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TECHNICAL ASPECTS OF TUNA PURSE SEINE OPERATIONS

(Paper prepared by the Secretariat)

1. INTRODUCTION

1.1. Fishery development

Tuna purse seine fisheries first developed off the west coast of North America. The size and capacity of modern tuna seiners gradually increased to capitalize on productive distant water fishing grounds and to supply the high volume demand of the canned tuna industry. The eastern tropical Pacific purse seine fishery was well established by the early 1970s dominated by large American vessels with carrying capacities of 1000 short tons or more.

The Japanese government encouraged the development of purse seine operations in the western Pacific region by funding research and assessment surveys during the mid 1970s using a 1000 GRT Japanese purse seiner patterned after the successful US design. Survey effort concentrated on areas already demonstrated to be productive by the Japanese distant water pole and line and longline fleets. Results of these surveys proved the viability of purse seining in the equatorial western Pacific through the use of larger, deeper nets and modified seining techniques. Seining methods for fishing on tuna schools aggregated under drifting flotsam and on unassociated schools were sucessfully developed proving the feasibility of purse seine operations in the area during the entire year.

The American fleet began to prospect the area assisted by exploratory charter fees and encouraged by favorable reports on the Japanese operations. Additional US vessels entered the western Pacific region through participation in a developing skipjack seine fishery in New Zealand. The use of larger nets and concentration on seining on schools associated with floating debris then allowed the US fleet to successfully enter the equatorial western Pacific fishery.

A dramatic increase in US tuna seiner activity in the western Pacific occurred in the early 1980s encouraged by reports of high catch rates in the western fishery and poor fishing conditions in the eastern Pacific brought about by El Nino conditions. This fleet joined an already active Japanese high seas purse seine fishery.

1.2. Purse seine fisheries of the southwest Pacific region

Tuna purse seine fisheries of the western Pacific region employ a variety of vessel and gear types to exploit skipjack, yellowfin, bigeye and bluefin tuna. The major purse seine fishery of the western Pacific is concentrated between Papua New Guinea and the Federated States of Micronesia along the Equator between 5 degrees S and 10 degrees N latitude. Fishing operations extend on a seasonal or exploratory basis west to the Republic of Belau and east to the Phoenix Islands (Kiribati) but the majority of fishing effort takes place between 135 E and 165 E longitude (Figure 1).

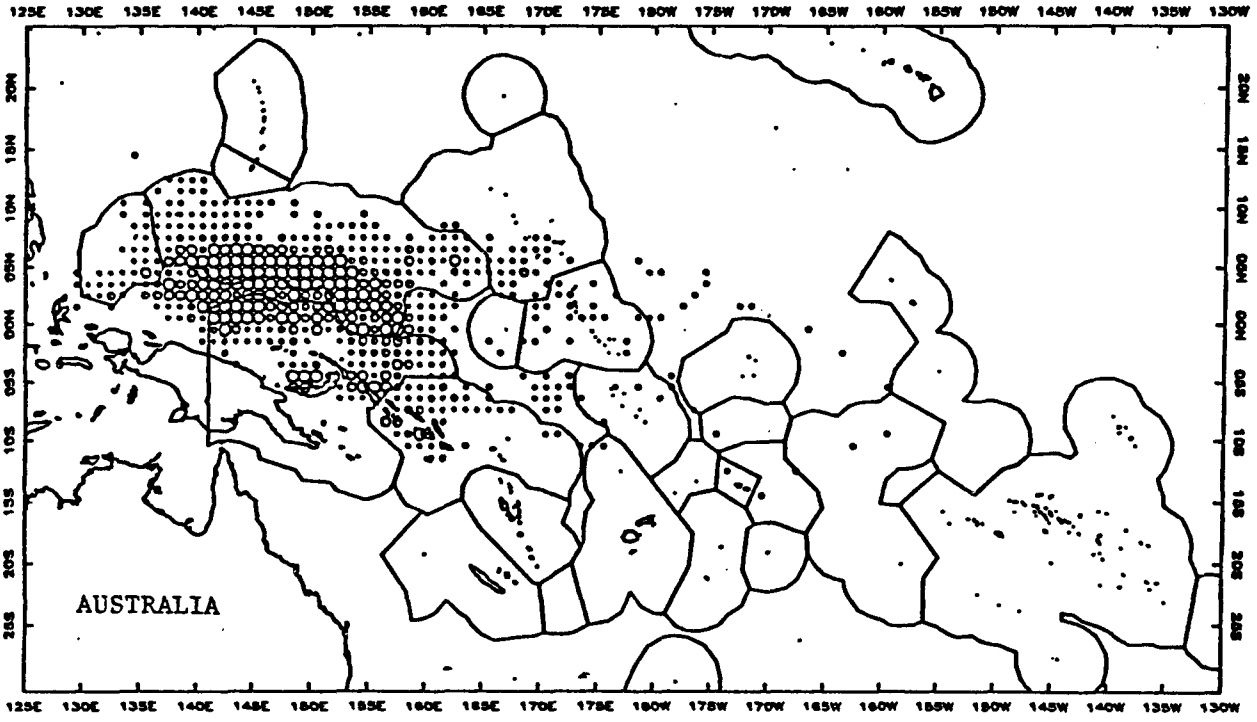


Figure 1. Distribution of tuna purse seine effort during 1988 (SPC 1989).

This fishery has expanded rapidly since 1980 currently producing around 380,000 tonnes of skipjack, yellowfin and bigeye tuna per year primarily for the canned tuna industry. Relatively large seiners of 499 to 1500 GRT participate in this fishery delivering catches to canneries in American Samoa, Japan, Taiwan, Thailand and the Philippines or transship catched from ports in Guam, PNG, CNMI or southeast Asia.

Approximately 125 purse seine vessels from a dozen countries of registry were active in this fishery during 1988 with the majority of the fleet originating from Japan, the US, Taiwan and South Korea. Some of the American owned vessels actually operate under registry from Vanuatu, Panama, the Cayman Islands or Puerto Rico. Purse seiners from Indonesia, Australia, the Soviet Union, and the Philippines also operate within this zone

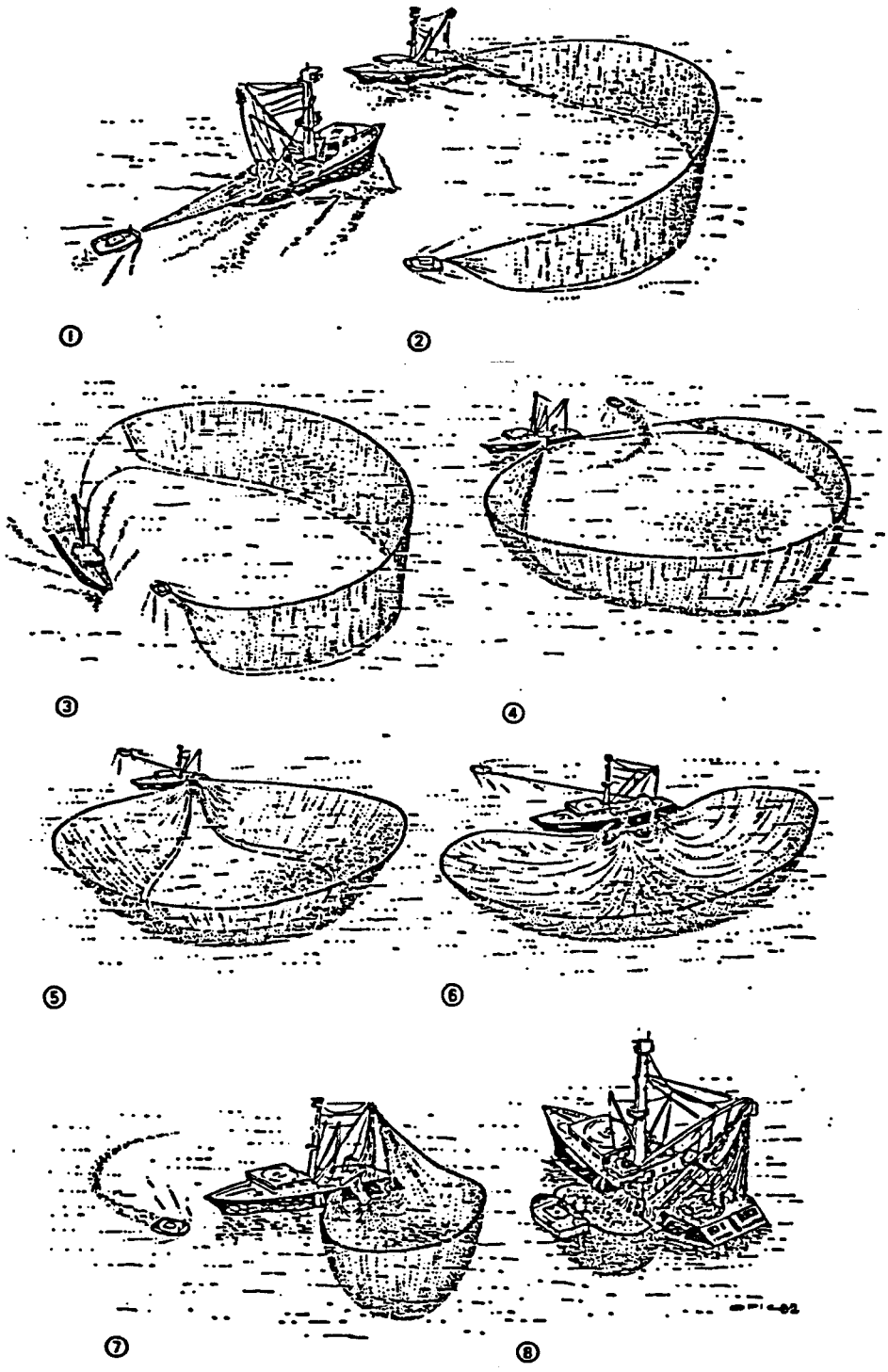
Additional tuna seine fisheries based primarily on anchored FADs are well established in the Philippines, PNG and the Solomon Islands. Seasonal tuna seine fisheries also exist in Australia and New Zealand for southern bluefin and skipjack tuna.

1.3. General description of purse seine method

The purse seine method was developed to take advantage of the surface schooling behavior of small pelagic fishes. Coastal seine fisheries for mackerel, sardine and anchovy developed basic techniques later adapted to tuna purse seining. The development of nylon netting and the hydraulic power block allowed larger, stronger nets to be efficiently retrieved by powerful winches and paved the way for modern tuna purse seining.

The basic fishing operation consists of circling a tuna school with a long panel of net that is buoyed at the top with polystyrene floats and weighted at the bottom with a chainline and chain bridles attached to steel purse rings. A small auxiliary skiff or a float is used to anchor one end of the net while the seiner sets the net around the school. When the circle is complete, a powerful hydraulic purse winch closes the bottom of the net by retrieval of a steel cable that passes through the purse rings attached to the chainline at the bottom of the net. Most of the net is retrieved by a hydraulic net winch or power block and is restacked on the stern in preparation for the next set. The end of the net containing the catch is hauled or

"sacked up" by strapping and winching portions of the heavy net until the catch is concentrated in a bag of strong netting next to the seiner. The catch is then transferred to refrigerated holds using a specialized scoop called the brail (Figure 2).



Source: Stequert and Marsac (1983).

Figure 2. Details of a Marco style single purse siene operation.

1. Net skiff released from the seiner to begin the set.
2. Seiner deploys the net around the school.
3. Seiner rejoins the net skiff to complete the net circle.
4. Towline cable is retrieved to close the net circumference while pursing begins.
5. Purse winch continues to retrieve purse cable to close the bottom of the net.
6. Pursing completed as all of the purse rings are hoisted clear of the water.
7. Power block hauling net to be restacked on the stern.
8. Catch is concentrated between seiner and skiff for brailing.

Details of this operation will vary depending on the type of net handling machinery used and the kind of auxiliary equipment employed. The size and weight of the net determine the machinery and hydraulic power necessary for setting, pursing and net hauling and can determine the minimum vessel size. The refrigeration system employed will determine the trip duration, range of operation, potential markets and several economic factors. This paper will describe the gear and methods used by the different purse seine fisheries and vessel types operating in the western Pacific region.

2. PURSE SEINE OPERATIONS

2.1. Single purse seine vessels

Single seiners operate individually and perform all the functions of catching, storage, and preservation of the catch. Therefore, each vessel is equipped with a net, fishing gear and refrigerated fish holds. Single seiners usually unload their catch directly to the processing plant or unloading port although some single seiners transship catches to refrigerated carrier vessels at sea. The majority of tuna purse seine operations in the Pacific are conducted by large single seiners.

2.2. Group seine vessels

Group seiners work in conjunction with other support vessels in a coordinated manner to locate, catch, store and transport the catch. Group seine operations are less common than single seiners with groups from Japan, Taiwan and the Solomon Islands operating in the region. A single group seine operation will consist of one catcher/net vessel (commonly 116 or 135 GRT), one or two refrigerated carrier vessels (around 300 GRT each) and a small utility/light boat of around 45 GRT. All of the vessels engage in searching for and locating tuna schools. The net boat performs all fishing operations with herding and towing assistance from the other vessels. The carrier vessels receive the catch directly from the net and store, refrigerate and transport it to the unloading point. A single group seine operation can require 45 to 50 crewmen. Group seine operations can be very efficient making large annual landings as the net boat remains on the fishing grounds while the carrier transports catch and supplies.

3. FISHING METHODS

3.1. Non-associated seining

This is the most basic form of seining involving setting the net on free swimming tuna schools that are not associated with any flotsam or other object. Schools are usually located visually by directly observing the school on the surface or birds activity feeding on baitfish in the area. The speed and direction of the school must be accurately judged and in order to successfully circle the school. Free school fishing is difficult in tropical waters due to the clarity of the water and lack of a distinct thermocline cold and shallow enough to restrict the escape of the school under the net before pursing is complete.

Tuna schools actively feeding on surface baitfish concentrations cause large, visible disturbances on the water that are referred to as "foamers" or "boilers". Tuna schools foaming or boiling on the surface are considered more vulnerable to purse seine gear as the fish are preoccupied with feeding behavior and the aggregation is often relatively stationary or moving very slowly.

Seining on free schools during the early morning or late afternoon also increases the chance for success due to the reduced visibility of the net and increased feeding activity during the early morning hours.

Gear modifications can improve the success rate of school fish sets. Longer nets allow more area for school movement during the setting and pursing operation. Deeper nets that sink quickly also lessen the chance of the school escaping under the chainline before the setting and pursing operations are complete. Increased pursing speed will also improve catches on free schools and is enhanced by more powerful purse winches and lighter net materials that produce lower overall weight. The use of larger mesh sizes and thinner twine size will speed net sinking and pursing rates due to lowered water resistance on the net.

3.2. Associated seining

3.2.1. Log fishing

Tuna schools are known to concentrate under flotsam (logs, floats, seaweed etc) making them easier to locate and capture. Any flotsam located on the fishing ground will be examined for the presence of subsurface tuna schools with side scanning sonar or echo sounder. Promising logs are marked and relocated with transmitting radio buoys and checked regularly. Logs with associated tuna schools will be set about one hour prior to daylight usually with the aid of sonar. The success rate on log sets is very high as the schools are stabilized under the log and unable to see the net in pre-dawn darkness. Even very small logs or clumps of debris can produce large catches (ie >150 mt/set) and can continue to aggregate additional schools for extended periods. The productive equatorial western Pacific seine fishery of PNG and the FSM was originally based on this technique and log seining continues to produce the majority of purse seine catches from the region.

3.2.2. Fish Aggregation Device (FAD) fishing

Man-made rafts or buoys (FADs) can be anchored or set adrift in productive fishing locations to concentrate tuna schools similar to the manner in which fish aggregate to natural logs. The fishing technique is similar to that described for log fishing except the mooring line is towed away or detached from the FAD prior to the set to avoid tangling the net. FADs combine the advantages of log fishing (concentrating schools, pre-dawn sets) with reduced fuel expenses and search time due to the known location of the FAD. A light raft or skiff is often used during log and FAD seining to concentrate and hold the tuna school before the set.

3.2.3. Live bait assisted seining

Tuna schools can be chummed to the surface and held in one area near a live bait carrier while the purse seiner sets around the school and baitboat. This technique is standard practice in the southern bluefin tuna fishery of Australia where purse seiners work in conjunction with pole and line vessels.

3.2.4. Other associations

Tuna schools in some areas are known to travel or associate strongly with porpoise, whales, whale sharks and manta rays. The tuna can be more vulnerable to purse seine gear under these conditions and special seining techniques have been developed to capitalize on these occurrences. This form of seining is more common in the eastern tropical Pacific fishery.

4. GEAR AND EQUIPMENT

4.1. Net

The purse seine net consists of a long panel of nylon webbing supported by the corkline and weighted at the bottom edge by the leadline or chain and the attached purse rings. The net tapers to a point at each end reaching maximum depth near the midway point. The corkline consists of thousands of polystyrene floats strung and laced on a continuous nylon rope of around 25 to 28 mm diameter. The leadline is made of galvanized steel chain with chain or nylon rope bridles attached to the purse rings.

Purse seines must have extra netting strung on a shorter corkline to allow the net to form the rounded bowl shape when fully pursed. The difference in these lengths is termed the hanging ratio and is generally in the range of 23 to 26%. These are actually average figures as the ratio may be as much as 30% in the center and taper to only 15% on either end. Differences in the hanging ratio will effect the rate of net sinking, pursing and the maximum pursing depth.

Two basic styles of net are used in the western Pacific tuna fishery. The American fleet uses knotted nylon webbing manufactured in long panels or "strips" about 11 meters deep that are laced together horizontally (parallel to corkline) to form the net. Thin strips of heavy netting are laced vertically in the net at regular intervals to increase strength and prevent a long rip from running the length of the net. Mesh size generally ranges from around 5 to 15 cm in stretched mesh length with twine diameters ranging from approximately 2 to 8 mm in diameter. A heavy steel chainline, chain ring bridles and steel purse rings provide the ballast necessary to sink the net at a reasonable rate.

Japanese style purse seines are constructed with lightweight two strand braided, knotless netting. This webbing is produced in sections 28 meters wide that are laced together vertically (corkline to leadline) to form the seine. Mesh size tends to be larger and twine diameter smaller than the American nets. The lighter construction allows a lighter chainline to be used to achieve a given sink rate as nylon ropes replace chain for ring bridles.

The knotted material is considered to be stronger and more durable than the knotless net but produces a larger net bulk with increased water resistance and weight. All of these factors combine to require a heavier leadline to sink the net quickly and a stronger, larger net winch and power block for pursing and hauling.

The Japanese prefer the lighter knotless nets due to the faster sinking rates and pursing speeds that are possible with a given amount of hydraulic power. An additional benefit of the knotless nets is the smaller power block, storage space and vessel payload required allowing large nets to be carried by smaller vessels.

The end of the net or "sack" actually supports the weight of the school as it is brailed and must be he heavily constructed with small mesh sizes and thick twine diameter. The beginning of the net that is first to be hauled on board serves primarily as a visual barrier to the school and can be constructed with large mesh sizes and thin twine to reduce costs and increase net sinking and pursing speed.

Two types of purse rings are in use on purse seines in the region. Most vessels use continuous steel rings chained or tied to the chainline. When pursing is complete, all the rings are gathered together in a group next to the seiner with the purse cable through all the rings. Rings that are permanently chained to the leadline must be stacked on a steel boom (ring stripper) allowing the purse cable to be separated at a connecting link and removed. This procedure allows the net and rings to pass through the purse block for re-stacking. This operation is dangerous and time consuming and can be avoided by the use of rope ring bridles or release rings. Rope bridles are commonly used on Japanese purse seiners and are

untied or cut free from the leadline before the power block and retied after the net has been stacked.

Release type rings are often used on European seiners and some Australian and New Zealand tuna and mackerel seiners. These rings have a spring loaded opening in one side that allows the ring to be unsnapped from the purse cable allowing it to pass through the block.

4.2 Net size

The length and depth of the net is determined by the environmental conditions prevailing in the fishery and the seining method employed. The length of a seine net is defined as the length of the stretched corkline and depth is the maximum width of the webbing between the corkline and leadline. A shallow thermocline or water depth allow the use of relatively shallow nets. These conditions prevail in the bluefin tuna fishery of Southern Australia and the skipjack fishery of New Zealand. A typical seine effective in these areas may measure 900 to 1000 m in length and 80 to 140 m in depth.

A shallow thermocline exists in the eastern tropical Pacific ocean allowing the use of relatively shallow nets of around 150 meters. These nets were found to be ineffective in the western Pacific tropical fishery of PNG and Micronesia due to the lack of a distinct thermocline near the surface and the clarity of the waters. Net sizes steadily increased to become effective under these conditions and the size and power of purse winches and power blocks grew accordingly. Purse seines used by large American seiners in the western Pacific are now in the range of 1500 to 1800 meters in length and 240 to 280 meters in depth. Purse seines used by Japanese seiners in the tropical western Pacific can exceed 2000 meters in length and 300 meters in depth.

4.3 Purse winch

The purse winch is the major item of deck machinery consisting of three drums loaded with steel cable of 15 to 25 mm diameter. The towline drum pays out cable attached to the end of the net if the circumference of the set exceeds the net length. The end of the net is retrieved to the seiner and the other two drums haul in the purse cable to close the bottom of the net. The power and speed of pursing is critical when seining on free schools. Full pursing of a tuna purse seine will require approximately 15 to 50 minutes depending on the size and weight of the net, winch power, current speed and direction, etc. Pursing speed is less critical when fishing on logs or FADs before dawn when the fish are unable to see and avoid the net. Pursing under these conditions may actually be stopped or slowed intentionally to allow the net to sink deeper to capture the entire school.

4.4. Net retrieval systems

Purse seine nets are retrieved by means of a hydraulic net roller or power block mounted on a boom, crane or on the work deck. Three basic types of power block are in use on tuna purse seiners in the south Pacific region and are generally referred to by their trade names of Marco, Triplex and Petrel. The majority of tuna purse seine vessels use the Marco style power block.

4.4.1. Marco

This style of power block was first developed by Puretic of San Pedro, California and is sometimes referred to as the Puretic power block. Marco Marine of Seattle, Washington supplies most of the market for this type of block and produces a wide range of machinery and equipment for purse seine fisheries. This system is used by the US and most of the Japanese tuna seine fleet and has been widely adopted by Taiwanese, Korean, Philippine, French and Spanish tuna seiners.

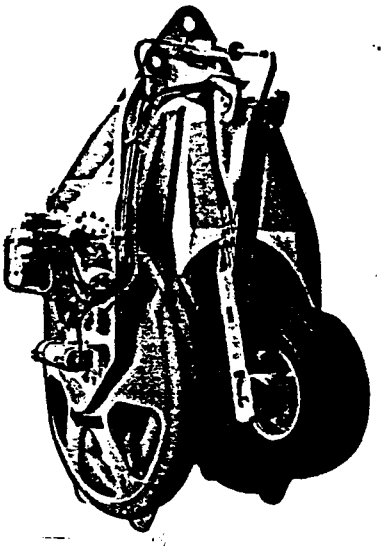


Figure 3. Marco power block
56 inch diameter sheave with power grip

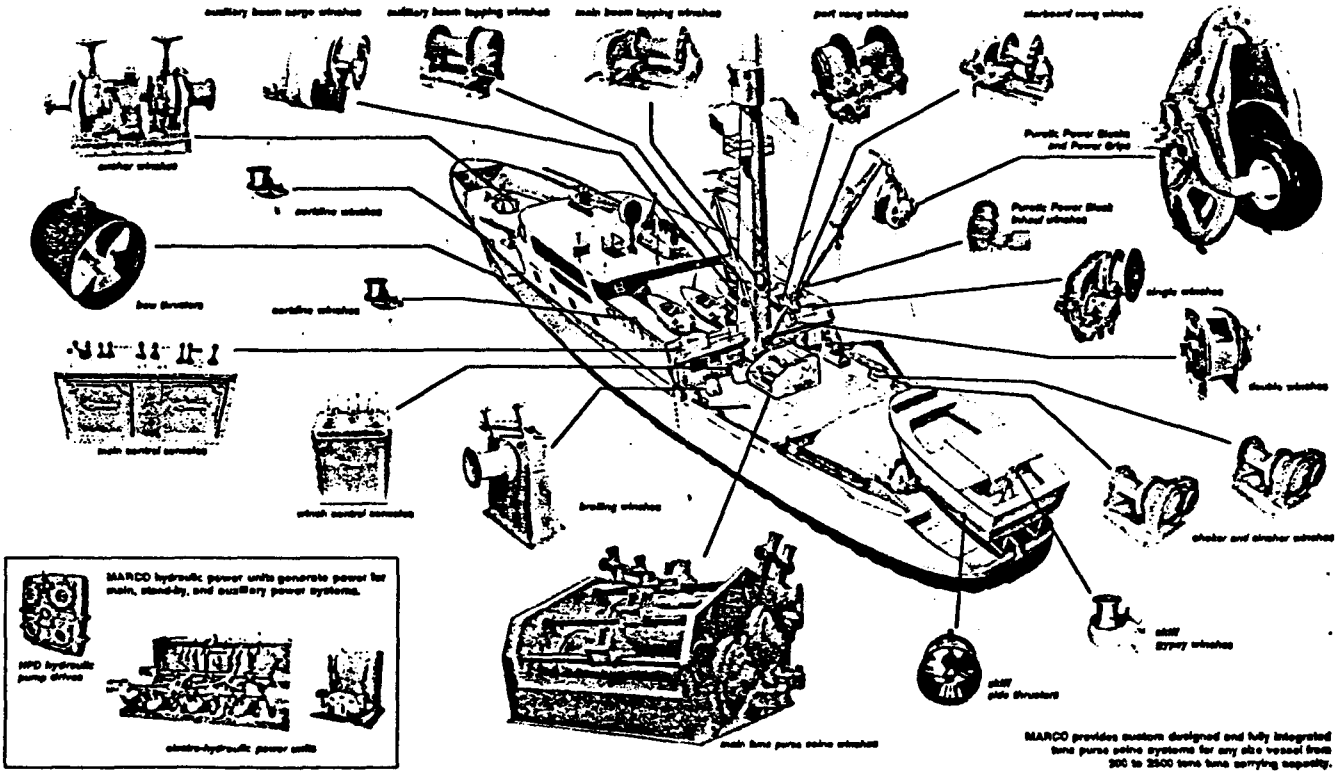


Figure 4. Marco deck machinery.

The power block consists of a hydraulic V-shaped sheave mounted high on the end of a long boom. The sheave is coated with a hard rubber lining or rubber cleats to improve traction on the net during retrieval and reduce wear. The larger Marco power blocks are supplied with a power grip wheel that exerts pressure on the net to reduce net slippage (Figure 3). The net is hauled from the water by the block and passes over the turning sheave before descending to deck level for stacking and cleaning by the crew.

The power block is driven by hydraulic power supplied by the main engine or auxiliaries and remotely controlled from a deck mounted console. The size and power of Marco blocks have gradually increased to accommodate the growing size and weight of tuna purse seines. The largest model currently available measures 81 inches in diameter and can generate almost 15 tonnes of net pull. The majority of tuna purse seiners operating in the region use power blocks 48 to 56 inches in diameter. Figure 4 indicates the position of the power block and pictures additional equipment described in this section (purse winch, net skiff, side thruster).

4.4.2. Triplex

The Triplex net handling system is manufactured in Norway and is widely used in Atlantic seine fisheries. The net hauling machinery consists of three counter rotating rubber coated hydraulic rollers that are usually mounted on the starboard rail or deck aft of amidships (Figure 5). The net is passed over the first, under the second and over the last roller before being pulled to the stern for stacking. This system provides a very strong and positive grip on the net reducing net slippage and wear while providing a fast hauling speed. Triplex net haulers can exert enough pull on the corkline to permit sacking up and brailing of the catch without a net skiff supporting the corkline.

Net handling and stacking is assisted by another hydraulic roller mounted on a net crane. A net chute and transport roller can be added between the net hauler and net crane to aid the transfer of the net to the stern. The net crane reduces the crew requirements for net stacking and can reduce the time required for net retrieval. Figure 6 indicates a Triplex equipped seiner in operation with deck mounted net winch and net stacking crane.

Triplex net handling gear is commonly used in various north Atlantic fisheries but the main market for Triplex gear is now in South America. Triplex gear has been used on tuna and mackerel seiners in Africa, the western Pacific and Australia and New Zealand. The largest Triplex net winch presently available is equipped with rollers 115 cm long x 50 cm in diameter and can achieve a maximum theoretical pull of 37 tonnes.

4.4.3. Petrel

Petrel Engineering of South Africa produces purse seine gear including purse winches and net hauling equipment. The Petrel system uses a rubber coated hydraulic sheave similar to a Marco style power block. The main difference is that the block is mounted at deck level instead of on a long boom above the deck. The net is hauled from the water by the power block and then passes under an idler sheave mounted below the level of the power block. This arrangement increases the friction between the net and power block thus reducing slippage and increasing hauling speed (figure 7). The Petrel system also uses a hydraulic net stacking block to transfer the net from power block to the net bin. The company also produces large triple roller net haulers very similar to the Triplex design.

Petrel power blocks are available in a range of sizes comparable to the Marco systems. The Petrel 56 inch diameter power block is rated to achieve 30.2 tons of pull. Petrel net handling systems are popular in the southern bluefin tuna and mackerel fisheries of south Australia.

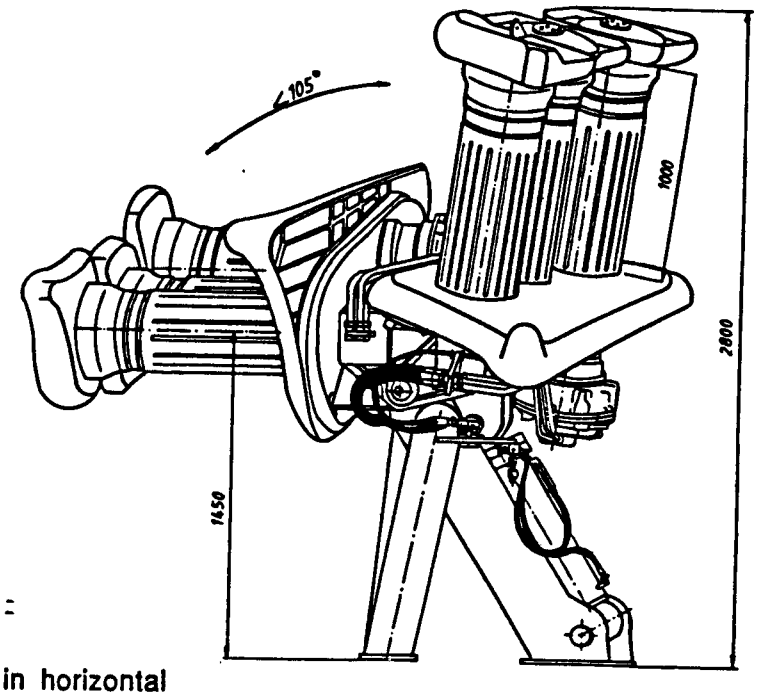


Figure 5. Triplex triple roller net winch in horizontal and vertical positions. (Triplex advertisement).

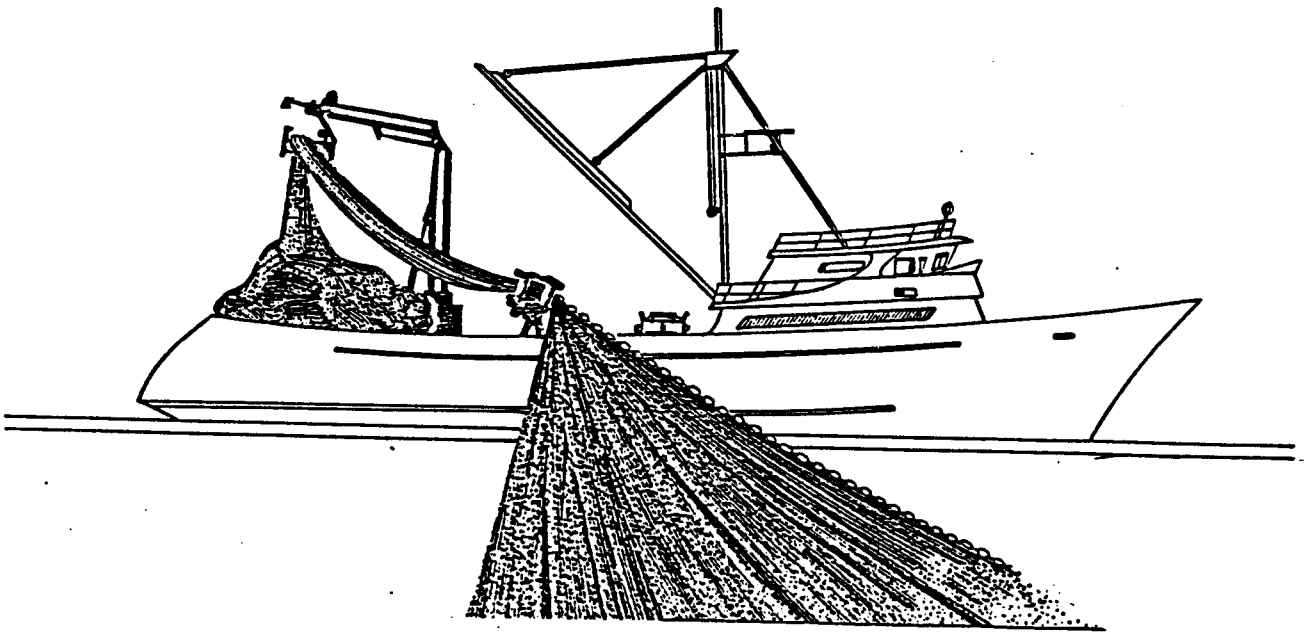


Figure 6. Triplex equipped seiner in operation.

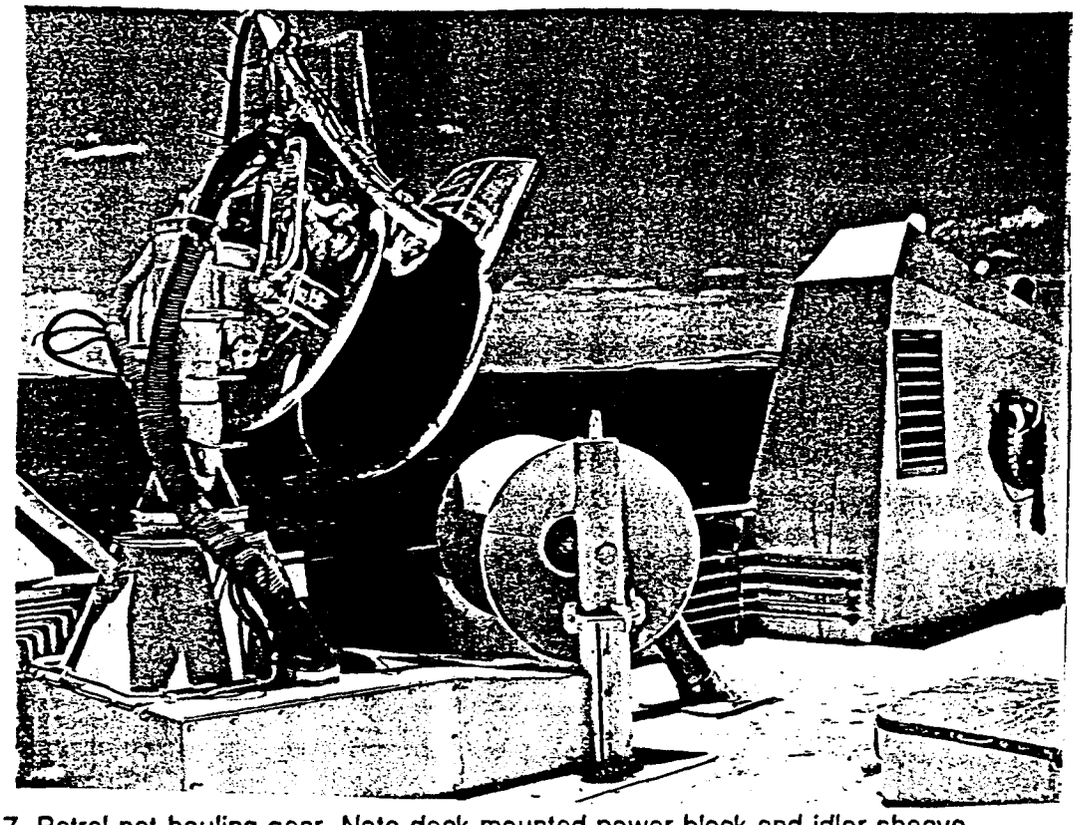


Figure 7. Petrel net hauling gear. Note deck mounted power block and idler sheave. (Stehr Group, F/V Tasman Dawn).

4.5. Net skiff

The Marco system of purse seining requires a heavy, powerful net skiff for the setting and brailing operations. The skiff is stored on an inclined ramp at the stern of the seiner and is released with one end of the net attached at the beginning of the set. The skiff will power away from the main vessel while the seiner proceeds to set the net around the school.

The skiff is then used as a towboat counteracting the tendency of the purse winch and power block to pull the seiner toward the center of the net. When most of the net has been retrieved, the catch is concentrated in a heavy bag of webbing between the seiner and the skiff to allow the fish to be brailed to the seiner. These functions require a purse seine skiff to be extremely heavy and stable to support the catch and be equipped with a powerful engine for towing. The skiff on a large 1200 ton Marco equipped seiner may measure 10 to 12 meters and weigh 18 tonnes.

4.6. Tow boat or light boat

Auxiliary work boats of four to five meters are often carried on board purse seine vessels to assist the fishing operation. They are often used to tow the log or debris out of the net during a log set and attach or retrieve the lights and radio buoy from logs. They are often equipped with recording depth sounders used to estimate the size and depth of subsurface tuna schools under a log or the school position and depth of the net during the set.

Tow boats equipped with a generator and powerful lights are used to concentrate and hold the school near the surface during pre-dawn sets on logs or FADs. They are an essential item of equipment for FAD purse seining.

4.7. Side Thrusters

Some purse seiners are equipped with auxiliary propellors mounted transverse to the keel used to position the vessel during pursing, net hauling and brailing operations. Side thrusters are usually mounted toward the bow or in the stern near the main propellor. The use of bow and stern thrusters can eliminate the need for an auxiliary skiff for towing the seiner out of the net.

4.8. Refrigeration

Three basic types of refrigeration are used on regional tuna vessels to preserve the catch. Most of the large single seiners operating in the equatorial western Pacific fishery freeze the catch in -12 to -18 C recirculating brine stored in large steel fish holds. The brine is cooled by continuous coils lining the inside of the holds that are linked to ammonia or freon compressors. The catch can be held frozen for months in this manner but the fish is generally suitable only for the canning market. Large catches will delay the time required to freeze the catch and increase salt penetration by the brine and reduce the quality and value of the catch. Some seiners use a combination of brine and dry coil freezing to maintain a higher quality catch at -35 to -40 C.

Blast freeze or dry freeze systems can maintain high quality tuna without the problems of salt penetration from brine. These systems are used on distant water longline vessels to maintain sashimi grade tuna at -60 C. A few purse seine vessels from the Australian southern bluefin tuna fishery that specialize in an export sashimi market are equipped with blast freezers.

Refrigerated sea water systems (RSW) are used on short range fishing vessels and are capable of maintaining a high quality product for a limited time. Most RSW systems use freon compressors and heat exchangers to maintain the catch at around -3 C. Trip length is limited to around 15 days or less depending on the required market quality. RSW systems require far less energy and expense compared to freezer systems but can only operate in a limited area for short trips.

The southern bluefin seiners of south Australia are usually equipped with RSW systems as the fishing is close to port and targets a sashimi market. Small, fast carrier boats are sometimes used to ferry the highest quality catch to port while the catcher vessel remains on the grounds. Skipjack and mackerel seiners in New Zealand also use RSW systems as most of the fishing trips are short and conducted close to port.

4.9. Electronic equipment

4.9.1 Radio/communication equipment

A wide range of radio and communication equipment is necessary on modern purse seine vessels. Long range communication is usually provided by single side band radio that allow clear verbal communication across the entire Pacific basin. INMARSAT terminals with FAX capability are used to communicate concise typed information and have proved extremely useful for assisting vessel management and reprovisioning.

Medium and short range communication is usually provided by VHF, CB or two meter band radios for communications between vessels or within the seiner during fishing operations. The fishing captain may keep in contact and coordinate the fishing operation via VHF radio communication with the bridge, helicopter, sonar operator, skiff driver or operator of the light boat. Fishing operations on large purse seine vessels are often directed by intercom system or public address loudspeakers.

4.9.2. Satellite Navigation systems

Navigation and positions are generally determined by satellite navigation receivers. Current systems provide accurate position fixes at irregular intervals of about every one to four hours. The units calculate intermediate positions by calculating course and speed data from the last known fix (ded reconing). The new Global Positioning Systems will provide continuous position fixes with extreme accuracy when the sattelite networks become fully operational.

4.9.3. Radar

Radar units are standard units of safety and navigation equipment on any fishing vessel especially useful during periods of restricted visibility and at night.

4.9.4. S Band "Bird" Radar

S Band radar units are designed to aid fishermen in the location of bird schools that often indicate the presence of bait and fish schools. The units are very effective and are reported to be able to locate bird flocks that are not visible from the seiner due to long distance or rain squalls. These units are becoming standard equipment on large tuna purse seiners and can greatly reduce the time required to locate seinable tuna concentrations.

4.9.5. Sonar

Multidirectional scanning sonars are almost essential for effective purse seining on logs and FADs. These operations are usually conducted before dawn in complete darkness. The set is often conducted from information provided by the sonar on the position, depth and size of the tuna school.

4.9.6. Depth sounder

Paper recording and video depth sounders are used for a variety of purposed during fishing operations. The towboat or lightboat used during log or FAD fishing can use a depth sounder to judge the size, depth, position and species composition of fish beneath the FAD and relay this information to the seiner. A depth sounder on the smaller towboat can also determine the depth at which the net is pursing in relation to the fish school. A larger, more powerful depth sounder should be installed on the seiner to assist in the setting of FADs.

4.9.7. Current meter

Doppler current meters indicate the speed and direction of subsurface currents that have a strong influence on fishing success. Information gained from a current meter before a set may determine the speed, direction and position of the seiner at the beginning of the set or whether to cancel the operation. A large, deep purse seine creates a tremendous resistance to current flow and can be easily damaged by strong or conflicting currents. Purse seines have been lost or ripped for hundreds of meters due to strong currents.

4.9.8. Weather facsimile receiver

Marine facsimile machines receive and print out weather maps transmitted from meteorological stations receiving satellite information. Information on cloud cover, barometric pressure, sea surface temperature, storms, wind speed etc. can be obtained. This is a very useful piece of equipment for plotting and avoiding hurricanes and bad weather.

4.9.9. Automatic Direction Finder

Indicates the direction of a transmitted signal and is used for navigation and positioning. The frequency of the signal is input to the ADF and a relative bearing to the source is provided. This device can be used to locate the direction of other vessels that are transmitting radio signals or to obtain a position fix by triangulation on land based navigational beacons. On purse seiners, ADFs are most often used to locate logs or FADs that have been marked by position indicating radio buoys for future reference.

5. VESSEL TYPES

Single purse seine vessels operating in the western Pacific region can be divided into three basic categories depending on the net retrieval system that is installed. The majority of purse seine vessels operating in tuna fisheries worldwide are equipped with Marco or Marco style fishing gear. Triplex and Petrel equipped seiners are very uncommon in the Pacific and are primarily restricted to Australian and New Zealand fisheries.

5.1. Marco

Marco style purse seiners come in a wide range of sizes and operate in all of the tuna seine fisheries in the region. Vessel sizes range from around 150 GRT to 3000 GRT with most ranging between 499 and 1500 GRT. All of these Marco style seiners have certain features in common including a power block for net retrieval mounted on the end of a long boom and a large net skiff mounted on an inclined ramp at the stern of the seiner.

The net skiff anchors one end of the net during the setting operation and tows the seiner away from the net during the pursing and net hauling operations. When most of the net has been retrieved by the power block, the remaining corkline is tied to the side of the net skiff. The remaining net is hauled aboard the seiner until the catch is concentrated between the seiner and skiff in preparation for brailing (Figure 2).

The elevated position of the power block creates a high angle of pull from the net and exposes a large area of netting. These factors combine to make the operation of Marco style gear very difficult in rough seas or strong winds. The large net skiff is also difficult to handle in rough seas or large swells and can make sacking up and brailing operations extremely dangerous.

5.1.1. Marco style purse seine fleets

The American high seas purse seine fleet is equipped entirely with Marco gear. Most of the vessels range in size from 950 to 1500 GRT with a length of 60 to 70 meters and capacities of 900 to 1500 tonnes. The catch is maintained in circulating brine freezers at -12 to -18 C with most of the catch unloaded at the canneries in American Samoa or transhipped from Tinian in the CNMI. Some of the vessels unload in southeast Asian ports.

American tuna seiners usually operate with a helicopter to assist in the location of tuna schools and logs. Crew size is typically 20 to 22 composed mostly of non-US citizens from Central America, South America and the Pacific islands region (Figure 8).

Korea and Taiwan entered the western Pacific fishery through the purchase of used US seiners and continue to purchase or construct large Marco style vessels. The largest seiners that have operated in the region are Marco style Russian vessels ranging up to 2600 GRT.

These vessels operate in the highly productive western Pacific fishery centered between PNG and the FSM. Fishing operations concentrate on "log" fishing for skipjack and yellowfin tuna while making free school sets when conditions are favorable.

Japanese single seiners are equipped with Marco style gear but are considerably smaller than a typical US vessel. Government licensing regulations originally restricted the size of these vessels to 499 GRT but there is a trend toward larger capacity vessels. A typical Japanese 499 GRT single seiner is 51 to 53 meters in length and can hold 450 to 550 mt. Some 750 GRT vessels have joined the fleet and some of the original 499 GRT seiners have been cut and lengthened to increase their capacity.

The Japanese seiners use a combination of brine and dry coil refrigeration and can maintain the catch at a higher quality than the American vessels at -35 to -45 C. These vessels will make between 5 and 7 trips per year and deliver catches to Japan or transship from ports in the region.

Japanese seiners do not use helicopters to locate fish but rely heavily on sonar, onboard spotters and working cooperatively with other vessels to locate tuna concentrations. The crews are entirely Japanese numbering 18 to 24.

The smallest Marco equipped tuna seiners operating in the region are based in New Zealand and fish for skipjack and mackerel. These vessels range from 23 to 36 meters in length with capacitite of 90 to 300 tonnes (Figure 9).

5.2. Petrel and Triplex equipped seiners

Petrel and Triplex equipped seiners do not require the use of a net skiff for setting and brailing operations. A buoy or drogue can be used to anchor one end of the net to begin the set while the seiner circles the school. Most of the net is retrieved by the deck mounted power block and restacked in a stern net bin with the assistance of a hydraulic net stacking crane. A heavy steel boom holds the corkline away from the side of the vessel to form a brailing pocket in the heavy netting in the end of the net. Bow and stern thrusters are necessary to counteract the tendency of the vessel to be pulled toward and surrounded by the net during pursing and net hauling. The thrusters can also orient the vessel in a favorable direction to assist brailing the catch during rough weather.

The southern bluefin tuna fishery of south Australia prefers Petrel gear over the Marco system as it operates more efficiently in the rougher weather and is less expensive when compared to Triplex gear. One of these vessels has been converted to tropical conditions and has moved operations to the Solomon Islands and PNG. The vessels range in length from 27 to 47 meters carrying 90 to 500 tonnes. The small Australian Petrel seiners are similar to the Triplex seiner pictured in Figure 10.

The European or Norwegian style Triplex seiners operate in a similar manner to the clipper style Petrel seiners but are are of a completely different vessel type. The wheelhouse is located toward the stern with an open foredeck to accomodate the purse winch and brailing operations (Figure 11). The Triplex net hauler is ususally positioned on the starboard rail aft of the working deck with a net storage bin on the stern. These vessels are well adapted to operating in rough sea conditions and are generally preferred in fisheries where rough weather and winds are common.

One of the most successful seiners in the Australian bluefin fishery is a 44 m Norwegian style Triplex seiner similar to the vessel pictured in Figure 11. A similar Triplex seiner operates in the New Zealand mackerel fishery. The Australian seiner can hold 300 tonnes of catch in RSW tanks and operates with a crew of 10.

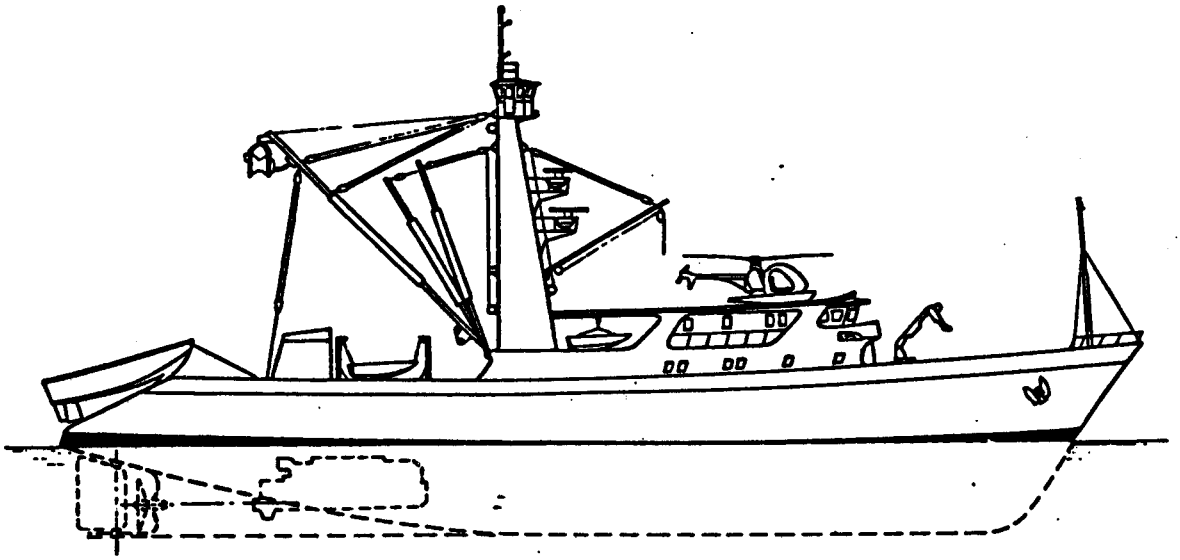


Figure 8. Typical 1200 ton Marco equipped tuna seiner (68 m)
(FAO 1985)

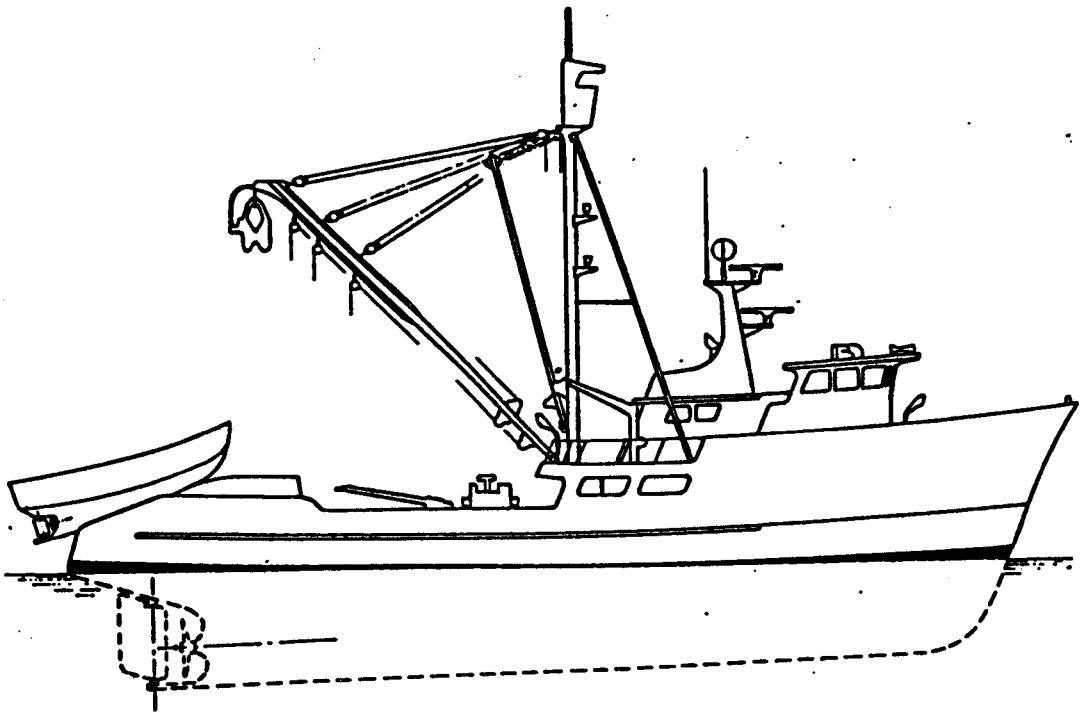


Figure 9. Small Marco equipped seiner (36 m)

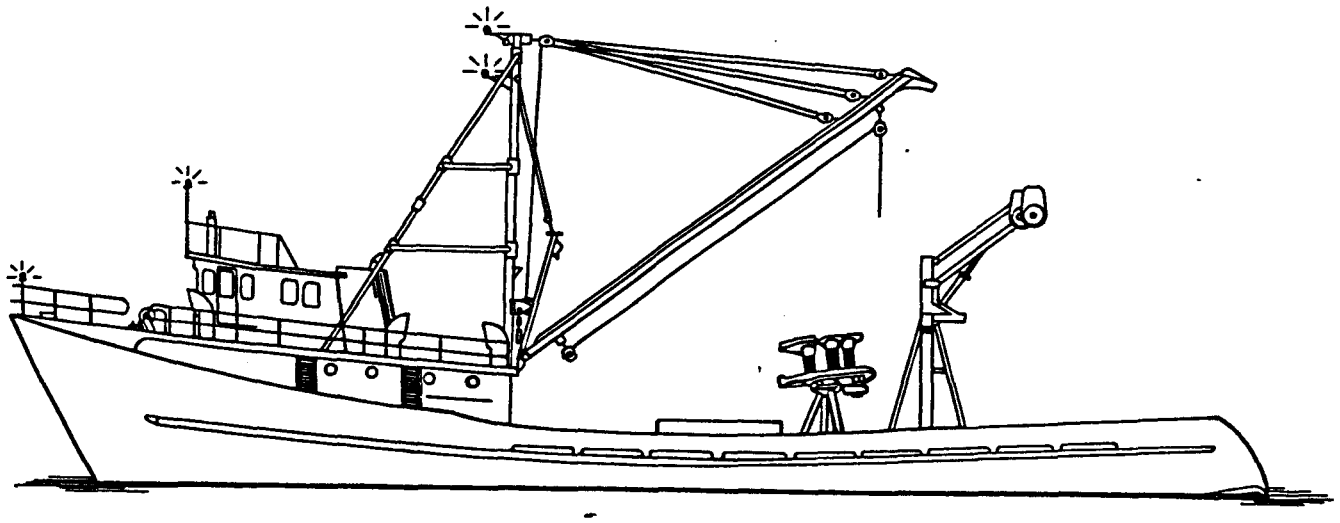


Figure 10. Clipper style Triplex seiner (25 - 35 m)

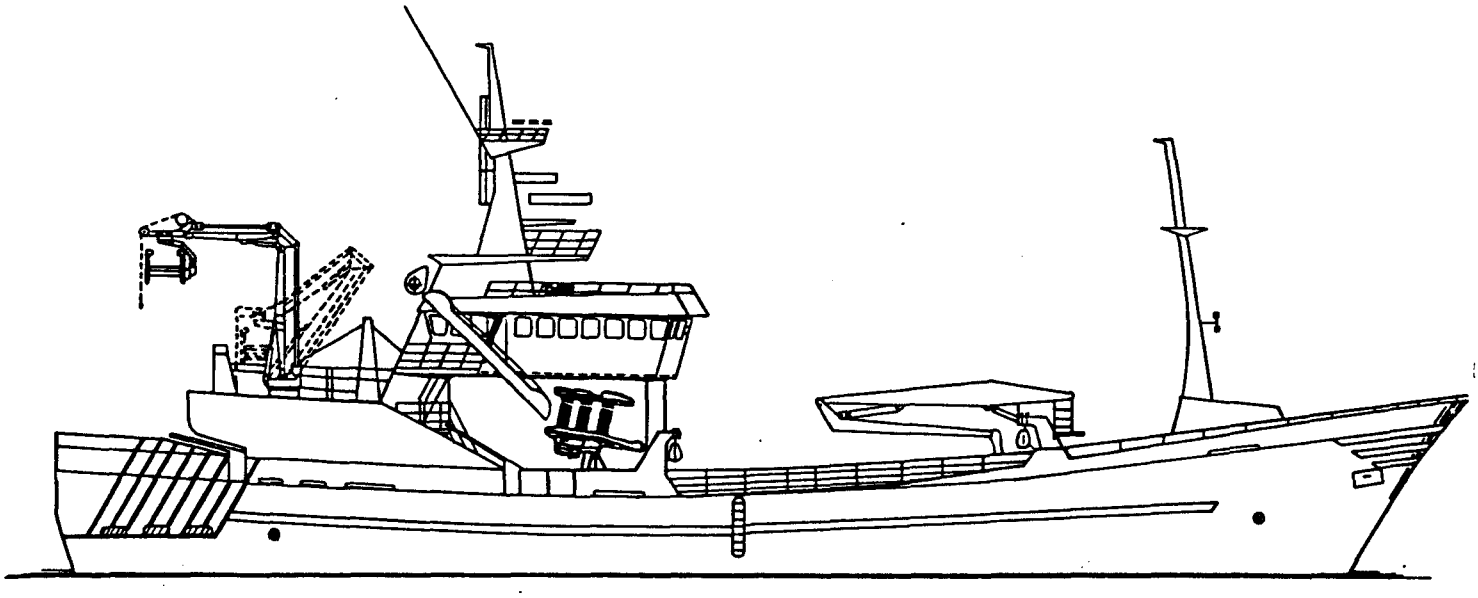


Figure 11. Norwegian or European style Triplex seiner.