded brine tank until full and decrease temperature to -16°c which normally took period for half day. If fish amount much enough, next day refrigerated brine should pump out and keep as dry condition with continuous lower temperature using reciprocating refrigerator No.3 or No.4

Figure 48: (Top) Crew is checking density of Brine solution (Down left) Fish in Brine solution and (Down right) frozen fish is unloading (Photo of M.V. SEAFDEC)

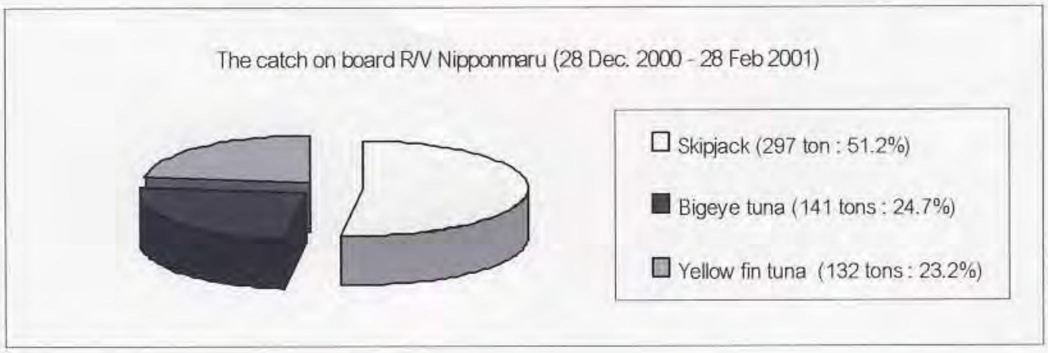
In case of catch amount in tank does not enough for that tank, often condition, engineer will reduce refrigerated brine for preparing space to receive more fish before fishing operation. Engineer should estimate the free space in brine take and loading fish not over than their capability, otherwise fish may be deform. Then do follow the same way after enough fish in brine tank. After dried out, brine tank temperature should be -25°c or lower until fish unloading.

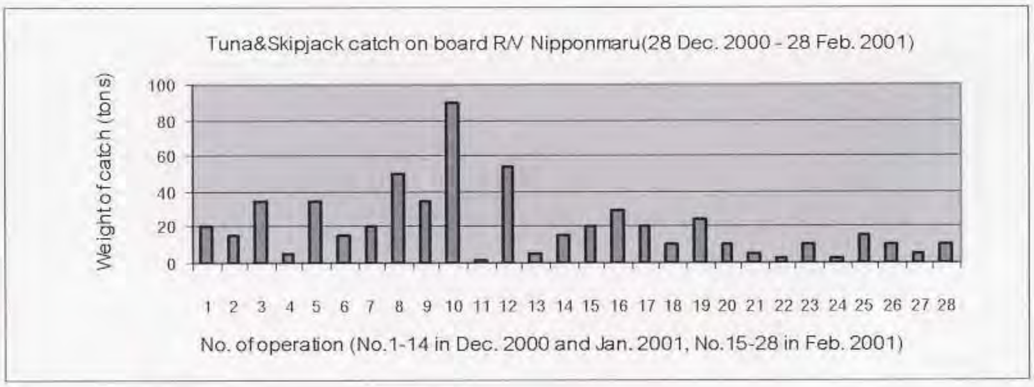
RESULT OF CATCH

During period from 28 December 2000 to 28 February 2001, R/V Nippon Maru had navigates in western of Indian Ocean for 63 days. She had exploited around British territory of Indian Ocean (Chagos Island). R/V Nippon Maru has set 28 Payao and found 5 drifting objects during stayed in fishing ground for 63 day. The 28 fishing operations were conducted within 58 days of fishing period (other 5 days were traveled to fishing ground). Twenty-three fishing operations had fished at Payao. Five fishing operations had fished at drifting logs. There were not any fish schools, free swimming and swim with porpoise school, found in the fishing ground. Total catch was 570 tons. The average catch for an operation was about 20 tons. The most catch in an operation was 90 tons and the lowest catch was 1 ton. There is notified that 14 operation with 395 ton (69.3%) doing in January. The average catch for an operation was about 28 tons. The other 14 operations were done in February. Total catch in February was 175 tons (30.7%). The average catch for an operation in February was about 12.5 tons. It is shown that the trend of tuna catch in Indian ocean is low, starting from February. Mr. Master-fisherman of R/V Nippon Maru said that the tunas are plenty during October to January and tuna resource starts to decline from February to April.

The catches, onboard R/V Nippon Maru, was mostly are Skipjack tuna (Katsuwonus pelamis) 297 tons (52.1%), Bigeye tuna (Thunnus obesus) 141 tons (24.7%) and Yellowfin tuna (Thunnus albacares) 132 tons (23.2%). The other fishes, not only trash but also damage fishes from hauling operation were discarded. These were many fishes, should be studied the on the amount and species composition in the future.

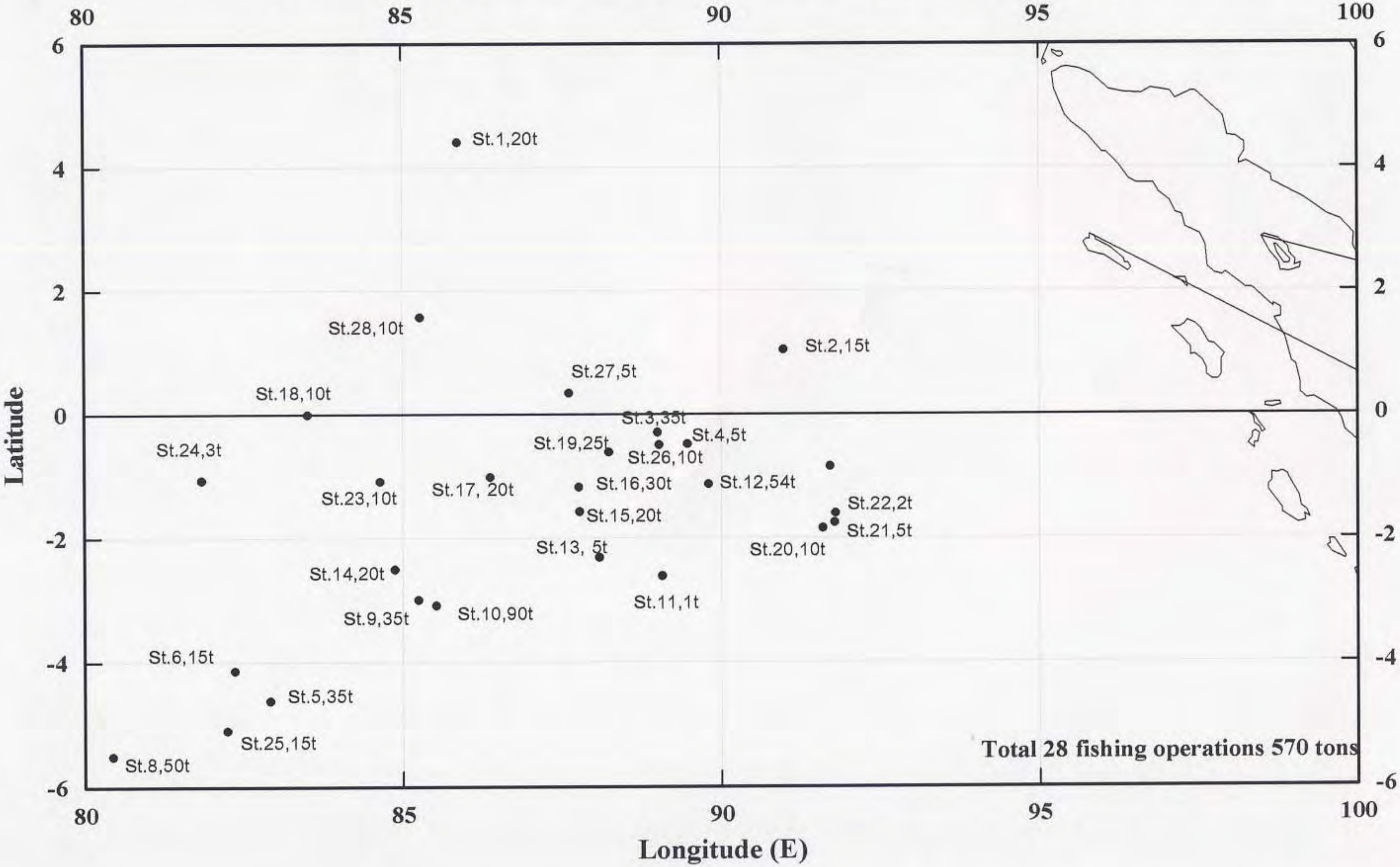
R/V Nippon Maru catch composition of tuna and skipjack (up)





R/V Nippon Maru catch of each operation (Down)

Figure 49: Fishing operation of R/V Nippon Maru during 28 December 2000 to 28 February 2001



MARINE RESEARCH ON R/V NIPPONMARU

A researcher from JAMARC conducted marine research on board R/V Nippon Maru. Three types of data are collected. The first is the oceanographic data collecting. The instruments for collecting these data are STD (Salinity-temperature-depth meter), XCTD (Expendable conductivity temperature and depth) and XBT (Expendable bathy-thermograph). Researcher collects the data of temperature, salinity and depth. Thermocline layer are also indicated by temperature date from STD of XBT or XCTD. The STD is operated a day before fishing operation. XBT is operated while R/V Nippon Maru navigated in the fishing ground and before fishing operation in case of bad weather. XBT is 2 types, i.e. T- 6 and T-7. XCTD is shot during the ship was passing some interesting area during navigation. Just 4 XCTD stations are shot because cost of XCTD is very expensive. 18 oceanographic stations are conducted by STD. 61 oceanographic stations are conducted by using XBT. Other weather conditions i.e., air temperature, air pressure, humidity, wind condition (direction/velocity). Sea condition included current condition in the depth of 10 m, 60 m and 120 m are recorded every fishing stations. The positions of oceanographic survey are appeared in oceanographic survey table.


Figure 50: (Left) Mr. Ikame S., Researcher is collecting oceanographic data by STD (Photo by I. Chanrachkij, 2001)
(Right) Mr.Kurihara, Researcher is collecting oceanographic data by launching the XCTD (Photo by W. Laongmanee, 2001)

The second research activity is tuna biology. The sampling of length & weight, gonad stage, stomach content of the target catch and the tagging on the Yellow fin tuna and Bigeye tuna which have weight about 2-3 kgs, are conducted every operations. The information let the marine scientist know about the biology and life circle of tuna in Indian Ocean. The data will and analyze on the stock, abundant and migration of tuna in Indian Ocean.

The third information is the fishing information, which received from other ships in Indian Ocean. During stay in the fishing ground, there are not only R/V Nippon Maru but also other Japanese and Japanese allies, namely F/V Genpukumaru, F/V Mukmanee and M/V SEAFDEC. R/V Nippon Maru is the center information exchange in the group. Fishing and weather information are send from these ships to R/V Nippon Maru everyday. All of information, oceanographic, biology, fishing and weather information are set to JAMARC center, Tokyo everyday. The catch information is sent to the center every day of operation too. The format of information is followed;

Quantity of fishes are checked and estimated. The estimation is separated into:

1. Total weight of fish (ton)
2. Individual species weight (ton). There are two patterns of individual species weight as follow;

1. The first record

Skipjack tuna	Yellow fin tuna	Bigeye tuna
8.0 kgs. Up	10.0 kgs. Up	3.0 kgs. up
6.0 kgs. Up	5.0 kgs. Up	1.5 kgs. up
4.5 kgs. Up	3.0 kgs. Up	1.5 kgs. Down
2.5 kgs. Up	1.5 kgs. Up	
1.5kgs. Up	1.5 kgs. Down	

2. The second record

Skipjack tuna	Yellow fin tuna	Bigeye tuna
3.4 kgs. Up	9.0 kgs. Up	9.0 kgs. up
1.8 kgs. Up	3.4 kgs. Up	3.4 kgs. up
1.4 kgs. Up	1.8 kgs. Up	1.8 kgs. Down
1.4 kgs. Down	1.4 kgs. Up	1.4 kgs. Up
		1.4 kgs. Down

This information is necessary for the fish marketing company in order that the negotiation between the company and the cannery where buy R/V Nippon Maru' s fishes.

All of information, oceanographic, biology, fishing and weather information are transferred to JAMARC center, Tokyo everyday. They are necessary to monitor the fishing ground, fishing season and tuna resource stock in Indian Ocean every year. Different from Pacific Ocean, Indian Ocean has rarely information of tuna stock and tuna migratory so that R/V Nippon Maru is necessary to search and collecting of this important information. The advantage is provided for the fishermen and fisheries biologists to predict the trend of tuna resource included the bycatch and fish selectivity of tuna purse seine the Indian Ocean in the future.

DISCUSSION

R/V Nippon Maru is one of the modern purse seiner operated in Indian Ocean. She is equipped with modern fishing, navigation, hauling devices and the purse seine net. Fish hold capacity is designed for contain over thousand tons fro a cruise. Her voyages ability in the sea is always as long as 60 days. Consider by her ship particular e.g. fishing net, deck machineries and fish holds, she was constructed for the professional tuna purse seine fishing activities. The ship has been improved year by year according to the innovations of the new technologies. Even though she is 15 years olds, her performance stills good condition with the modern equipments.

R/V Nippon Maru replaced the new cargo wire and purse wire, after 3 cruises finish, more than 100 operations, in order to maintain the supreme standard of safety of operations for crew. So that any accidents hardly happened while conduct fishing operation. During authors had stayed with R/V Nippon Maru for 2 months, there were not any accidents happened. It has shown not only the good maintenance of the fishing equipments but also the high seaman ability of crew. The crew understand their jobs and shown their responsible and highly skill during both navigation and fishing activities. The operation time of R/V Nippon Maru was very short (about 4:30 hour for 90 tons) and less the risky. Skill and high experience of all crew gathered from few hundred fishing operation each years.

M/V SEAFDEC was constructed for 9 years from the same dockyard as Nippon Maru. Because her purpose is training ship, some instruments are lower capacity than R/V Nippon Maru. The net, the working boat and the skiff boat with engines are smaller. But Navigation fishing and oceanographic instruments in M/V SEAFDEC are more performance. The fish hold in M/V SEFADEC is about 100 tons, 10% compare with R/V Nippon Maru. That is so far different from R/V Nippon Maru. Because small fish hold, few operations can make M/V SEAFDEC's the fish hold full in the short period. M/V SEAFDEC operates 3-5 cruises in a year. And 3-5 fishing operations are conducted during a cruise. The maximum total operations are about 20-25 times a year. That is not able to compare with R/V Nippon Maru. The seaman and purse seine performance, ability of M/V SEAFDEC's crew hardly to develop for the same class of R/V Nippon Maru. It is not included the fishing background of R/V Nippon Maru's crew. All of them come from the high sea fisheries companies. They are familiar to stay in the sea for long time.

The purposes for assigning the SEAFDEC staffs trained in R/V Nippon Maru are not only established the co-operating between SEAFDEC and JAMARC but also to develop the skill of M/V SEAFDEC staffs for tuna fishing operation. One of the major objectives of M.V. SEAFDEC is to training the participant of member counties on marine capture. The success of SEAFDEC/TD is come from the success of the training, that first priority is improvement the performance of instructors and crew. Shipboard working in professional ship i.e. R/V Nippon Maru, M/V Mukmanee is indirect method for improve their skill. High performance staff shall bring the success of training to SEAFDEC/TD. The success of training shall be up the performance trainee both fishing and engineering and that is important envisage of the training.

Tuna purse seine is large scale fishing gear. The fishing ground is quite distance from the motherland and operation is very dangerous because the heavy weight of gear and devices. The risky of crew can be reduced by own experience of crew and performance fishing equipments. Trainings and learning the new technology of purse seine is necessary, as well as the investment of the high quality fishing gear hauling devices and safety equipment onboard.

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Appendix 1: Table of Oceanographic survey station

Station	Date	Time	Position (Latitude/Longitude)	Instrument
1	29/12/2000	2015	Lat.04°50.5'N / Long.090°00.0'E	XBT / T6
2	30/12/2000	0249	Lat.04°45.1'N / Long.089°00.0'E	XBT / T6
3		0700	Lat.04°41.3'N / Long.088°00.0'E	XBT / T6
4		1130	Lat.04°38.2'N / Long.087°00.0'E	XBT / T6
5		1820	Lat.04°30.9'N / Long.085°36.9'E	STD
6	31/12/2000	1145	Lat.04°00.0'N / Long.085°49.5'E	XBT / T6
7		1743	Lat.03°00.0'N / Long.086°46.6'E	XBT / T7
8	01/01/2001	0020	Lat.01°59.4'N / Long.088°01.7'E	XBT / T7
9		1340	Lat.01°07.4'N / Long.090°41.4'E	STD
10	02/01/2001	2105	Lat.00°21.4'N / Long.088°54.0'E	STD
11	04/01/2001	1210	Lat.01°00.0'S / Long.089°21.0'E	XBT / T7
12		1515	Lat.01°36.8'S / Long.089°08.2'E	XBT / T6
13		1825	Lat.02°15.6'S / Long.088°54.0'E	XBT / T7
14		2100	Lat.02°36.4'S / Long.088°45.1'E	STD
15	05/01/2001	1330	Lat.03°04.0'S / Long.087°00.0'E	XBT / T7
16		2115	Lat.03°38.5'S / Long.085°30.0'E	XBT / T7
17	06/01/2001	0540	Lat.04°15.9'S / Long.084°00.0'E	XBT / T7
18		1120	Lat.04°21.8'S / Long.083°00.0'E	XBT / T7
19		1530	Lat.04°30.6'S / Long.082°28.5'E	STD
20	07/01/2001	1820	Lat.04°51.4'S / Long.081°30.0'E	XBT / T7
21	08/01/2001	0220	Lat.05°04.5'S / Long.080°00.1'E	STD
22		1520	Lat.06°06.8'S / Long.077°56.0'E	XBT / T6
23		2220	Lat.06°07.5'S / Long.076°30.0'E	XBT / T6
24	14/01/2001	1545	Lat.04°09.5'S / Long.082°03.4'E	STD
25	15/01/2001	1515	Lat.05°02.9'S / Long.081°57.7'E	STD
26	16/01/2001	2020	Lat.05°34.1'S / Long.080°18.1'E	STD
27	18/01/2001	2050	Lat.02°57.1'S / Long.085°10.1'E	STD
28	20/01/2001	1635	Lat.03°05.6'S / Long.087°06.1'E	XBT / T7
29	21/01/2001	0840	Lat.02°35.4'S / Long.089°10.0'E	XBT / T7
30	22/01/2001	1010	Lat.02°08.8'S / Long.092°27.9'E	STD
31	23/01/2001	1405	Lat.02°59.2'S / Long.091°08.3'E	STD
32	24/01/2001	1700	Lat.01°01.4'S / Long.089°48.1'E	STD
33	29/01/2001	1430	Lat.02°33.1'S / Long.087°50.3'E	STD
34	31/01/2001	0915	Lat.02°33.2'S / Long.087°00.1'E	XBT / T7
35		1410	Lat.02°38.0'S / Long.086°00.0'E	XBT / T7
36		1910	Lat.02°12.4'S / Long.087°05.0'E	XBT / T7
37	1/02/2001	1645	Lat.01°27.1'S / Long.087°59.1'E	STD
38	2/02/2001	1450	Lat.01°08.1'S / Long.089°00.0'E	XBT / T7
39		1920	Lat.01°09.3'S / Long.090°00.0'E	XBT / T7
40	3/02/2001	2135	Lat.01°05.0'S / Long.087°00.0'E	XBT / T7
41	4/02/2001	1110	Lat.01°17.7'S / Long.086°00.0'E	XBT / T7
42		2125	Lat.01°02.6'S / Long.085°00.0'E	XBT / T7
43	5/02/2001	1305	Lat.00°13.0'S / Long.083°58.1'E	XBT / T7
44	7/02/2001	1620	Lat.00°30.0'S / Long.088°05.5'E	XBT / T7
45	9/02/2001	1320	Lat.01°51.5'S / Long.091°32.7'E	XBT / T7
46	11/02/2001	2025	Lat.00°38.4'S / Long.089°57.7'E	STD
47	12/02/2001	1025	Lat.00°34.4'S / Long.089°00.0'E	XBT / T7
48		2000	Lat.00°32.5'S / Long.087°00.3'E	XBT / T7
49	13/02/2001	0600	Lat.00°34.4'S / Long.085°58.7'E	XBT / T7
50		1115	Lat.01°07.9'S / Long.085°00.0'E	XBT / T7

Station	Date	Time	Position (Latitude/Longitude)	Instrument
51		1645	Lat.01°14.5'S / Long.084°28.7'E	STD
52	14/02/2001	1400	Lat.01°48.2'S / Long.083°54.6'E	XBT / T7
53		2010	Lat.02°29.3'S / Long.083°00.0'E	XBT / T7
54	15/02/2001	0100	Lat.02°27.6'S / Long.082°00.0'E	XBT / T7
55		0540	Lat.02°26.4'S / Long.081°00.0'E	XBT / T7
56		1225	Lat.02°47.5'S / Long.079°55.3'E	XBT / T7
57		1850	Lat.02°24.8'S / Long.079°00.3'E	XBT / T7
58	16/02/2001	0525	Lat.02°07.0'S / Long.078°22.3'E	XBT / T7
49		0950	Lat.01°30.2'S / Long.078°30.6'E	XBT / T7
60		1310	Lat.01°23.1'S / Long.079°10.0'E	XBT / T7
61		1645	Lat.01°20.8'S / Long.080°00.0'E	XBT / T7
62		2100	Lat.01°18.0'S / Long.081°00.0'E	XBT / T7
63	17/02/2001	0920	Lat.01°07.1'S / Long.082°00.1'E	XBT / T7
64		1510	Lat.01°04.9'S / Long.083°05.4'E	XBT / T7
65		1935	Lat.01°35.5'S / Long.083°41.3'E	STD
66	18/02/2001	0615	Lat.00°30.6'S / Long.084°05.4'E	XBT / T7
67	18/02/2001	1515	Lat.00°15.6'S / Long.085°00.0'E	XBT / T7
68		1945	Lat.00°12.7'S / Long.086°54.0'E	XBT / T7
69	19/02/2001	1005	Lat.00°46.9'S / Long.088°00.0'E	XBT / T7
70		1515	Lat.01°05.5'S / Long.089°00.0'E	XBT / T7
71		1925	Lat.01°04.0'S / Long.090°00.0'E	XBT / T7
72		2345	Lat.01°01.6'S / Long.091°00.0'E	XBT / T7
73	20/02/2001	0825	Lat.00°50.8'S / Long.091°45.5'E	XBT / T7
74	21/02/2001	1115	Lat.00°52.3'N / Long.089°28.9'E	XBT / T6
75	23/02/2001	1715	Lat.00°13.1'N / Long.087°33.7'E	STD
76	24/02/2001	1420	Lat.00°50.3'N / Long.086°30.0'E	XBT / T6
77	25/02/2001	0955	Lat.01°33.4'N / Long.085°02.4'E	XCTD
78		1435	Lat.01°50.7'N / Long.086°00.0'E	XBT / T7
79		1920	Lat.02°07.7'N / Long.087°00.0'E	XCTD
80	26/02/2001	0000	Lat.02°25.1'N / Long.088°00.0'E	XBT / T7
81		0435	Lat.02°40.4'N / Long.089°00.0'E	XCTD
82		0915	Lat.02°55.7'N / Long.090°00.0'E	XBT / T7
83		1555	Lat.03°18.0'N / Long.091°30.0'E	XCTD

Appendix 2: Table of Fishing operation Station

Date (dd:mm:yy)	Time	Position (Lat./Long.)	Pressure (Hpa)	Wind Dir/Spd	Temp. (°C)		Thermocline Layer	Current Dir./Spd.(kts.)			Payao drifting	Shooting Spd/dir	Net Depth (m)	Catch (ton)
					Air	sea		0 m	50 m.	100 m.				
31/12/2000	0520-0926	Lat.04°23.1′N / Long.085°30.1′E	1009.5	NNW / 2	27.0	28.1	90-180m/ 14°C	SSW / 0.0	ESE / 0.2	NE / 0.5	230° / 0.7′	160°/ 8.5′	160	20
02/01/2001	0503-0815	Lat.01°01.6′N / Long.091°00.7′E	1008.2	W/14	27.0	28.0	120-180m/ 15°C	ESE / 0.0	SE/E / 0.2	SE / 0.5	094°/ 0.8′	070°/ 7′	160	15
03/01/2001	0505-0910	Lat.00°25.1′S / Long.089°01.8′E	1009.0	W/14	27.5	27.8	0-130m/ 18.5°C	NE/N / 0.0	E/N / 0.1	E / 0.6	102°/ 0.54′	040°/ 8′	160	35
04/01/2001	0518-0926	Lat.00°30.8′S / Long.089°30.1′E	1008.7	W/10-14	27.5	27.8	0-130m/ 18.5°C	NW/N / 0.0	NW/N / 0.3	N/W / 0.3	096°/ 0.47′	025°/ 8.5′	180	5
07/01/2001	0546-0957	Lat.04°38.3′S / Long.082°56.2′E	1008.6	NW/20	27.5	27.8	30-160m/ 14°C	N / 0.0	NE/E / 0.7	E/N / 1.0	097°/ 1.9′	080°/ 10.3′	110	35
15/01/2001	0552-0940	Lat.04°09.3′S / Long.082°23.0′E	1009.4	NW/12-14	27.0	28.1	0-160m/ 14.5°C	NE / 0.1	NE / 0.4	ENE / 1.0	072°/ 1.15′	040°/ 10.9′	105	15
16/01/2001	0550-0945	Lat.05°07.1′S / Long.082°15.6′E	1009.5	WNW/14-16	27.0	27.8	40-175m/ 13.2°C	NE / 0.0	NNW / 0.4	ENE / 0.3	090°/ 0.92′	020°/ 8.2′	150	20
17/01/2001	0558-1010	Lat.05°31.5′S / Long.080°27.6′E	1010.0	W/16-18	27.0	28.0	40-180m/ 12.5°C	NE / 0.0	NE / 0.6	NE / 0.6	056°/ 0.56′	005°/ 8.5′	125	50
19/01/2001	0538-0942	Lat.03°01.0′S / Long.085°16.4′E	1008.0	WNW/18-20	27.5	27.8	70-150m/ 15°C	ENE / 0.0	NE / 0.6	NE/E / 0.6	071°/ 0.70′	045°/ 8.8′	155	35
20/01/2001	0537-0954	Lat.03°06.3′S / Long.085°32.8′E	1008.7	NW/W/ 8-10	27.5	27.8	-	NNW / 0.0	N / 0.5	SE/E / 0..6	105°/ 0.72′	090°/ 8-9′	135	90
21/01/2001	0518-0813	Lat.02°38.1′S / Long.089°05.8′E	1007.5	SSE / 6	27.5	27.8	80-160m/ 14°C	E / 0.0	E / 0.2	NE/E / 0.6	031°/ 0.60′	020°/ 8-9′	136	1
26/01/2001	0527-0958	Lat.01°09.3′S / Long.089°49.5′E	1008.2	SW / 12-15	27.5	27.8	90-120m/ 15°C	SW / 0.0	NNW / 0.2	E / 0.6	245°/ 0.19′	353°/ 8-9′	150	54
30/01/2001	0536-0853	Lat.02°20.4′S / Long.088°06.6′E	1008.7	NW / 6-8	27.0	27.4	80-125m/ 19°C	NE / 0.0	NE/N / 0.2	N/W / 1.1	036°/ 1.0′	347°/ ~ 9′	115	5
31/01/2001	0541-0846	Lat.02°31.9′S / Long.084°53.7′E	1008.6	S / 8	27.0	27.8	80-95m/ 20.5°C	NE / 0.0	NNE / 0.2	S / 1.0	132°/ 0.53′	140°/ ~ 9′	125	15
01/02/2001	0530-0858	Lat.01°35.7′S / Long.087°47.7′E	1008.0	S/W / 6	27.0	27.6	100-125m/ 18°C	NW/W / 0.0	N/W / 0.3	NW/W / 0.8	319°/ 1.21′	290°/ ~ 9′	110	20
02/02/2001	0532-0859	Lat.01°12.0′S / Long.087°47.5′E	1007.0	SW / 15-17	27.4	28.0	100-150m/ 14°C	NE/E / 0.0	WNW / 0.2	W/N 1.0	326°/ 1.18′	300°/ ~ 9.4′	110	30
04/02/2001	0549-0858	Lat.01°02.4′S / Long.086°24.2′E	1008.6	W / 10	27.5	27.6	-	E/S / 0.1	NE/N / 0.1	NW/N 0.7	333°/ 1.04′	300°/ 8.5-9′	130	20
05/02/2001	0549-0858	Lat.00°01.8′S / Long.083°01.5′E	1009.4	W / 10	27.5	27.9	-	ESE / 0.1	E/S / 0.1	SW/W 0.9	-	250°/ 8.5-9′	135	10
08/02/2001	0530-0907	Lat.00°38.5′S / Long.088°15.6′E	1009.7	SW / 6	25.0	27.4	95-100m/ 18°C	SE / 0.0	N/E / 0.1	SE / 0.1	118°/ 0.63′	015°/ ~ 9′	158	25
09/02/2001	0503-0840	Lat.01°52.2′S / Long.091°36.9′E	1009.2	W / 18-30	27.5	27.5	-	NNE / 0.0	E/N / 0.1	E/N / 1.0	074°/ 0.95′	03°/ 7.5- 9′	124	10
10/02/2001	0502-0817	Lat.01°46.9′S / Long.091°48.8′E	1008.6	W / 15-17	27.5	27.5	95-100m/ 18°C	SSW / 0.1	NW/W / 0.1	E/N / 0.9	070°/ 1.0′	015°/ ~ 9′	128	5
11/02/2001	0506-0803	Lat.01°57.8′S / Long.091°49.0′E	1008.2	NW /15	27.5	28.0	-	E / 0.0	SE/E / 0.2	E/N / 0.4	066°/ 0.66′	080°/ 8-9′	145	2
14/02/2001	0544-0835	Lat.01°06.6′S / Long.084°40.3′E	1009.5	NW/W /10	27.5	27.7	95-130m/ 14°C	NE/N / 0.1	NE / 0.4	NNE / 0.9	034°/ 1.19′	023°/ ~ 9′	95	10
17/02/2001	0556-0840	Lat.01°05.1′S / Long.081°52.1′E	1010.8	NW / 12	27.5	28.2	-	WSW / 0.0	NNE / 0.4	NE/E / 0.8	029°/ 0.73′	027°/ ~10′	115	3
20/02/2001	0515-0822	Lat.00°52.4′S / Long.091°44.4′E	1010.9	W / 12	27.5	27.5	-	E/S / 0.0	NE / 0.3	NE/E / 1.0	037°/ 0.87′	025°/ ~9′	120	15
23/02/2001	0556-0840	Lat.00°29.6′S / Long.089°03.0′E	1010.0	SW / 10	28.0	28.1	-	SE / 0.0	ENE / 0.3	E / 0.6	064°/ 0.58′	045°/ 8-9′	145	10
24/02/2001	0533-0820	Lat.00°19.4′N / Long.087°38.5′E	1009.8	WSW / 4	28.1	27.5	90-120m/ 17.5°C	S / 0.0	E / 0.4	WSW / 0.5	012°/ 0.56′	342°/ ~9′	122	5
25/02/2001	0557-1000	Lat.01°32.8′N / Long.085°01.6′E	1009.8	NE / 10	28.7	27.5	-	SSE / 0.0	NE / 0.2	E/S / 0.4	055°/ 0.47′	080°/ ~9′	145	10

Appendix 3: Table of Activities of R/V NIPPONMARU (28 December 2000 – 4 March 2001)

Date	Time	Particular	Remark
25/12/2000	0800-1915	SEAFDEC/DSG* visited Phuket fishing port.	
	1000-1130	SEAFDEC/DSG* discussed with the senior staffs of R/V Nippon Maru at Phuket harbor.	
	1400	DSG returned to Bangkok.	
26/12/2000	0845	Embarked board R/V Nippon Maru.	
	0900-1500	Fish unloading and taking some equipments and spare parts.	
	1500-1615	Tuna information discussion with DOF people.	
	1630	R/V Nippon Maru finished all activities.	
27/12/2000	0100-2400	Holiday	
28/12/2000	0600	St/by main engine, prepare for leaving Phuket Port.	
	0630-0715	Loaded some provision and drinking water.	
	0725	R/V Nippon Maru left Phuket harbor for fishing ground.	
	0730-0810	Crews arranged all wire, hooks and cargo booms.	
	0810	Ship proceeded to Payao No.147 Lat. 05°24.13′N λ 085°56.9′E.	
	1200	Noon position was Lat. 07°17.9′N λ 097°32.3′E.	
29/12/2000	0800-1100	Fish hold cleaning. Prepared fishing gear for fishing operation.	
	2015	Oceanographic survey at Lat. 04°50.5′N λ 090°00.0′E.	XBT / T6
30/12/2000	0240	Oceanographic survey at Lat. 04°45.1′N λ 089°00.0′E.	XBT / T6
	0700	Oceanographic survey at Lat. 04°41.3′N λ 088°00.0′E.	XBT / T6
	1130	Oceanographic survey at Lat. 04°38.2′N λ 087°00.0′E.	XBT / T6
	1200	Noon position was Lat. 04°37.8′N λ 086°53.0′E.	
	1738	Ship arrived Payao No.147 on Lat. 04°29.7′N λ 085°35.7′E then attached a light buoy for fishing operation.	
	1820	Oceanographic survey at Lat. 04°30.9′N λ 085°36.9′E.	STD
31/12/2000	0415-0926	Purse seine operation 1st at Lat. 04°23.1′N λ 085°30.1′E. Picked Payao No.147 up after finished fishing then R/V Nippon Maru proceed to Payao No.79	Fish 20 tons
	1145	Oceanographic survey at Lat. 04°00.0′N λ 085°49.5′E.	XBT / T6
31/12/2000	1200	Noon position was Lat. 03°56.8′N λ 085°52.4′E.	
	1743	Oceanographic survey at Lat. 03°00.0′N λ 086°46.6′E.	XBT / T7
01/01/2001	0020	Oceanographic survey at Lat. 01°54.9′N λ 088°01.7′E.	XBT / T7
	1200	Noon position was Lat. 01°08.8′N λ 090°39.2′E.	
	1245	Found Payao No.79 Lat. 01°03.1′N λ 090°46.4′E then attached light buoy for fishing operation.	

Date	Time	Particular	Remark
01/01/2001	1340	Oceanographic survey at Lat. 01°07.4′N λ 090°41.4′E.	STD
02/01/2001	0503-0815	Purse seine operation 2nd at Lat. 01°01.6′N λ 091°00.7′E. Picked Payao No.79 up after finished fishing then R/V Nippon Maru proceed to Payao No.39	Fish 15 tons
	1200	Noon position was Lat. 00°31.9′N λ 090°21.9′E.	
	2019	Found Payao No.39 Lat. 00°23.8′S λ 088°58.9′E then attached a light buoy for fishing operation.	
	2105	Oceanographic survey at Lat. 00°21.4′N λ 088°54.0′E.	STD
03/01/2001	0510-0910	Purse seine operation 3rd at Lat. 00°25.1′S λ 089°01.8′E. Picked Payao No.39 up after finished fishing then R/V Nippon Maru proceeded to Payao No.40	Fish 35 tons
	1034	Found Payao No.40 Lat. 00°30.0′S λ 089°21.1′E then attach light buoy for fishing operation.	
	1200	Noon position was Lat. 00°28.0′S Long. 089°19.9′E.	
04/01/2001	0518-0925	Purse seine operation 4th at Lat. 00°25.1′S λ 089°01.8′E. Picked Payao No.40 up after finished fishing then R/V Nippon Maru proceeded to Payao No.42	Fish 5 ton.
	1200	Noon position was Lat. 00°56.6′S Long. 088°23.1′E.	
	1210	Oceanographic survey at Lat. 01°00.0′S λ 089°21.0′E.	XBT / T7
	1515	Oceanographic survey at Lat. 01°36.8′S λ 089°08.2′E.	XBT / T6
	1825	Oceanographic survey at Lat. 02°15.6′S λ 088°54.0′E.	XBT / T7
	2013	Found Payao No.42 Lat. 00°30.0′S λ 089°21.1′E then attached a light buoy for fishing operation.	
	2105	Oceanographic survey at Lat. 02°36.4′S λ 088°45.1′E.	STD
05/01/2001	0440	Canceled purse seine operation because of few fishes. Drifted Payao No.42 then R/V Nippon Maru proceeded to a drifting object.	
	1200	Noon position was Lat. 02°59.1′S Long. 087°19.0′E.	
	1330	Oceanographic survey at Lat. 03°04.0′S λ 087°00.0′E.	XBT / T7
	2115	Oceanographic survey at Lat. 03°38.5′S λ 085°30.0′E.	XBT / T7
06/01/2001	0540	Oceanographic survey at Lat. 04°15.9′S λ 084°00.0′E.	XBT / T7
	1120	Oceanographic survey at Lat. 04°21.8′S λ 083°00.0′E.	XBT / T7
	1200	Noon position was Lat. 04°23.1′S λ 082°53.2′E.	
	1345	Found a drifting object at Lat. 04°34.5′S λ 082°27.4′E then attached a light buoy for fishing operation.	Drifting log is steel Cylindrical tank
	1530	Oceanographic survey at Lat. 04°30.6′S λ 082°28.5′E.	STD
07/01/2001	0546-0957	Purse seine operation 5th at Lat. 04°38.3′S λ 082°56.2′E. Drifted the drifting object after finished fishing then R/V Nippon Maru proceeded to British Indian Ocean Territory (BIOT) EEZ.	Fish 35 tons
	1200	Noon position was Lat. 04°41.7′S λ 082°39.6′E.	
	1820	Oceanographic survey at Lat. 04°51.4′S λ 081°30.0′E.	XBT / T7
08/01/2001	0220	Oceanographic survey at Lat. 05°04.5′S λ 080°00.0′E.	STD
	0700-1100	All crew searched for drifting object.	

Date	Time	Particular	Remark
08/01/2001	1030	Found a bamboo pole Lat. 05°37.4′S λ 078°43.1′E. Payao No.40 was set at that bamboo pole.	
	1200	Noon position was Lat. 05°46.5′S Long. 078°38.0′E.	
	1218	Payao No.39 set at Lat. 05°48.3′S λ 078°35.9′E.	
	1330	Payao No.79 set at Lat. 05°57.2′S λ 078°26.9′E.	
	1430	Payao No.3 set at Lat. 06°06.2′S λ 078°26.9′E.	
	1520	Oceanographic survey at Lat. 06°06.8′S λ 077°56.0′E.	XBT / T6
	2220	Oceanographic survey at Lat. 06°07.5′S λ 076°30.0′E.	XBT / T6
09/01/2001	0630-1230	All crew searched for drifting object.	
	0800	Payao No.97 set at Lat. 06°04.4′S λ 075°89.2′E.	
	0912	Payao No.105 set at Lat. 05°57.6′S λ 074°58.4′E.	
	1012	Payao No.104 set at Lat. 05°53.8′S Long. 074°49.2′E.	
	1124	Payao No.98 was set at Lat. 05°56.2′S λ 074°37.6′E.	
	1200	Noon position was Lat. 05°59.0′S λ 074°33.9′E.	
	1230	Payao No.148 set at was Lat. 06°00.8′S λ 074°29.7′E.	
	1330	Payao No.8 was set at Lat. 05°55.2′S λ 074°20.5′E.	
	1430	Payao No.147 was set at Lat. 05°50.0′S λ 074°11.4′E.	
	1520	Payao No.132 was set at Lat. 05°44.7′S λ 074°02.2′E.	
10/01/2001	0630-1100	All crew searched for drifting object.	
	1200	Noon position was Lat. 04°37.0′S λ 072°00.1′E.	
11/01/2001	0700-0940	All crew searched for drifting object.	
	0940-1100	Crew built 3 Drifting Payao	
	1200	Noon position was Lat. 05°22.6′S λ 069°12.8′E.	
12/01/2001	0700-1100	All crew searched for drifting object.	
	0730-1100	Crew built 4 Payao	
	1200	Noon position was Lat. 04°09.2′S λ 071°25.0′E.	
13/01/2001	0554	Payao No.43 was set at Lat. 04°10.0′S λ 074°45.2′E.	
	0600-1100	All crew searched for drifting object.	
	0700	Payao No.44 was set at Lat. 04°11.3′S λ 074°57.9′E.	
	0745	Payao No.45 was set at Lat. 04°09.1′S λ 075°06.4′E.	
	0845	Payao No.46 was set at Lat. 04°03.9′S λ 075°15.7′E.	
	0937	Payao No.47 was set at Lat. 04°05.3′S λ 075°26.8′E.	
	1026	Payao No.48 was set at Lat. 04°07.4′S λ 075°57.1′E.	
	1200	Noon position was Lat. 04°06.1′S λ 075°57.1′E. Then R/V Nippon Maru proceed to Payao No.22	
14/01/2001	1200	Noon position was Lat. 04°17.2′S λ 081°31.4′E.	
	1420	Found Payao No.22 Lat. 04°14.4′S λ 082°06.4′E then attached a light buoy for fishing operation.	
	1545	Oceanographic survey at Lat. 04°09.5′S λ 082°03.4′E.	STD
15/01/2001	0552-0900	Purse seine operation 6th at Lat. 04°09.3′S λ 082°23.0′E. Drifted Payao No.22 after finished fishing then R/V Nippon Maru proceeded to Payao No.150.	Fish 15 tons
	1200	Noon position was Lat. 04°40.4′S Long. 082°09.4′E.	
	1410	Found Payao No.150 Lat. 05°07.0′S λ 082°01.1′E then attach a light buoy for fishing operation.	
	1515	Oceanographic survey at Lat. 05°02.9′S λ 081°57.7′E.	STD
16/01/2001	0550-0945	Purse seine operation 7th at Lat. 05°07.1′S λ 082°15.6′E. Drifted Payao No.150 after finished fishing then R/V Nippon Maru proceeded to Payao No.120	Fish 20 tons

Date	Time	Particular	Remark
16/01/2001	1200	Noon position was Lat. 05°13.0′S λ 081°49.8′E.	
	1920	Found Payao No.120 Lat. 05°034.4′S λ 080°22.8′E attached a light buoy for fishing operation.	
	2020	Oceanographic survey at Lat. 05°34.1′S λ 080°18.1′E.	
17/01/2001	0558-1010	Purse seine operation 8th at Lat. 05°31.5′S λ 080°27.6′E. Drifted Payao No.120 after finished fishing then R/V Nippon Maru proceeded to Payao No.151	Fish 50 tons
	1200	Noon position is Lat. 05°18.8′S Long. 080°54.1′E.	
18/01/2001	0700	Found Payao No.151 Lat. 03°05.6′S λ 085°01.5′E then attached a light buoy for fishing operation.	
	1200	Noon position was Lat. 02°35.9′S λ 086°94.4′E.	
	1330	Found Payao SEAFDEC No.26 Lat. 02°21.4′S λ 086°19.6′E. Checked fish and left it back to Payao No.151	
	2050	Oceanographic survey at Lat. 02°57.1′S λ 085°10.1′E.	STD
19/01/2001	0538-0942	Purse seine operation 9th at Lat. 03°01.0′S λ 085°16.4′E. Drifted Payao after finished fishing. then R/V Nippon Maru proceed back to the same Payao No.151	Fish 35 tons
	1010	Found Payao No.151 Lat. 03°02.6′S λ 085°19.3′E then attached a light buoy for fishing operation.	
	1200	Noon position is Lat. 03°02.0′S λ 085°20.0′E.	
20/01/2001	0537-0954	Purse seine operation 10th at Lat. 03°06.3′S λ 085°32.8′E. Drifted Payao No.151 after finished fishing then R/V Nippon Maru proceeded to the Drifting Payao No.34	Fish 90 tons
	1200	Noon position was Lat. 03°09.0′S λ 086°02.6′E.	
	1443	Found Payao No.34 Lat. 03°06.6′S λ 086°41.2′E. Changed radio buoy to be SEAFDEC No.32 then R/V Nippon Maru proceeded to the Payao No.100.	
	1635	Oceanographic survey at Lat. 03°05.6′S λ 087°06.1′E.	XBT / T7
	0142	Found Payao No.100 Lat. 02°40.2′S λ 089°04.6′E then attached a light buoy for fishing operation.	
21/01/2001	0518-0813	Purse seine operation 11th at Lat. 02°38.1′S λ 089°05.8′E. Picked up Payao No.100 after finished fishing then R/V Nippon Maru proceeded to Payao No.139	Fish 1 ton
	0840	Oceanographic survey at Lat. 02°35.4′S λ 089°10.0′E.	XBT / T7
	1200	Noon position was Lat. 02°26.5′S λ 089°55.0′E.	
	1500	Found Payao No.139 Lat. 02°10.8′S λ 090°33.5′E. Picked it up after checking fish school.	
	1555	Oceanographic survey at Lat. 02°15.3′S λ 090°41.8′E.	XBT / T7
	1922	Found Payao No.19 Lat. 02°33.0′S λ 091°22.3′E then attached a light buoy for fishing operation.	
	2010	Oceanographic survey at Lat. 02°34.4′S λ 091°18.1′E.	STD
22/01/2001	0410	Cancel purse seine operation because of few fishes. Picked Payao No.19 up after checking fish school then R/V Nippon Maru proceeded to Payao No.149	
	0930	Found Payao No.149 Lat. 02°11.4′S λ 092°30.3′E then attached a light buoy for fishing operation.	

Date	Time	Particular	Remark
22/01/2001	1010	Oceanographic survey at Lat. 02°08.8′S λ 092°27.9′E.	
	1200	Noon position was Lat. 02°08.5′S λ 092°27.3′E.	
23/01/2001	0410	Cancel purse seine operation because of gale (20-30 knots). Drift Payao N0.149 after checking fish school then R/V Nippon Maru proceeded to drifting object	
	1200	Noon position was Lat. 02°51.7′S λ 091°16.8′E.	
	1310	Found the drifting object Lat. 03°03.2′S λ 091°09.6′E then attached light buoy for fishing operation then proceed to drifting	
	1405	Oceanographic survey at Lat. 02°59.2′S λ 091°08.3′E.	STD
24/01/2001	0420	Cancelled purse seine operation because of strong wind (20-30 knots). Drifted the drifting log after checking fish school then R/V Nippon Maru proceeded to Payao N0. 41	
	1535	Found Payao No.41 Lat. 01°08.4′S λ 089°55.9′E then attach light buoy for fishing operation.	
	1700	Oceanographic survey at Lat. 01°01.4′S λ 089°48.1′E.	STD
25/01/2001	0445	Cancelled purse seine operation because of rough sea (swell 3-4 m.) then R/V Nippon Maru drifted for fishing operation tomorrow.	
	1200	Noon position was Lat. 01°07.2′S λ 089°53.9′E.	
26/01/2001	0527-0958	Purse seine operation 12th at Lat. 01°09.3′S λ 089°49.1′E. Drifted Payao No.41 after finish fishing then R/V Nippon Maru proceeded to Payao No.42	Fish 54 tons.
	1200	Noon position was Lat. 01°17.7′S λ 090°12.1′E.	
	1243	Found Payao No.42 Lat. 01°19.7′S λ 090°21.5′E then attached light buoy for fishing operation.	
27/01/2001	0445	Cancelled purse seine operation because of rough sea (swell 3-4 m, wind 20-25 knot). Drifted Payao N0.42 after checking fish school then R/V Nippon Maru proceeded to Payao No.149	
	1200	Noon position was Lat. 02°04.0′S λ 091°42.6′E.	
	1440	Found Payao No.149 Lat. 02°16.9′S λ 092°18.9′E then picked it up after checking fish school.	
	1735	Found a drifting object Lat. 02°45.9′S λ 092°29.6′E then attached a light buoy for fishing operation.	
28/01/2001	0445	Cancelled purse seine operation because of rough sea (swell 5 m, wind 30-40 knots) Drifted drifting object after checking fish school then R/V Nippon Maru proceeded to Payao No.151	Very rough sea, Force 6-7 (30-40 Knots)
	1200	Noon position was Lat. 02°40.5′S λ 091°55.1′E.	
29/01/2001	1200	Noon position was Lat. 02°28.9′S λ 088°08.3′E.	
	1255	Found Payao No.151 Lat. 02°32.1′S λ 087°59.6′E was attached a light buoy for fishing operation.	
	1320	Found drifting log Lat. 02°33.4′S λ 087°57.1′E then attach a light buoy for fishing operation.	
	1430	Oceanographic survey at Lat. 02°33.1′S λ 087°50.3′E.	STD
30/01/2001	0536-0853	Purse seine operation 13th at Lat. 02°20.4′S λ 088°06.6′E. Drifted a log after finished fishing then R/V Nippon Maru proceeded to Payao No.120	Fish 5 tons
	0945-1200	Transferred catches from brine tank No.6 starboard to	

Date	Time	Particular	Remark
30/01/2001	0945-1200	freezer No.11 starboard 30 ton, No.11 port side 10 ton	
	1200	Noon position was Lat. 02°18.0′S λ 087°31.0′E.	
31/01/2001	0015	Found Payao No.120 Lat. 02°30.9′S λ 084°51.5′E then attached a light buoy for fishing operation.	
	0541-0846	Purse seine operation 14th at Lat. 02°31.9′S λ 084°53.7′E. Drifted Payao No.120 after finishing fishing then R/V Nippon Maru proceeded to Payao No.151	Fish 15 tons
31/01/2001	0915	Oceanographic survey at Lat. 02°33.2′S λ 085°00.0′E.	XBT / T7
	0950	Payao No.19 was set at Lat. 02°35.9′S λ 085°07.1′E.	
	1035	Payao No.149 was set at Lat. 02°38.0′S λ 085°17.2′E.	
	1120	Found a drifting log. Payao No.139 was set at Lat. 02°41.7′S λ 085°25.1′E.	
	1200	Noon position was Lat. 02°41.5′S λ 085°31.4′E.	
	1230	Payao No.100 was set at Lat. 02°41.6′S λ 085°38.1′E.	SEAFDEC GPS Buoy No.35
	1410	Oceanographic survey at Lat. 02°38.0′S λ 086°00.0′E.	XBT / T7
	1910	Oceanographic survey at Lat. 02°12.4′S λ 087°05.0′E.	XBT / T7
	2300	Drifting for purse seine operation at Lat. 01°44′S λ 087°53′E., near Payao No.151	
01/02/2001	0530-0858	Purse seine operation 15th at Lat. 01°35.7′S λ 087°47.7′E. Drifted Payao No.151 after finishing fishing then R/V Nippon Maru proceeded to Payao No.150.	Fish 20 tons
	0958-1200	Transferred fishes 35 ton from brine tank No.4 port side to freezer No.9 port side. There were fishes 4 ton in brine tank No.4 port side	
	1007	Found a drifting log at Lat. 01°30.9′S λ 087°57.3′ S. A radio buoy was set at log.	
	1033	Found Payao No.150 Lat. 01°30.9′S λ 088°00.0′E tehn attached a light buoy for fishing operation.	
	1130	Found a drifting log at Lat. 01°31.7′S λ 087°56.7′S. A radio buoy was set at log.	
	1200	Noon position was Lat. 01°32.3′S λ 087°56.7′E.	
	1645	Oceanographic survey at Lat. 01°27.1′S λ 087°51.9′E.	STD
02/02/2001	0530-0858	Purse seine operation 16th at Lat. 01°12.0′S λ 087°47.5′E. Drifted Payao No.150 after finished fishing then R/V Nippon Maru proceeded to Payao No.42	Fish 30 tons
	1200	Noon position is Lat. 01°10.3′S λ 088°21.7′E.	
	1450	Oceanographic survey at Lat. 01°08.1′S λ 089°00.0′E.	XBT / T7
	1920	Oceanographic survey at Lat. 01°09.3′S λ 090°00.0′E.	XBT / T7
	2022	Found Payao No.42 Lat. 01°09.8′S λ 090°13.8′E then attached a light buoy for fishing operation.	
03/02/2001	0540	Cancelled purse seine operation because of few fishes and the current and wind were not suitable for fishing. Drifted Payao No.42 after checking fish school then R/V Nippon Maru proceeded to Payao No.28	
	0628	Found Payao No.28 Lat. 01°17.1′S λ 090°07.5′E. Drifted Payao No.28 after checking fish school. Then	

Date	Time	Particular	Remark
03/02/2001	0628	R/V Nippon Maru proceeded to Payao 35	
	1200	Noon position was Lat. 01°14.1′S λ 089°05.0′E.	
	2135	Oceanographic survey at Lat. 01°05.0′S λ 087°00.0′E.	XBT / T7
04/02/2001	0005	Found Payao No.35 Lat. 07°07.9′S λ 086°27.0′E then attached a light buoy for fishing operation.	
	0549-0858	Purse seine operation 17th at Lat. 01°02.4′S λ 086°24.2′E. Drifted the Payao after finish fishing then R/V Nippon Maru proceeded to Payao No.22	Fish 20 tons Payao 36 drift near fishing station.
	0958-1200	Transferred fish from brine tank No.4 starboard to freezer No.9 starboard 35 ton, brine tank No.6 port side to freezer No.11 port side 10 ton.	
	1110	Oceanographic survey at Lat. 01°17.7′S λ 086°00.0′E.	XBT / T7
	1200	Noon position was Lat. 01°13.5′S λ 085°51.7′E.	
	1510	Found Payao No.22 Lat. 01°58.9′S λ 085°59.3′E. drift Payao No.22 after checking fish school then R/V Nippon Maru proceeded to Payao No. 27	
	2115	Oceanographic survey at Lat. 01°02.6′S λ 085°00.0′E.	XBT / T7
05/02/2001	0526	Found Payao No.27 Lat. 00°01.8′S λ 083°31.5′E. Launched work boats for fishing operation	
	0600-0855	Purse seine operation 18th at Lat. 00°01.8′S λ 083°31.5′E. Drifted Payao No.27 after finished fishing then R/V Nippon Maru proceeded to Payao No. 16	Fish 10 tons
	1200	Noon position was Lat. 00°07.9′S λ 084°08.7′E.	
	1305	Oceanographic survey at Lat. 01°13.0′S λ 083°58.1′E.	XBT / T7
	2305	Found Payao No.16 Lat. 00°01.6′N λ 086°30.1′E then attached a light buoy for fishing operation.	
6/02/2001	0515	Cancelled purse seine operation because of rough sea (swell 3-4 m, wind 30 knot) then R/V Nippon Maru drifted for fishing tomorrow	
	1200	Noon position was Lat. 00°04.0′S λ 086°24.8′E.	
7/02/2001	0545 0838	Cancelled purse seine operation because of few fishes. Drifting Payao No.16 after checking fish school then R/V Nippon Maru proceeded to Payao No.20 Found Payao No.20 Lat. 00°09.0′S λ 087°01.6′E. Drifting it after checking fish school. Then R/V Nippon Maru proceeded to Payao No.21	
	0905	Found Payao No.21 Lat. 00°11.9′S λ 087°05.6′E. Drifted it after checking fish school then R/V Nippon Maru proceeded to a drifting log, radio buoy 19	
	1007	Found a drifting log Lat. 00°23.0′S λ 087°52.1′E. Picked the radio buoy up after checking fish school then R/V Nippon Maru proceeded to another drifting log.	
	1200	Noon position was Lat. 00°54.7′S λ 088°54.6′E.	
7/02/2001	1450	Found drifting log, radio buoy 19 Lat. 02°34.5′S λ 088°07.2′E then attached a light buoy for fishing operation.	
	1600	Oceanographic survey at Lat. 00°30.0′S λ 088°05.5′E.	STD
8/02/2001	0530-0907	Purse seine operation 19th at Lat. 00°38.5′S λ 088°15.6′E. Drifted the drifting log after finish fishing	Fish 25 tons

Date	Time	Particular	Remark
8/02/2001		then R/V Nippon Maru proceeded to Payao No. 42	
	1200	Noon position was Lat. 00°54.7′S λ 088°54.6′E.	
9/02/2001	0030	Found Payao No.42 Lat. 01°53.7′S λ 091°32.3′E then attached a light buoy for fishing operation.	
	0530-0907	Purse seine operation 20th at Lat. 01°52.2′S λ 091°36.9′E. Drifted Payao No.42 after finished fishing then R/V Nippon Maru proceeded to Payao No. 28.	Fish 10 tons
	0935	Found Payao No.28 Lat. 01°52.5′S λ 091°33.4′E then attach a light buoy for fishing operation then R/V Nippon Maru proceeded to Payao No.37.	
	1015	Found Payao No.37 Lat. 01°50.3′S λ 091°26.6′E. Picked it up after finish checking fish school.	
	1200	Noon position was Lat. 01°51.5′S λ 091°30.9′E.	
	1320	Oceanographic survey at Lat. 00°51.5′S λ 091°32.7′E.	STD
10/02/2001	0503-0840	Purse seine operation 21st at Lat. 01°52.2′S λ 091°36.9′E. Picked Payao No.42 up after finished fishing then R/V Nippon Maru proceeded to Payao No.3	Fish 5 tons
	0945	Found Payao No.3 Lat. 01°42.8′S λ 091°37.4′E. then attach a light buoy for fishing operation.	
	1200	Noon position was Lat. 01°40.5′S λ 091°36.2′E.	
11/02/2001	0506-0803	Purse seine operation 22nd at Lat. 01°37.8′S λ 091°49.0′E. Picked Payao No.3 up after finished fishing then R/V Nippon Maru proceeded to Payao No.41	Fish 2 tons
	1155	Found Payao No.41 Lat. 01°36.7′S λ 091°04.0′E. Picked it up after finish checking fish school then R/V Nippon Maru proceeded to Payao No.6	
	1200	Noon position was Lat. 01°32.8′S λ 090°34.5′E.	
	1430	Found Payao No.6 Lat. 01°32.8′S λ 090°34.5′E. Picked it up after finished checking fish school then R/V Nippon Maru proceeded to Payao No.4	
	1930	Found Payao No.4 Lat. 01°42.8′S λ 091°37.4′E then attached a light buoy for fishing operation.	
	2025	Oceanographic survey at Lat. 00°38.4′S λ 089°57.7′E.	STD
12/02/2001	0445	Cancelled purse seine operation because of severe weather condition (heavy rain) and few fishes. Picked Payao No.4 up after finished checking fish school. Then R/V Nippon Maru proceeded to Payao No.23	
	1025	Oceanographic survey at Lat. 00°34.4′S Long. 089°00.0′E.	XBT / T7
	1200	Noon position was Lat. 00°29.2′S λ 088°41.3′E.	
	1930	Found only radio buoy of Payao No.23 Lat. 00°24.0′S λ 088°09.2′E. Retrieved radio buoy then R/V Nippon Maru proceeded to Payao No.36	
	2000	Oceanographic survey at Lat. 00°32.5′S λ 087°00.3′E.	
13/02/2001	0025	Found Payao No.36 Lat. 00°35.0′S λ 086°01.8′E then attached a light buoy for fishing operation.	XBT / T7
	0445	Cancelled purse seine operation because of few fishes. Picked up Payao No.36 after finished checking fish school then R/V Nippon Maru proceeded to Payao	

Date	Time	Particular	Remark
13/02/2001	0445	No.40	
	0600	Oceanographic survey at Lat. 00°34.4′S λ 085°58.7′E.	XBT / T7
	1115	Oceanographic survey at Lat. 01°07.9′S λ 085°00.0′E.	XBT / T7
	1200	Noon position is Lat. 01°14.1′S λ 084°53.7′E.	
	1400	Found Payao No.36 Lat. 01°22.4′S λ 084°29.5′E then attached a light buoy for fishing operation.	
	1645	Oceanographic survey at Lat. 01°14.5′S λ 085°28.7′E.	STD
14/02/2001	0544-0835	Purse seine operation 23rd at Lat. 01°06.6′S λ 084°40.3′E. Drifted Payao No.36 after finished fishing then R/V Nippon Maru proceeded to Payao No.132	Fish 2 tons
	1200	Noon position is Lat. 01°26.9′S λ 084°12.2′E.	
	1400	Oceanographic survey at Lat. 01°48.2′S λ 083°54.6′E.	XBT / T7
	1840	Found Payao No.132 Lat. 02°30.3′S λ 083°17.5′E. Drifted Payao No.132 after checking fish school then R/V Nippon Maru proceeded to set Payao	
	2010	Oceanographic survey at Lat. 02°29.3′S λ 083°00.0′E.	XBT / T7
15/02/2001	0100	Oceanographic survey at Lat. 02°27.6′S λ 082°00.0′E.	XBT / T7
	0540	Oceanographic survey at Lat. 02°26.4′S λ 081°00.0′E.	XBT / T7
	0700-1715	All crew searched for drifting object.	
	0947	Payao No.4 was set at Lat. 02°33.3′S λ 080°27.1′E.	
	1127	Payao No.6 was set at Lat. 02°48.3′S λ 080°08.3′E.	
	1200	Noon position was Lat. 02°46.7′S λ 080°03.1′E.	
	1225	Oceanographic survey at Lat. 02°47.5′S λ 079°59.3′E.	XBT / T7
	1242	Payao No.41 was set at Lat. 02°48.9′S λ 079°56.7′E.	
	1403	Payao No.3 was set at Lat. 02°51.9′S λ 079°43.9′E.	
	1536	Payao No.28 was set at Lat. 02°39.7′S λ 79°34.3′E.	
	1651	Payao No.37 was set at Lat. 02°33.9′S λ 079°22.3′E.	
	1850	Oceanographic survey at Lat. 02°24.8′S λ 79°00.0′E.	XBT / T7
16/02/2001	0525	Oceanographic survey at Lat. 02°07.0′S λ 078°22.3′E.	XBT / T7
	0700-1015	All crew searched for drifting object then R/V Nippon Maru proceeded to Payao No.44	
	0950	Oceanographic survey at Lat. 01°30.2′S λ 078°30.6′E.	XBT / T7
	1200	Noon position was Lat. 01°24.0′S λ 078°53.0′E.	
	1310	Oceanographic survey at Lat. 01°23.1′S λ 079°10.0′E.	XBT / T7
	1645	Oceanographic survey at Lat. 01°20.8′S λ 080°00.0′E.	XBT / T7
	2100	Oceanographic survey at Lat. 01°18.0′S λ 081°00.0′E.	XBT / T7
17/02/2001	0010	Found Payao No.44 Lat. 01°22.4′S λ 084°29.5′E then attached a light buoy for fishing operation.	
	0556-0840	Purse seine operation 24th at Lat. 01°05.1′S λ 081°52.1′E. Drifted Payao No.44 after finished fishing then R/V Nippon Maru proceeded to Payao No.43	Fish 3 tons
	0920	Oceanographic survey at Lat. 01°07.1′S λ 082°00.1′E.	XBT / T7
	1200	Noon position was Lat. 01°22.8′S λ 082°29.8′E.	
	1255	Found only Arugos buoy Lat. 01°22.7′S λ 083°32.9′E. Payao No.44 but radio buoy was disappearing Picked Argos buoy up then R/V Nippon Maru proceeded to Payao No.97	
	1510	Oceanographic survey at Lat. 01°04.9′S λ 083°05.4′E.	XBT / T7
	1835	Found Payao No.97 Lat. 00°38.1′S λ 083°44.8′E then attached light buoy for fishing operation.	XBT / T7

Date	Time	Particular	Remark
17/02/2001	1935	Oceanographic survey at Lat. 00°35.3′S λ 083°41.3′E.	STD
18/02/2001	0505	Cancelled purse seine operation because of few fishes. Drifted Payao No.97 after finished checking fish school then R/V Nippon Maru proceeded to Payao No.7	
	0615	Oceanographic survey at Lat. 00°30.6′S λ 084°00.0′E.	XBT / T7
	1200	Noon position was Lat. 00°16.5′S λ 085°18.1′E.	
	1515	Oceanographic survey at Lat. 00°15.6′S λ 085°00.0′E.	XBT / T7
	1915	Found Payao No.7 Lat. 00°14.0′S λ 086°57.9′E then attached a light buoy for fishing operation.	
	1945	Oceanographic survey at Lat. 00°12.7′S λ 086°54.0′E.	STD
19/02/2001	0515	Cancelled purse seine operation because of few fishes. Drifted Payao No.7 after finished checking fish school then R/V Nippon Maru proceeded to Payao No.20.	
	1005	Oceanographic survey at Lat. 00°46.9′S λ 088°00.0′E.	XBT / T7
	1200	Noon position was Lat. 00°58.8′S Long. 088°24.0′E.	
	1345	Found Payao No.21 Lat. 01°05.3′S λ 088°47.2′E. Drifted it after checking fish school.	Found all Payao in The same area, the current front.
	1355	Found 2 unknown Payao Lat. 01°05.4′S λ 088°48.8′E. Drifted them after checking fish school.	
	1402	Found Payao No.20 Lat. 01°05.4′S λ 088°49.7′E. Picked only radio buoy up after checking fish school.	
	1410	Found Payao No.120 Lat. 01°05.9′S λ 088°50.1′E. Picked it up after checking fish school.	
	1418	Found Payao No.19 Lat. 01°05.8′S λ 088°50.6′E. Picked it up after checking fish school.	
	1431	Found Payao No.31 Lat. 01°05.8′S λ 088°50.8′E. Picked it up after checking fish school then R/V Nippon Maru proceeded to drifting log radio buoy No.19	
	1515	Oceanographic survey at Lat. 01°05.5′S λ 089°00.0′E.	XBT / T7
	1925	Oceanographic survey at Lat. 01°04.0′S λ 090°00.0′E.	XBT / T7
	2345	Oceanographic survey at Lat. 01°01.6′S λ 091°00.0′E.	XBT / T7
20/02/2001	0256	Found drifting log radio buoy No.19 Lat. 00°54.0′S λ 091°43.2′E then attached a light buoy for fishing operation.	
	0515-0822	Purse seine operation 25th at Lat. 00°52.4′S λ 091°44.4′E. Picked radio buoy No.19 up after finished fishing then R/V Nippon Maru proceeded to Payao No.139	Fish 15 tons
	0825	Oceanographic survey at Lat. 00°50.8′S λ 091°49.5′E.	XBT / T7
	1200	Noon position was Lat. 00°49.2′S λ 091°00.7′E.	
	1900	Found Payao No.139 Lat. 01°03.1′S λ 087°37.5′E then attached a light buoy for fishing operation.	
21/02/2001	0450	Cancelled purse seine operation because of few fishes. Drifted Payao No.139 after finished checking fish school then R/V Nippon Maru proceeded to Payao	

Date	Time	Particular	Remark
21/02/2001	0450	No.151	
	0535	Found Payao No.151 Lat. 00°58.5′S λ 089°38.2′E. Drifted it after checking fish school then R/V Nippon Maru proceeded to Payao No.5	
	1000	Found drifting log Lat. 00°58.9′S λ 089°39.9′E then attached a radio buoy No.19 and a light buoy for fishing operation.	
	1200	Noon position is Lat. 00°52.1′S λ 089°28.4′E.	
22/02/2001	0450	Cancel purse seine operation because of few fishes. Drift Payao No.139 after finish checking fish school then R/V Nippon Maru proceed to Payao No.151	
	0905	Found Payao No.5 Lat. 00°34.7′S λ 088°52.1′E. Attach light buoy for fishing operation.	
	0914	Found unknown Payao without radio buoy Lat.00°34.8′S λ 088°51.7′E. Pick it up after checking fish school.	
	0917	Found Payao No.22 Lat. 01°35.0′S λ 088°51.7′E. Picked it up after checking fish school then R/V Nippon Maru proceeded to SEAFDEC Payao No.25	
	1200	Noon position was Lat. 00°33.2′S λ 088°51.2′E.	
	1600	Found SEAFDEC Payao No.25 Lat. 00°34.3′S λ 088°54.2′E then attached a light buoy for fishing operation.	
23/02/2001	0533-0821	Purse seine operation 26th at Lat. 00°29.6′S λ 089°03.0′E. Drifted Payao No.5 after finished fishing. then R/V Nippon Maru proceeded to Payao No.91	Fish 10 tons
	1200	Noon position is Lat. 00°10.1′S λ 088°18.2′E.	
	1545	Found a drifting log with and abandon Spanish radio buoy Lat. 00°11.3′N λ 087°36.7′E. Changed radio buoy to be No.8 and attached light buoy for fishing operation.	Found both of the in Drifting objects in the same area, the current front.
	1605	Found a submerse canoe Lat. 00°11.3′N λ 087°35.8′E then attached a radio buoy No.13	
	1715	Oceanographic survey at Lat. 00°13.1′N λ 087°33.7′E.	STD
24/02/2001	0533-0820	Purse seine operation 27th at Lat. 00°19.4′N λ 087°38.5′E. Drifted the log, radio buoy No.8 after finished fishing then R/V Nippon Maru proceeded to Payao No.40	Fish 5 tons
	1200	Noon position was Lat. 00°36.9′N λ 085°56.1′E.	
	1410	Found Payao No.40 Lat. 00°49.5′N λ 086°31.9′E. Drifted it after checking fish school then R/V Nippon Maru proceeded to Payao No.91	
	1420	Oceanographic survey at Lat. 00°50.3′N λ 086°30.0′E.	
	2212	Found Payao No.91 Lat. 01°30.9′N λ 084°58.7′E then attached a light buoy for fishing operation.	
25/02/2001	0557-1000	Purse seine operation 28th at Lat. 01°32.8′N λ 085°01.6′E then drifted Payao No.91 after finished fishing then R/V Nippon Maru proceeded to Port of Phuket.	Fish 10 tons

Date	Time	Particular	Remark
25/02/2001	1200	Noon position was Lat. 01°48.1'N λ 085°27.1'E.	
26/02/2001	1200	Noon position was Lat. 03°04.5'N λ 090°27.1'E.	
27/02/2001	0730-0930	Renewed all cargo wire and prepared all cargo booms for fish unloading.	
	0930-1230	All crew cleaned the ship.	
28/02/2001	0730	R/V Nippon Maru dropped anchor at the Port of Phuket.	
01/03/2001	0800	R/V Nippon Maru was alongside the Port of Phuket.	
	0800-1730	Fish unloading.	
02/03/2001	0730-1730	Fish unloading.	
03/03/2001	0730-1630	Fish unloading. Total weight was 546 ton. Tuna 10 ton could not be taken from fishhold	
04/03/2001	0800-1100	Renewed all purse wire	
	1200	Disembarked from R/V Nippon Maru and finished onboard activities	

Appendix 4: List of crew member

No.	Family Name/ First name	Age	Register Position	Fishing positon
1	Akiyama Takehiko	57	Master fisherman / 3rd officer	Fishing master
2	Imai Michiro	45	Captain	Float man
3	Yamaushi Toshiyuki	48	Chief officer	Net man
4	Kumagai Hideyuki	54	2nd officer	Net man
5	Takeyama Hidio	52	Boswien	Net man / ring man
6	Sasaki Osamu	50	Sailor	Skiff boat
7	Kumagami kouichi	46	Sailor	No.3 working boat
8	Abe Shiyoichi	54	Sailor	Chain man
9	Nitanai Takao	44	Sailor	No.2 working boat
10	Shizukuishi Hiroshi	40	Sailor	Net man
11	Abe Mutsuo	56	Chief engineer	Ring man
12	Yamauchi Kiyoyoshi	44	1st Engineer	Chain man
13	Okamoto Masaki	39	2nd Engineer	Float man
14	Suzuki Yoshinori	48	Oiler	Net man
15	Satou Norio	49	Oiler	Net man
16	Tsunoda takehiko	39	Oiler	Net man
17	Hayashi Kasuo	49	Chief operator	Net man
18	Nagamura Takahiko	44	Chief cook	Float man
19	Ikame Susumu	32	Researcher	Researcher
20	Isara Chanrachkij	32	Observer (28/12/00 - 4/03/01)	Trainee
20	Wirote Laongmanee		Observer (2/03/01 - 23/04/01)	Trainee