PELAGIC LONGLINE

Southeast Asian Fisheries Development Center
Training Department

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FOREWORD

Training Department of the Southeast Asian Fisheries Development Center (SEAFDEC) has been active in promoting fisheries development in Southeast Asian Countries for over 35 years through training in fishing technologies for small-, medium-, and large-scale fishermen. Pelagic longlining has been initiated by TD for more than two decade at the request of member countries. At present, many countries have carried out pelagic longlining from various techniques depend upon their own experiences such as in the Philippines, Vietnam and Indonesia. In some countries such as Thailand and Malaysia, Pelagic longlining has not yet been fully initiated by fishermen due to lack of experiences for both fishing techniques and fish handling techniques. This is part of the reason for compiling this manual of Pelagic Longline.

The main purpose of the manual, however, is to introduce the pelagic longline fishing method to fishermen through government officers in the SEAFDEC member countries, as well as to assist currently involved to improve their fishing success, particularly in commercial or semi-commercial situations. The manual is intended to act as a guide to the principles and techniques of good pelagic longline fishing, particularly in tuna longline fishing, for use by fishermen who want to start, refine or broaden their skills.

A further aim of the manual is to serve as a resource in formal training activities carried out by SEAFDEC/TD training program. The manual is intended for use as a training aid to help introduce and explain fishing topics to small- and medium-scale fishermen and others. This manual have split into topics, organized into seven main chapters, which deal with main target species, gear construction, bait selection, fishing operation (base on reel system), fishing handling, utilization of fish body and international organization.

Admittedly, this manual is not all-comprehensive but nevertheless, it will hopefully provide a useful introduction to officers, fishermen and others in Southeast Asian Region.

Niwes Ruangpanit

(Niwes Ruangpanit)
SEAFDEC Secretary-General

Target Species

Tuna Species

"Tuna" is the general name applied to the Teleostei, Percida, Scombina, and Scombridae species of fish. Mainly inhabiting the open sea, these fishes are extremely agile and can cover long distances at high speeds. They also reside at the top of the food chain among other fish species. There are seven types of tuna: bluefin tuna, Southern bluefin tuna, Atlantic tuna, Bigeye tuna, Yellowfin tuna, Albacore, and Longtail tuna. Approximately 1.6 tons of tuna are caught worldwide each year.

Bigeye tuna live in oceans all over the world in tropical, subtropical and temperate zones. Many inhabit the Pacific Ocean -- particularly in the Northern Hemisphere, though none are in the Mediterranean Sea. They live mainly off of other fish, crustaceans, and squid. The annual catch in tonnage of bigeye tuna is about 250,000. Regional administrative organs manage their catches. The meat of this fish is bright red and has a rather plain taste. It is canned and sold all over the world, though in Japan, it is most popular as sashimi and sushi in the area north of the Kanto Region.

Bigeye Tuna

Thunnus obesus (Lowe, 1839)
Family:Scombridae (Mackerels, tunas, bonitos)
Order: Perciformes
Class: Actinopterygii (ray-finned fishes)

Max. size : 250 cm TL ; max. published weight: 210.0 kg ; max. reported age: 11 years
Environment : pelagic; oceanodromous; marine ; depth range 0 - 250 m
Climate :subtropical; 13 - 29°C; 45°N - 43°S
Importance: fisheries: highly commercial; gamefish: yes
Resilience : Medium, minimum population doubling time 1.4 - 4.4 years (K=0.11-0.23; tm=3; tmax=11; Fec=2 million)
Distribution : Atlantic, Indian and Pacific: in tropical and subtropical waters. Absent in the Mediterranean. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea
Diagnosis : Dorsal spines (total): 13-14; Dorsal soft rays (total): 14-15; Anal spines: 0-0; Anal soft rays: 14-14; Vertebrae: 39. A large species, deepest near the middle of the first dorsal fin base. Lower sides and belly whitish; a lateral iridescent blue band runs along the sides in live specimens. The first dorsal fin is deep yellow, the second dorsal and anal fins are light yellow, the finlets are bright yellow edged with black.
Biology : Occur in areas where water temperatures range from 13°-29°C, but the optimum is between 17° and 22°C. Variation in occurrence is closely related to seasonal and climatic changes in surface temperature and thermocline. Juveniles and small adults school at the surface in mono-species groups or mixed with other tunas, may be associated with floating objects. Adults stay in deeper waters. Eggs and larvae are pelagic. Feed on a wide variety of fishes, cephalopods and crustaceans during the day and at night. Meat is highly prized and processed into sashimi in Japan. Marketed mainly canned or frozen , but also sold fresh .

Yellowfin Tuna inhabit oceans in both the torrid and temperate zones, but not in the Mediterranean Sea. The main fishing ground for this fish extends within 25 degrees of the north-south longitude line.

Yellowfin tuna primarily eat other fish, crustaceans, and cephalopods. Fishermen use the purse seine fishing method to catch smaller yellowfin tuna, which tend to live closer to the surface of the ocean. The larger type of this fish dwell deeper in the mid-depths, and are caught through lonelining. Some 62% of the 1.6 million tons of tuna caught worldwide each year are yellowfin tuna.

Since 1949 the ICCAT has been in charge of management yellowfin tuna catches in the eastern Pacific Ocean region. Such catches are managed by fishing management committees that have been designated according to each ocean region. The meat of this fish, which is pinkish in color, has a light taste. It is canned and sold throughout the world, though th Japanese also use it in sashimi and in fish sausage.

Yellowfin Tuna

Thunnus albacares (Bonnaterre, 1788)
Family : Scombridae (Mackerels, tunas, bonitos)
Order : Perciformes
Class : Actinopterygii (ray-finned fishes)

Max. size : 239 cm FL (male/unsexed; max. published weight: 200.0 kg; max. reported age: 8 years
Environment : reef-associated; oceanodromous; brackish; marine ; depth range 1 - 250 m
Climate :tropical; 15 - 31°C; 45°N - 45°S
Importance : fisheries:highly commercial; gamefish: yes
Resilience : Medium, minimum population doubling time 1.4 - 4.4 years (K=0.13-0.42; tm=2-5; tmax=8; Fec=200,000)
Distribution : Worldwide in tropical and subtropical seas, but absent from the Mediterranean Sea. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea.
Diagnosis : Dorsal spines (total): 11-14; Dorsal soft rays (total): 12-16; Anal spines: 0-0; Anal soft rays: 11-16; Vertebrae: 39. Fish with very long second dorsal fin and anal fin, which in some may reach well over 20% of the FL. The pectoral fin is moderately long, usually reaching beyond the second dorsal fin origin but not beyond the end of its base. Color is black metallic dark blue changing through yellow to silver on the belly. The belly frequently has about 20 broken, nearly vertical lines. The dorsal and anal fins and finlets are bright yellow.

Biology : An oceanic species occurring above and below the thermoclines. They school primarily by size, either in monospecific or multispecies groups. Larger fish frequently school with porpoises, also associated with floating debris and other objects. Feed on fishes, crustaceans and squids. It is sensitive to low concentrations of oxygen and therefore is not usually caught below 250 m in the tropics. Peak spawning occurs during the summer, in batches. Encircling nets are employed to catch schools near the surface. Marketed mainly frozen and canned, but also fresh and smoked. Highly valued for sashimi .

Albacore live in the open sea from 40 degrees North Latitude to 40 degrees South Latitude. They are the smallest of all tuna species, and mainly eat other fish, crustaceans, and cephalopods.

About 220,000 tons of albacore are caught each year via pole fishing, longline fishing and purse seine fishing. Regional administrative organs manage the catches of this fish, whose meat is white and soft, and thus often referred to as "sea chicken." Albacore is sold in cans the world over and used frequently in tuna sandwiches and salads.

Albacore

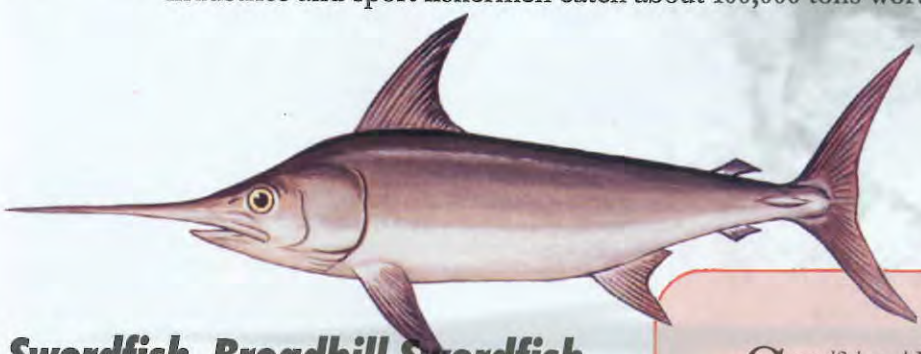
Thunnus alalunga (Bonnaterre, 1788)
Family : Scombridae (Mackerels, tunas, bonitos)
Order : Perciformes
Class : Actinopterygii (ray-finned fishes)

Max. size : 140 cm FL (male/unsexed; max. published weight: 60.3 kg
Environment : pelagic; oceanodromous; marine ; depth range 0 - 600 m
Climate :subtropical; 10 - 26°C; 45°N - 50°S
Importance : fisheries: highly commercial;
gamefish: yes
Resilience : Low, minimum population doubling time 4.5 - 14 years (K=0.13-0.18; tm=4-6; tmax=10; Fec=2 million)
Distribution : Cosmopolitan in tropical and temperate waters of all oceans including the Mediterranean Sea but not at the surface between 10?N and 10?S. Western Pacific: range extend in a broad band between 40°N and 40°S. Often confused with juvenile T. obesus which also have very long pectorals but with rounded tips. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea.
Diagnosis : Dorsal spines (total): 11-14; Dorsal soft rays (total): 12-16; Anal spines: 0-0; Anal soft rays: 11-16. Anterior spines much higher than posterior spines giving the fin a strongly concave outline. Interpelvic process small and bifid. Body with very small scales. Pectoral fins remarkably long, about 30% of fork length or longer in 50 cm or longer fish. Ventral surface of liver striated and the central lobe is largest.

Biology : An epi- and mesopelagic, oceanic species, abundant in surface waters of 15.6° to 19.4°C; deeper swimming, large albacore are found in waters of 13.5° to 25.2°C; temperatures as low as 9.5°C may be tolerated for short periods. Known to concentrate along thermal discontinuities. Form mixed schools with skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and bluefin tuna (*T. maccoyii*), schools may be associated with floating objects, including sargassum weeds. Feed on fishes, crustaceans and squids. Highly appreciated and marketed fresh, smoked, deep frozen or canned. Eaten steamed, broiled, fried and microwaved.Sexual maturity reached at 90 cm.

Swordfish&Marlin Species

"Swordfish" is the general name applied to fish within the Xiphidae (broadbill) species, and to Teleostei, Percida, and Scombina fish within the Istiophoridae (striped marlin) species. All these fish swim in oceans located within the torrid and temperate zones of the earth. Striped marlin live closer to the surface of the ocean, while broadbills inhabit deeper, mid-depth waters about 500 to 600 meters below the sea. There is one kind of broadbill in the Xiphidae fish species. Within the Istiophoridae fish species, there is a total of 11 kinds of fish: two kinds of Indo-Pacific sailfish, six kinds of striped marlin, and three kinds of Indo-Pacific blue marlin. At present, the world's fishing industries and sport fishermen catch about 100,000 tons worth of these kinds of fish.

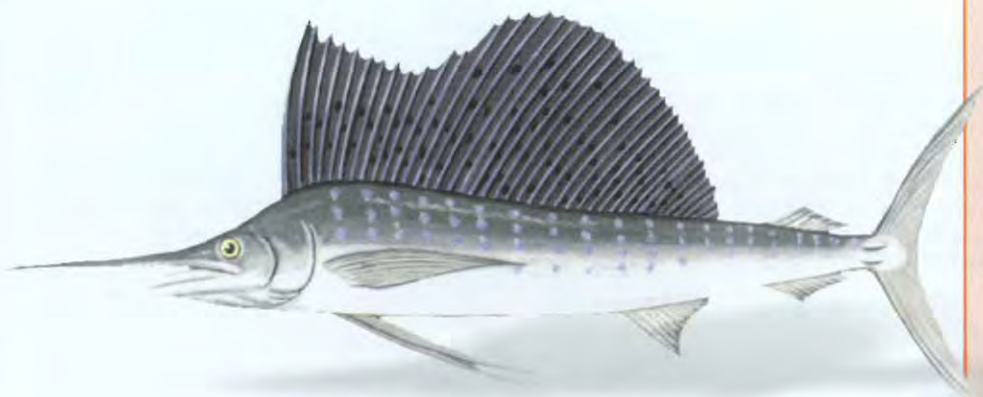


Swordfish, Broadbill Swordfish

Xiphias gladius (Linnaeus, 1758)
Family : Xiphiidae (Swordfish)
Order : Perciformes
Class : Actinopterygii (ray-finned fishes)

Swordfish and Marlin species live in the mid-depths of the ocean, in torrid and temperate zones all over the world. They are noted for their round bodies, long bills and overall flat appearance. The fishing methods used to catch swordfish and broadbill swordfish include longlining and hand-harpooning. The ICCAT is also responsible for managing the catches of these fish species. Their meat is soft and high in fat content. Europeans and Americans often eat them as steaks, While the Japanese prefer eating them raw as sashimi or broiled.

Max. size : 455 cm FL (male/unsexed); max. published weight: 650.0 kg
Environment : pelagic; oceanodromous; marine ; depth range 0 - 800 m
Climate :temperate; 5 - 27°C; 60°N - 45°S
Importance : fisheries: commercial;
gamefish: yes
Resilience : Low, minimum population doubling time 4.5 - 14 years (rm=0.076; K=0.23; tm=5-6; tmax=9;)
Distribution : Atlantic, Indian and Pacific: tropical and temperate and sometimes cold waters, including the Mediterranean Sea, the Sea of Marmara, the Black Sea, and the Sea of Azov. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea. Mt DNA restriction analysis reveal that genetic differentiation occurs between populations inhabiting the Mediterranean Sea and the tropical Atlantic ocean, indicating little genetic exchange occurring between the two.
Diagnosis : Dorsal spines (total): 0-0; Dorsal soft rays (total): 38-56; Anal spines: 0-0; Anal soft rays: 16-18. Blackish-brown fading to light-brown below; 1st dorsal fin with blackish-brown membrane, other fins brown or blackish-brown. A long, flat, sword-like bill and no pelvic fins.
Biology : Oceanic but sometimes found in coastal waters. Generally above the thermocline. Prefer temperatures of 18°C to 22°C. Larvae are frequently encountered at temperatures above 24 °C. Migrate toward temperate or cold waters in the summer and back to warm waters in the fall. Adults are opportunistic feeders, known to forage for their food from the surface to the bottom over a wide depth range. Use their sword to kill their prey. Feed mainly on fishes but also on crustaceans and squids. Good food fish, marketed fresh or frozen, and can be made into sashimi, teriyaki or fillets. Large individuals may accumulate large percentages of mercury in its flesh. Spawning takes place in Atlantic during spring in southern Sargasso Sea. Females grow fastest. Determination of age is difficult since the otoliths are very small and scales are missing in adults. Year rings have been successfully counted on cross sections of the fin rays. Pelagic eggs measure 1.6-1.8mm and the newly hatched larvae is 4 mm long. Sword is well developed at a length of 10mm and young live pelagically in the upper water layers where they quickly develop into very voracious predators. Mt DNA restriction analysis reveal that genetic differentiation occurs between populations inhabiting the Mediterranean Sea and the tropical Atlantic ocean, indicating little genetic exchange occurring between the two.



Striped marlin live in oceans in tropical regions of the Indian and Pacific Oceans and in temperate regions as well. Their bodies are flat, their bills long, and their shape round. There are eleven kinds of this type of fish, ranging from Indo-Pacific sailfish, and striped marlin to blue marlin. Indo-Pacific sailfish have very distinct dorsal fins and are famous for being the fastest of all fish, clocking in at about 120 kilometers per hour. Striped marlin mainly eat other fish ad cephalopodas. Since their dorsal fins break water when they are swimming under the surface of the ocean, these fish are often caught using a hand-harpooning technique. Longlining is another fishing method used to catch them. The ICCAT is in Charge of managing the catches of striped marlin. In both Europe and the United States, they are eaten as steaks, while the Japanese eat them either as sashimi or else broiled (striped marlin, blue marlin). They also use the Indo-Pacific sailfish in a fish-paste product.

Striped Marlin

Tetrapturus audax (Philippi, 1887)
Family : Istiophoridae (Billfishes)
Order : Perciformes
Class : Actinopterygii (ray-finned fishes)

Max. size : 420 cm TL (male/unsexed; max. published weight: 440.0 kg
Environment : pelagic; oceanodromous; marine ; depth range - 100 m
Climate :subtropical; 45°N - 45°S
Importance : fisheries: commercial;
gamefish: yes
Resilience :Medium, minimum population doubling time 1.4 - 4.4 years (rm=0.09; K=0.2-0-6; tm=2-3;)
Distribution : Indo-Pacific: tropical, subtropical and temperate waters. Occasionally found on the Atlantic side of the Cape of Good Hope. One stray individual was caught off Angola, West Africa. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea. Their distribution in the Pacific Ocean is unique among billfishes and tunas in that it forms a horseshoe-shaped pattern from the northwest Pacific through the eastern Pacific to the southwest Pacific. In the Indian Ocean, fish are more densely distributted in equatorial regions with higher concentrations off eastern Africa, in the western Arabian Sea, the Bay of Bengal and off northwestern Australia.
Diagnosis : Dorsal spines (total): 0-0; Dorsal soft rays (total): 42-48; Anal spines: 0-0; Anal soft rays: 18-24. Blue-black above and silvery white below, with about 15 rows of cobalt-coloured stripes; 1st dorsal fin dark blue; other fins dark brown, sometimes with a tinge of dark blue; anal fin bases with a tinge of silvery white.
Biology : Epipelagic and oceanic species, usually found above the thermocline. Generally inhabit cooler water than either black (*Makaira indica*) or blue marlin (*M. mazara*). Most dominant and widely distributed of all billfishes. Their abundance increases with distance from the continental shelf. Usually seen close to shore only where deep drop-offs occur. Mostly solitary, but form small schools by size during the spawning season. They are usually dispersed at considerably wide distances. Feed on fishes, crustaceans and squids. Also caught with the harpoon. The flesh is the best among billfishes for sashimi and sushi. Marketed mostly frozen, sometimes fresh; also smoked and frozen.

Black Marlin are a free-roaming pelagic. This robust fish is long and well streamlined with a steep forehead and a long, sharp spearlike snout. The overall body colour is metallic blue with the belly been white, though the fish changes to an overall deep black once landed. The stout bill is circular in cross section and is just shorter than the head length.

This is possibly the most common marlin of them all in South Africa. Although tuna and bonito are favoured food, this fast predator will eat virtually any fish, especially kingfish, dolphinfish, rainbow runner, yellowtail and squid. This fish uses it's rough bill to slash or impale it's prey. It is mainly a solitary fish wit it more often been caught at depths ranging from 400m to 1000m.

This prized game fish can be caught by deep sea anglers using lures, the biggest catches are invariably made on well prepared tuna baits and outriggers. More and more game fisherman are tagging and releasing marlin now for scientific research.

Black Marlin

Makaira indica (Cuvier, 1832)
Family : Istiophoridae (Billfishes)
Order : Perciformes
Class : Actinopterygii (ray-finned fishes)

Max. size : 465 cm FL (male/unsexed); max. published weight: 750.0 kg
Environment : pelagic; oceanodromous; marine ; depth range 0 - 915 m
Climate :subtropical; 15 - 30°C; 40°N - 45°S
Importance : fisheries: commercial;
gamefish: yes
Resilience : Medium, minimum population doubling time 1.4 - 4.4 years (K=0.47(?); Fec=67 million; assuming tm>2)
Distribution : Gazetteer Indo-Pacific: tropical and subtropical waters, occasionally entering temperate waters. Stray individuals migrate into the Atlantic Ocean by way of the Cape of Good Hope, but the existence of Atlantic breeding stocks is unlikely. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea .
Diagnosis : Dorsal spines (total): 0-0; Dorsal soft rays (total): 39-50; Anal spines: 0-0; Anal soft rays: 16-21. Dark blue above, silvery white below; sometimes with light blue vertical stripes; 1st dorsal fin blackish to dark blue, other fins dark brown with tinges of dark blue in some specimens.
Biology : Oceanic, usually found in surface waters above the thermocline, often near shore close to land masses, islands and coral reefs. Feed on fishes, squids, cuttlefishes, octopods, large decapod crustaceans and mostly on small tunas when abundant. The flesh is of good quality; marketed refrigerated or frozen and prepared as sashimi in Japan.

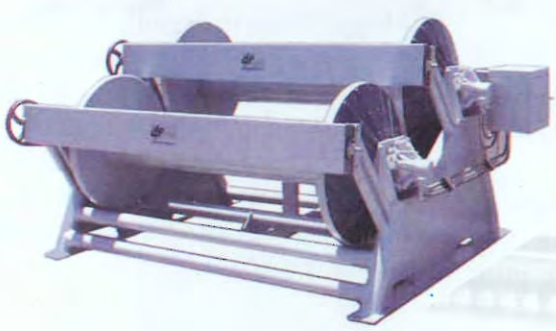
GEAR CONSTRUCTION

Deck Machinery

Line Shooter

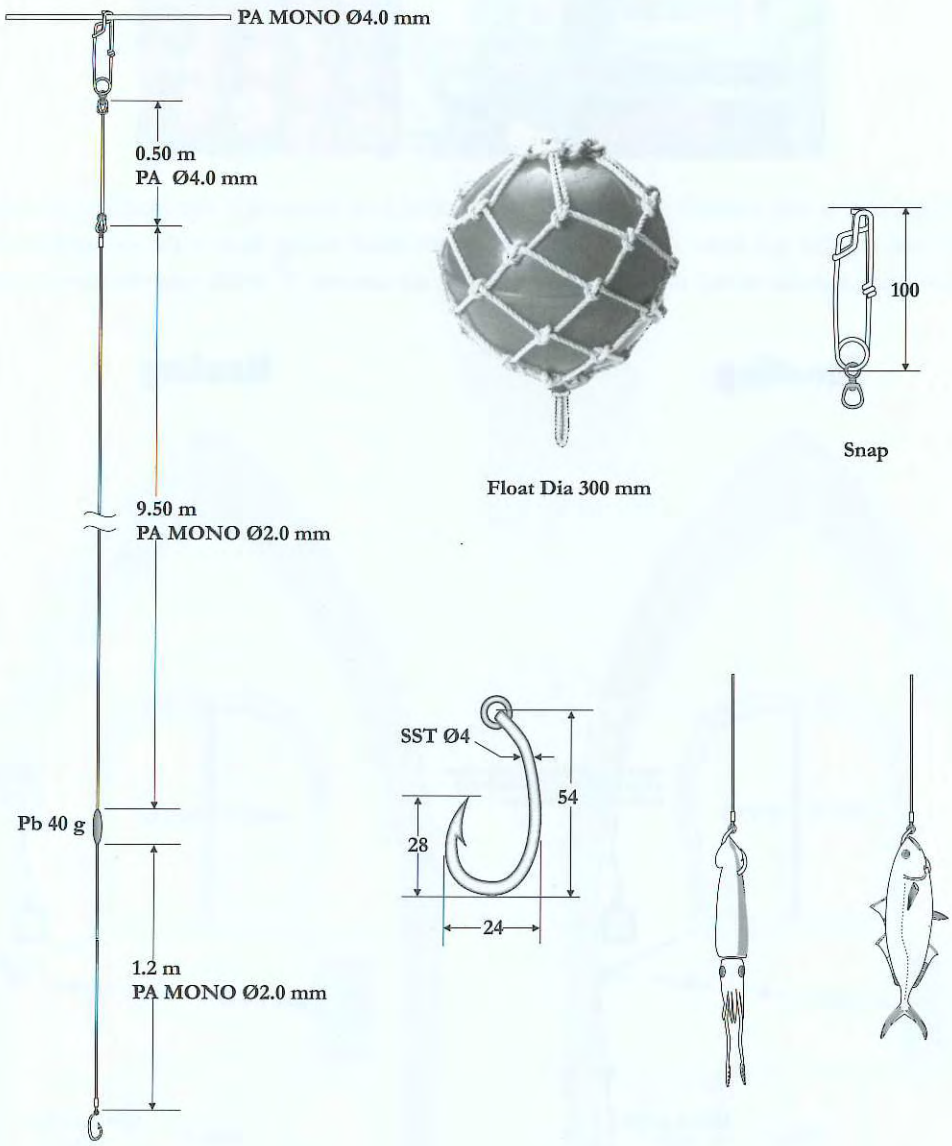
Mainline Reels
Single spool

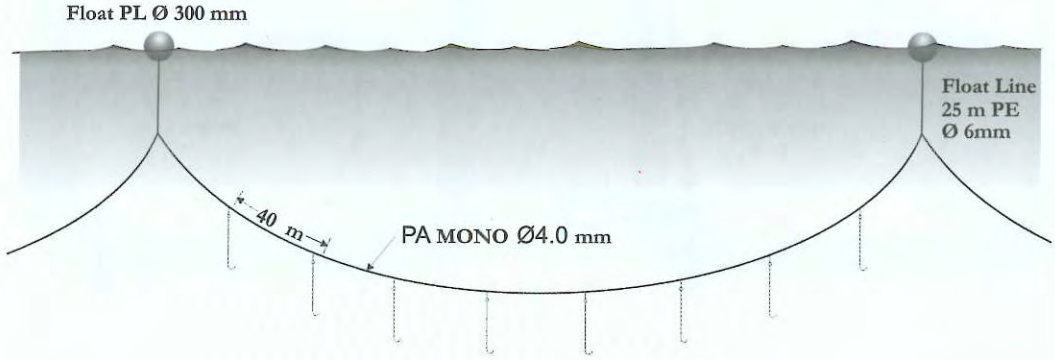
Mainline Reels
Double spool



GEAR CONSTRUCTION

Gear Overall Layout



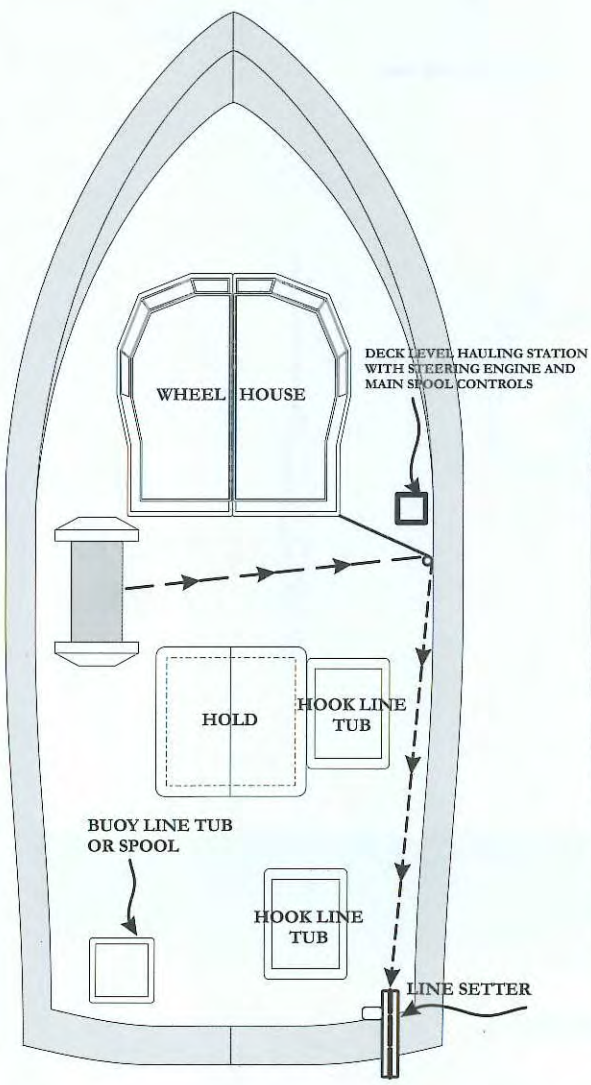


Typical Deck Layout

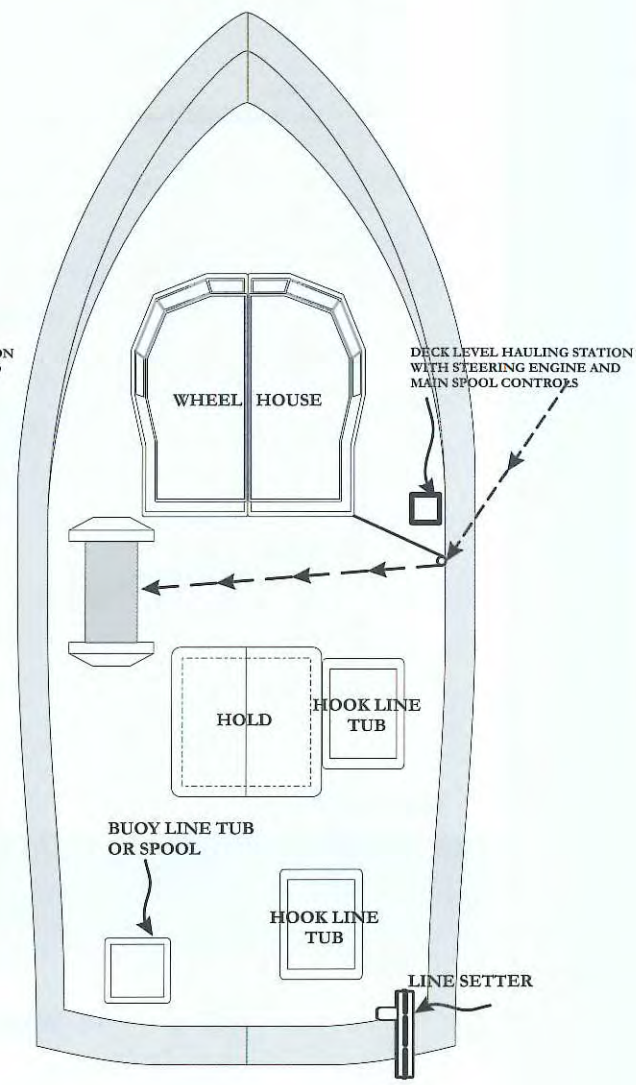
Small Vessel

The longline is a very versatile gear that can be operated from almost any size and type of vessel. In principle the same longline can be used form a dugout canoe or small rowing boat as the one used on board a 60-m ocean-going autoline vessel, the only difference being the amount of hooks and line carried and operated.

Shooting



Hauling

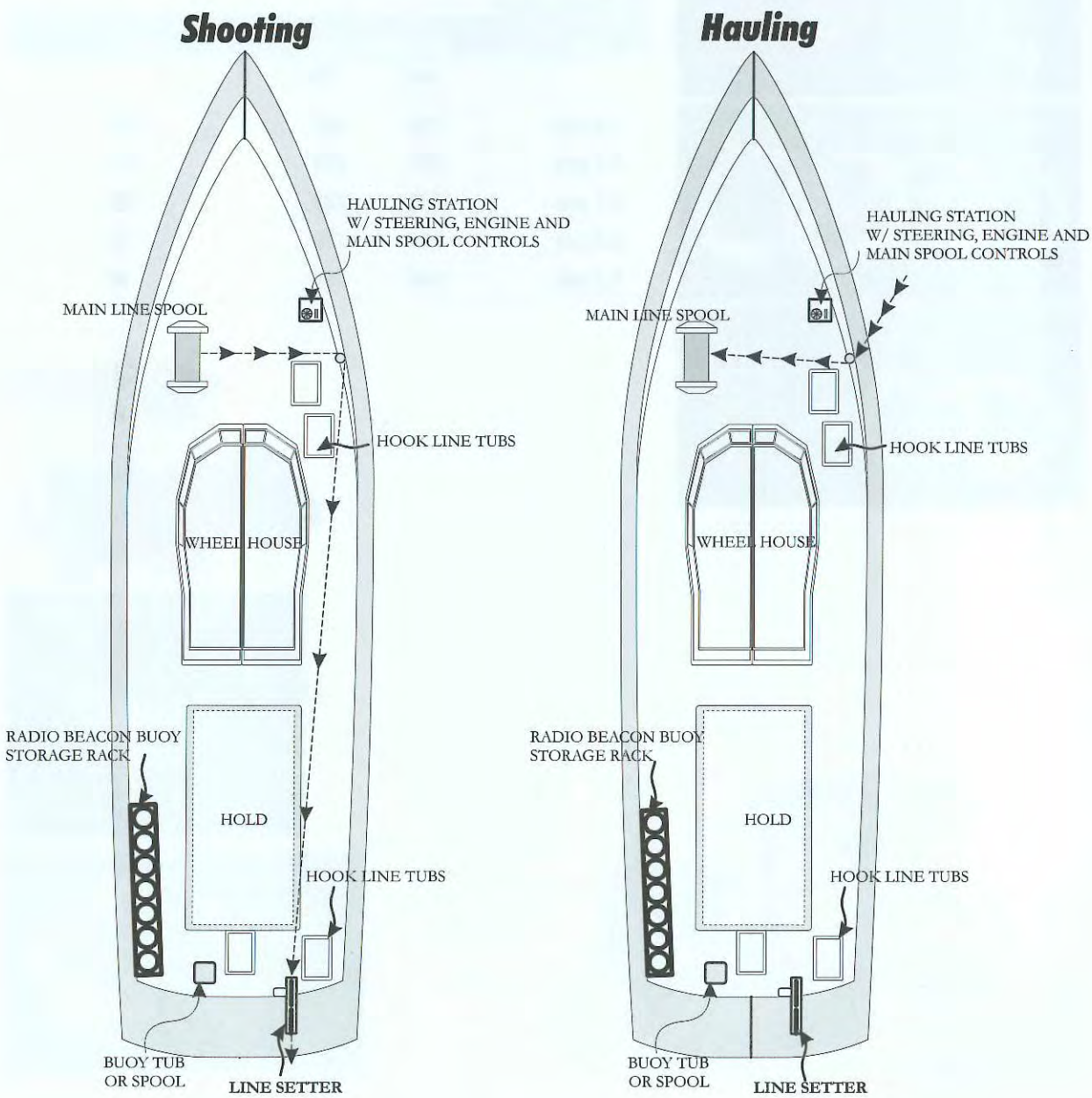


Typical Deck Layout

Large Vessel



The main characteristics of a longline vessel that distinguish it from other fishing vessels are the rail roller, the longline hauler and in particular the setting chute on traditional longline vessels or the baiting and gear handling system on mechanised longliners.



Nylon Monofilament

Physical Strength of Nylon Monofilament

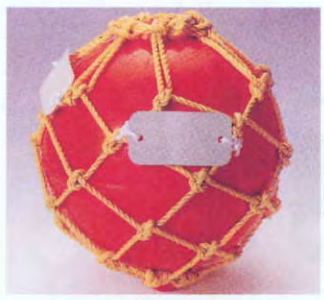
Main Line

Size	Breaking strength		Weigh/Nautical mile	
	Lbs.	Kg.	Lbs.	Kg.
3.0 mm	970	440	34	16
3.5 mm	1,230	560	43	20
3.6 mm	1,300	590	46	21
4.0 mm	1,430	650	56	26

Branch Line

Size	Breaking strength		Meter/Lb
	Lbs.	Kg.	
1.8 mm	396	180	160
2.0 mm	507	230	130
2.1 mm	530	240	120
2.3 mm	595	270	100
2.5 mm	705	320	80

Floats



Reflective Plate for Float

Reflective Disc for Float

Top Buoy

Fishing Burner

Top Light

Swivels

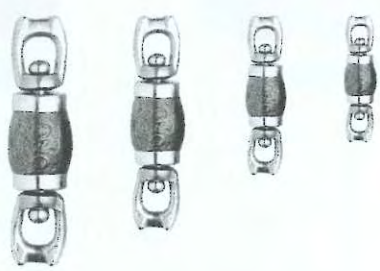
Heavy Duty Swivel

SBL Swivel

8-Type Swivel

Course Type Swivel

Leaden Swivel



Leaden Course Type Swivel

Hooks

Tuna Circle Hook

Tuna Hook with Ring

Skipjack Hook with Ring

Tuna & Swordfish Hook

Snaps&Sinkers

Branch Hanger with Lead Swivel

Branch Hanger

Snap A-Type American Style

Branch Hanger with Swivel

Sinkers varies in shape, size, and weight

Snap A-Type American Style with Swivel

Joints Parts

Aluminum & Stainless Course

Protect Pipe

Protect Plate

Luminous Heart

Lock Cap

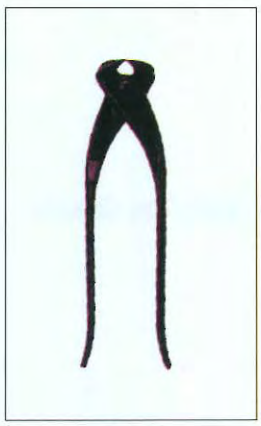
Luminous Course

Tools

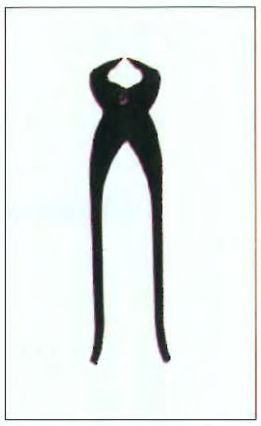
Aluminum Sleeve

Wire Cutter

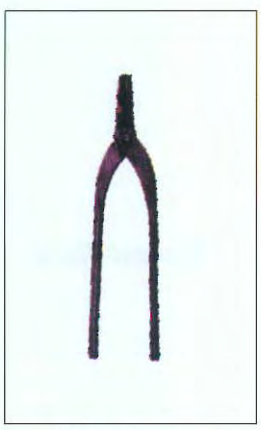
Hand Presser with Tips



Pincer



Spiker



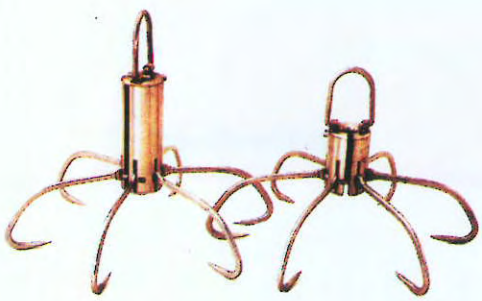
Wire Cutter Small

Marine Presser

Scissors

Mini Presser

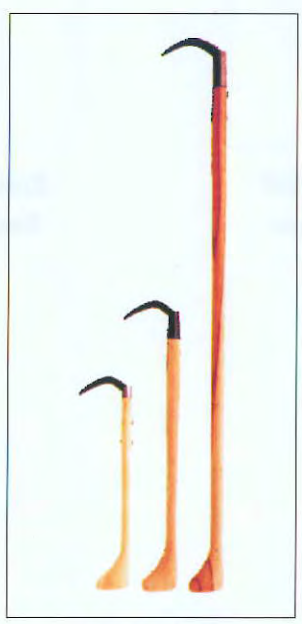
Gaffing Tool



Tuna Missile

Using of Tuna Missile

Shark Shear



Hand Hook

Fish Hammer

Cutting Tools

Hand Hatchet
Single edge

Hand Hatchet
Double edge

Deba Knife-Single Edge

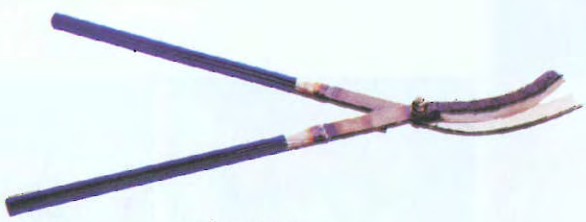
Kaibo Knife-Double Edge

Hand Saw

Sashimi Knife

Magiri Knife&case

Drop Blood Knife



Fin Cutter

Tail Cutter

HOOK LINE STORAGE

Hook Tub, Hook line Bin

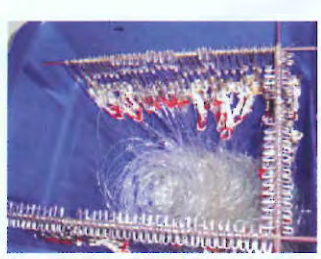
Hook Tub, Hook line tub or Hook line Bin provides easy access and excellent storage for leaders. The tub can be easily moved about the boat. The construction of both the tub and its custom built cover is of rugged polypropylene which assures long life in the harsh marine environment. The polypropylene cover prevents the sun from damaging mono-filament leaders.

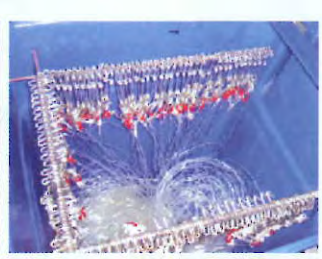
Tubs are used primarily for the storage of hook line leaders, however they are equally useful for storing buoy line leaders.

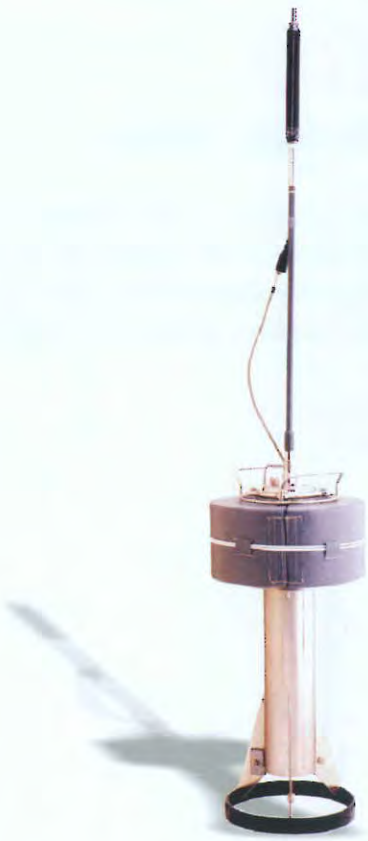
All metal components including the wire tracks where the snaps are attached should be stainless steel.

Snaps will be attached to the wire tracks and after laying the leader lines in the tubs, fishermen attach the hook to the snap by passing the hook point through either the snap or its swivel, guaranteeing quick and trouble free access to the leaders when needed.

Hook line tubs had been used effectively, in a Tuna Longline operation by M.V. Platoo.



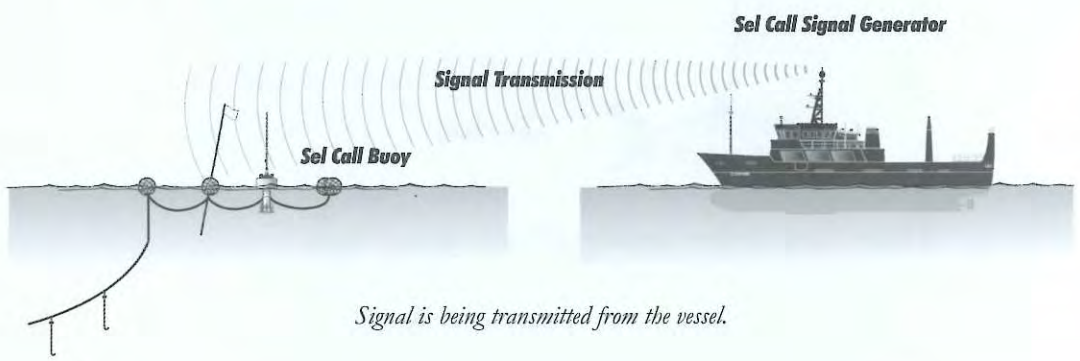




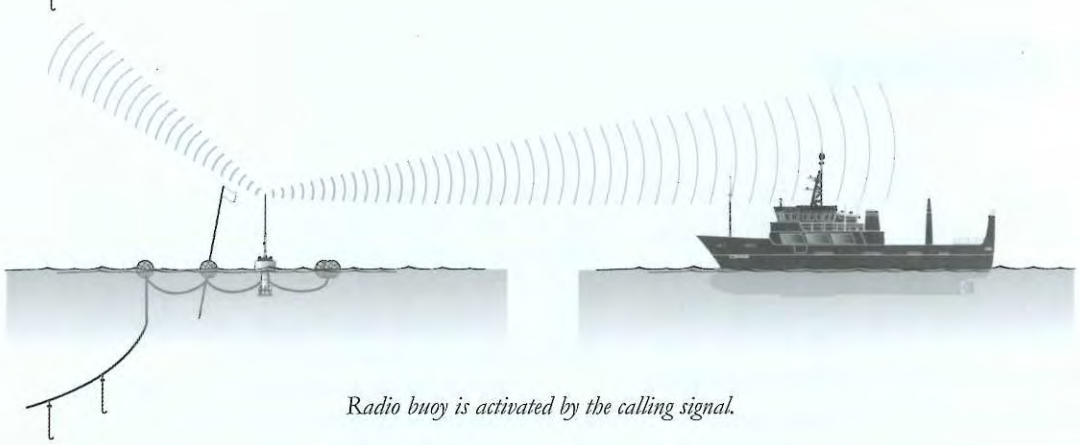
RADIO BUOY

The Radio Buoy is a device that was developed to improve the efficiency of the fishing industry and to prevent the washing away of fishing net. An electrical wave emitted by the Radio Buoy fastened to the fishing net is received by the direction finder of the ship, which indicates the direction and fish quantity information of the Radio Buoy.

The **SEL-CALL BUOY** *consists of Radio Buoy with a receiver installed in it, and it answers only when it is called by its own ship. For this reason, the battery power consumed is small , and could reduce buoy stolen trouble by other ship .*



Signal is being transmitted from the vessel.



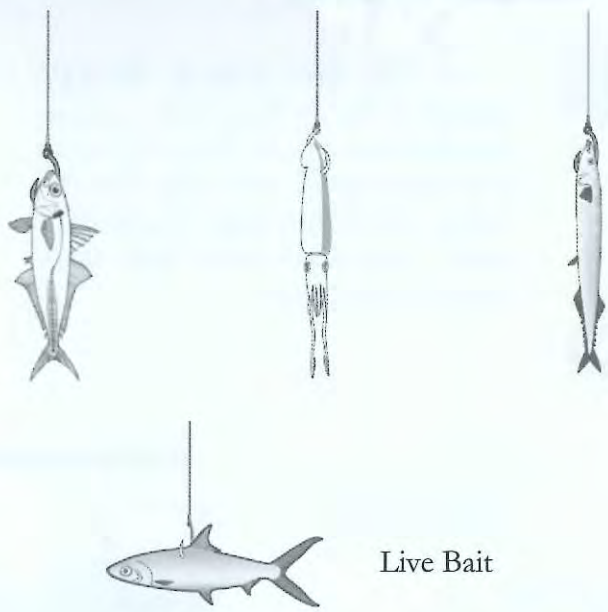
Radio buoy is activated by the calling signal.

Descriptive figures show how a Radio Buoy works.

Bait Type Selection

Stimulating Food-Searching Behaviour of Fish by Baits' Odour

Longline fishing is based on stimulating the food-searching behaviour of fish through the odour released from the baits. Once the fish have been attracted to the longline by the bait odour, the baits serve to trigger the fish to attack and ingest the baited hooks. The type and quality of the bait are therefore very important factors for the catching efficiency of longlines.



Live Bait

Figures show proper hooking for each type of baits.

Bait Efficiency

Longline fishing is based on stimulating the food-searching behaviour of fish through the odour released from the baits. Once the fish have been attracted to the longline by the bait odour, the baits serve to trigger the fish to attack and ingest the baited hooks. The type and quality of the bait are therefore very important factors for the catching efficiency of longlines.

The fisherman has learned from experience that different bait types give different catching efficiencies for different species. The type of bait chosen for a specific fishing operation is therefore determined by the target species.

In addition to the attractiveness of the smell and taste stimuli, the efficiency of a bait is determined by its physical strength and ability to remain on the hook throughout the soaking period.

Some of the Most Common Bait types used to target main species

Saury

Scad

Squid

Milkfish

In addition to the type of bait used, the quality of bait is of significant importance for the caatching efficiency. The quality and quantity of odour released by a bait may be affected by the feeding history of the bait specimen.

Bait of the same type but caught in different seasons or areas may give different catching efficiency.

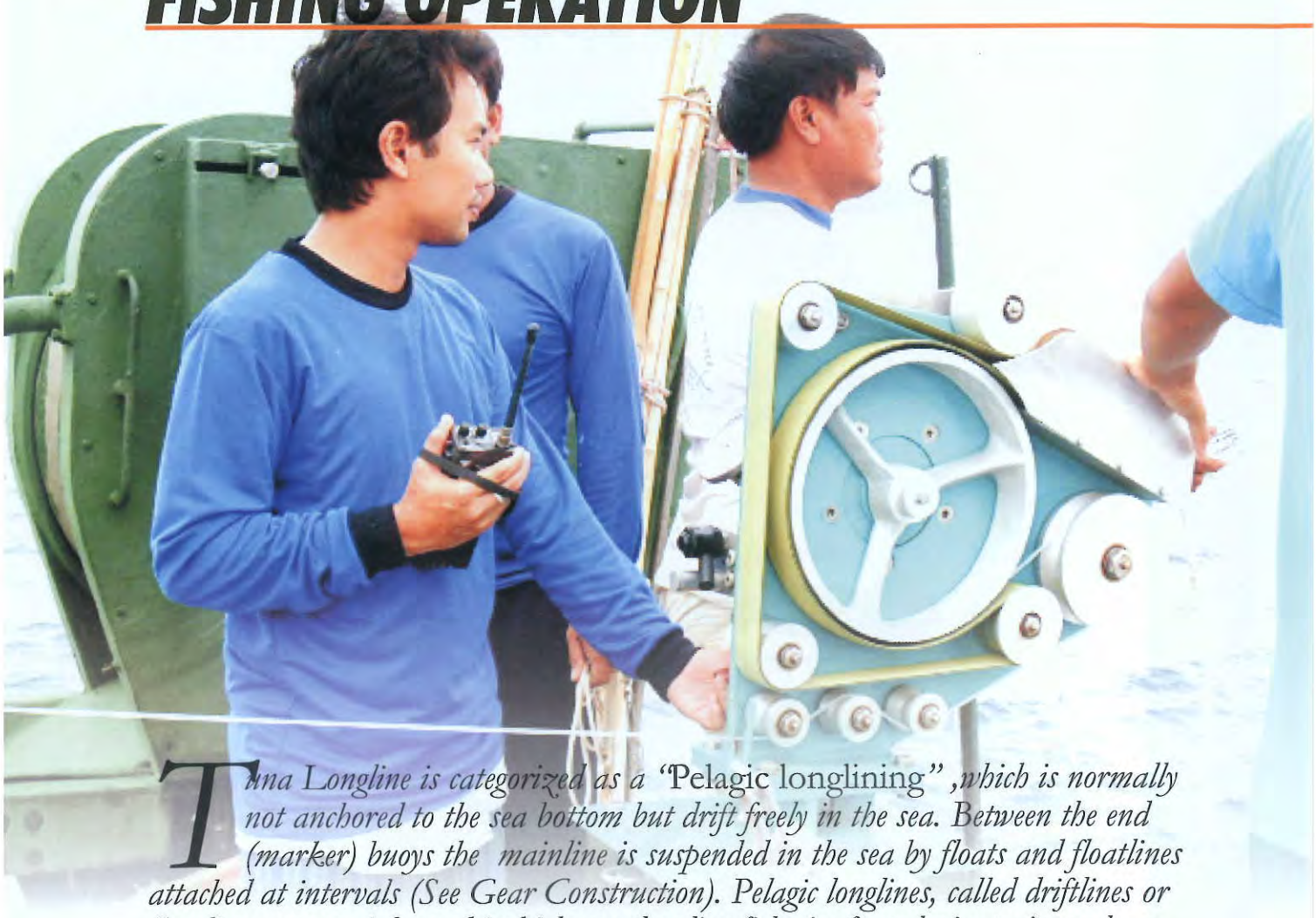
Proper landing and storage of bait after it has been caught are also of importance for the bait quality and hence the catching efficiency.

The decomposition process that changes the chemical composition of the bait may start very quickly and go fast once it has started.

The bait must be cooled and frozen as soon as possible after capture, and kept frozen until baiting. If the longlines are not set shortly after baiting, they should be kept in cold storage to preserve the bait quality.

The bait size is an important factor affecting the size of fish caught by longline. The bait cost represent a high proportion of the total cost of the longline operation, and using smaller baits therefore significantly reduce the expense.

FISHING OPERATION



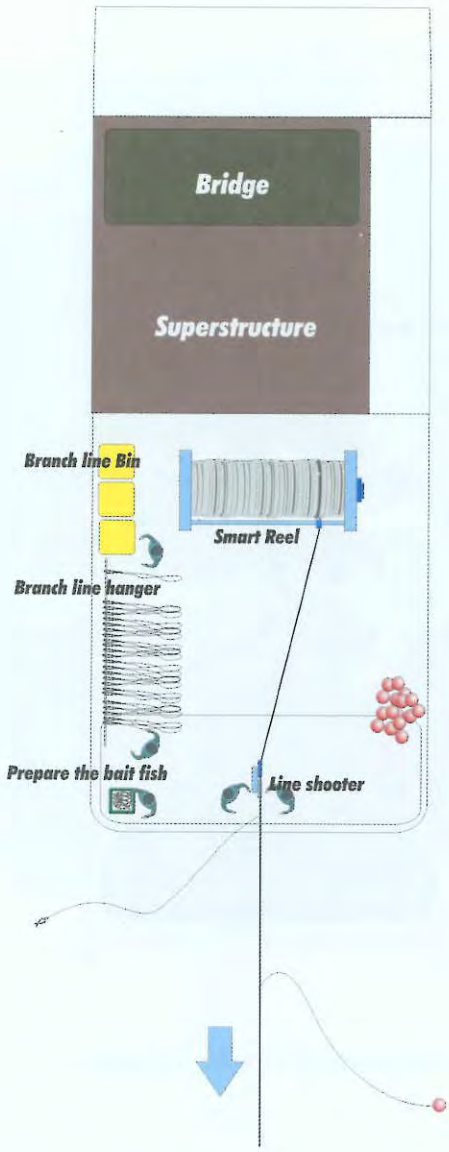
Tuna Longline is categorized as a "Pelagic longlining" ,which is normally not anchored to the sea bottom but drift freely in the sea. Between the end (marker) buoys the mainline is suspended in the sea by floats and floatlines attached at intervals (See Gear Construction). Pelagic longlines, called driftlines or floatlines, are mainly used in high-seas longline fisheries for pelagic species such as swordfish, tuna, shark and salmon, but are also used in coastal waters for species such as haddock during periods when the fish are feeding on pelagic prey.

Fishing Cycle

The longline fishing cycle includes the following sequences, which are common for all longline operation: Baiting, Setting or Shooting, Fishing, Hauling, and Maintenance

Baiting

The hooks are baited either by hand or mechanically by baiting machines. Hand baiting is predominant and the baiting is commonly done on shore, but on larger vessels operating off shore the baiting is conducted on board. However, an increasing number of larger longline vessels are now using baiting machines.

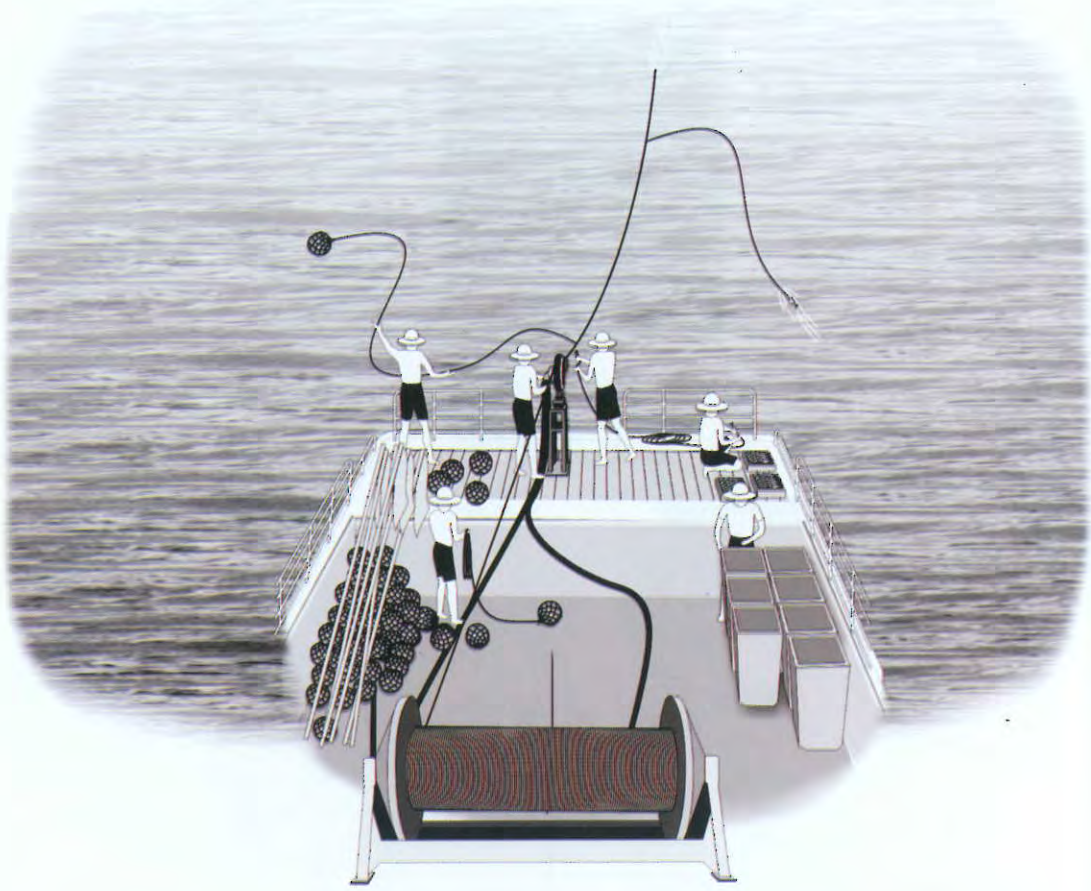


Overview of Shooting Operation

Setting or shooting

The longlines are set from the stern of the vessel at speeds of 2-4 m/s (4-8 knots) according to the size of the vessel and the type of operation. Shooting the gear is normally done from the stern of the longline vessel, regardless of vessel of vessel size and type. Time and place of setting the gear is based on experience, and the modern technology is also of importance aid.

Time of Setting is also of importance in longline fishing. The feeding motivation of fish varies with time of day and so do the feeding period of bait scavengers. Try to set most of the gear in time corresponds to the main feeding period of most scavengers, which are mainly night feeders.



Perspective of Shooting Operation

When ready for setting, the end marker buoy and floats are dropped as the vessel moves slowly forward. Then the buoy line is dropped before the vessels speeds up and the setting of the gear starts, normally at a speed of 4-10 knots.

Although setting of the gear is the least time consuming part of the longline fishing cycle, the setting of the daily gear amount takes 3-4 hours in tuna longlining, where more than 50 km of line is fished daily.

Fishing

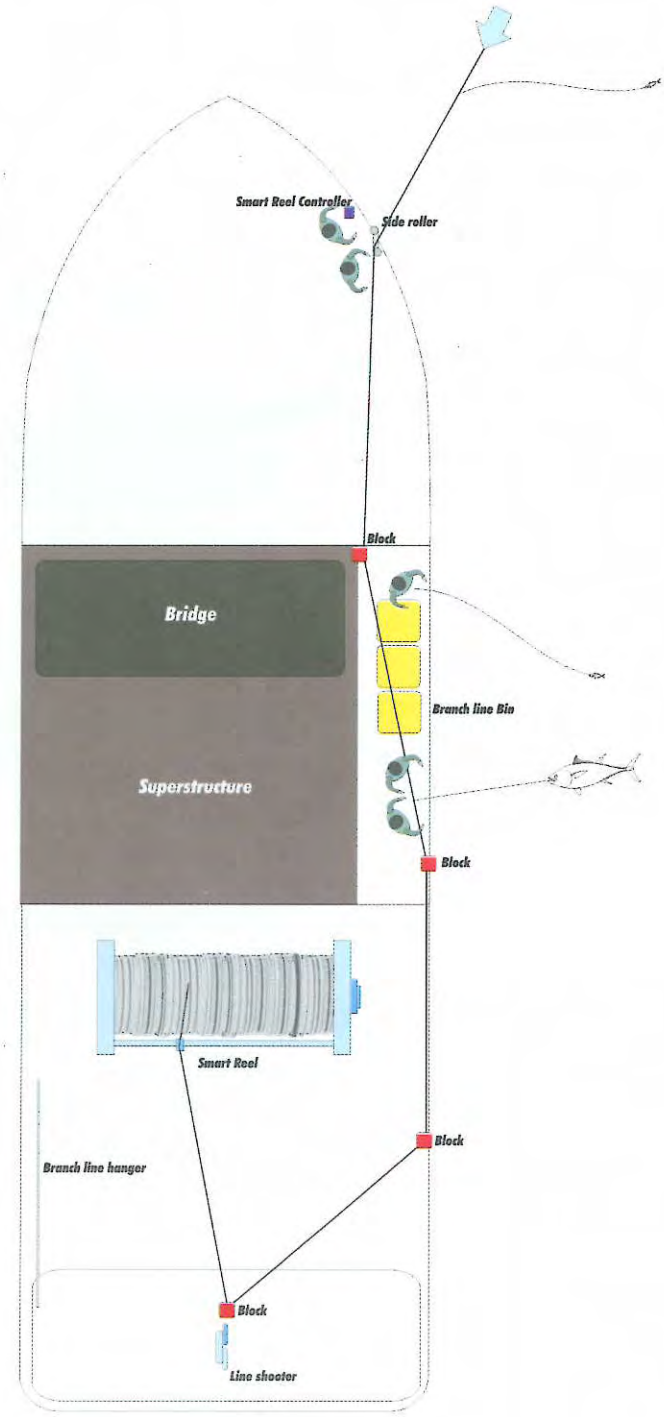
The line are left in the sea for between 3 and 24 hours (fishing or soak time) depending on the target species, the size of vessel and the number of hooks used.

Hauling

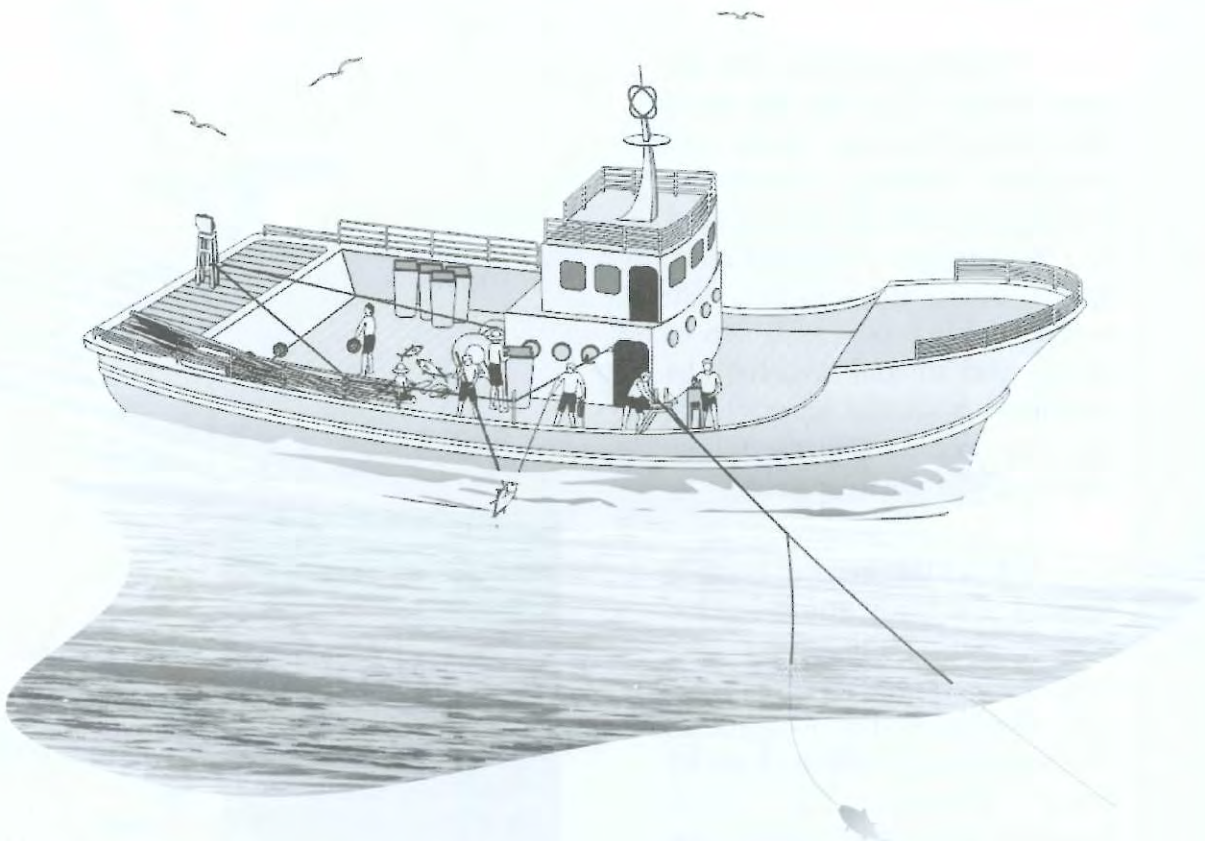
Hauling or retrieving the gear, which is by far the most time-consuming part of longline fishing, starts by locating the marker buoy. Aided by navigation instruments, Radio buoy, the markers are usually easily recovered,even in foggy and dismal weather. In darkness, powerful searchlights are also used to spot the buoys effectively in the near field.

After the marker buoy is located, the buoy line is hauled before the hauling of the longline can start. In small scale and shallow-water longlining, the hauling may still be done by hand. However, in most longline fisheries today, the hauling is done by so-called line haulers: powered capstans with specially designed sheaves for holding and pulling in the rope or line.

The lines are hauled, normally over the starboard side forward of the centre of the vessel, The hauling speed varies according to fishing depth, weather and current conditions, but the lines are normally hauled at speeds of 3-5 m/s (6-10 knots) with pelagic (tuna) longlining. During hauling, the fish are removed from the hooks, bled, dressed and iced or frozen.



Overview of Hauling Operation



Perspective of Hauling Operation

Maintenance (*repair or mending of the gear*)

Before the line can be rebaited, the old bait has to be removed, broken snoods and hooks have to be replaced and tangles of the mainline must be removed, At this point the mainline is also inspected for damage.

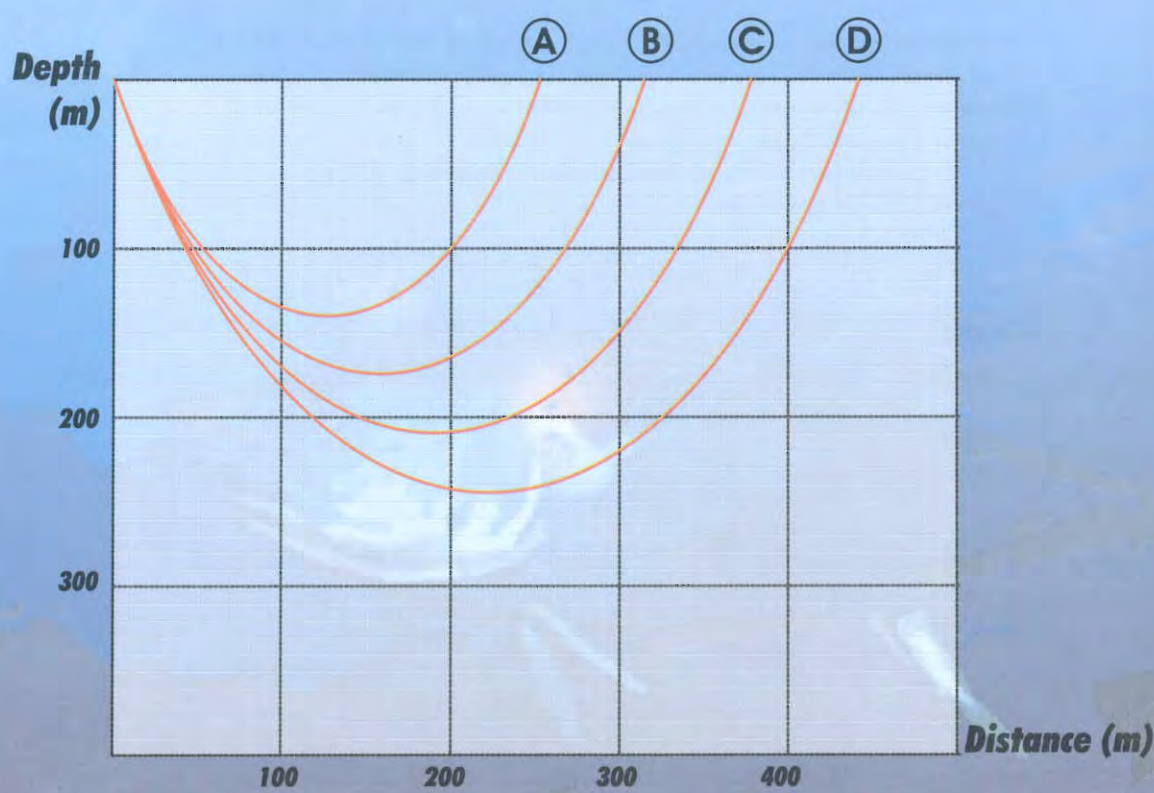
Depth calculation

The vertical geometry of each longline set represented by a 'basket' of gear, which is the section of gear from one float to the next. Branch lines are assumed to be equally spaced along the mainline between floats. Depth layer of hooks in basket, which are varied as positioning of branch line attached, should cover the target species' swimming layer.

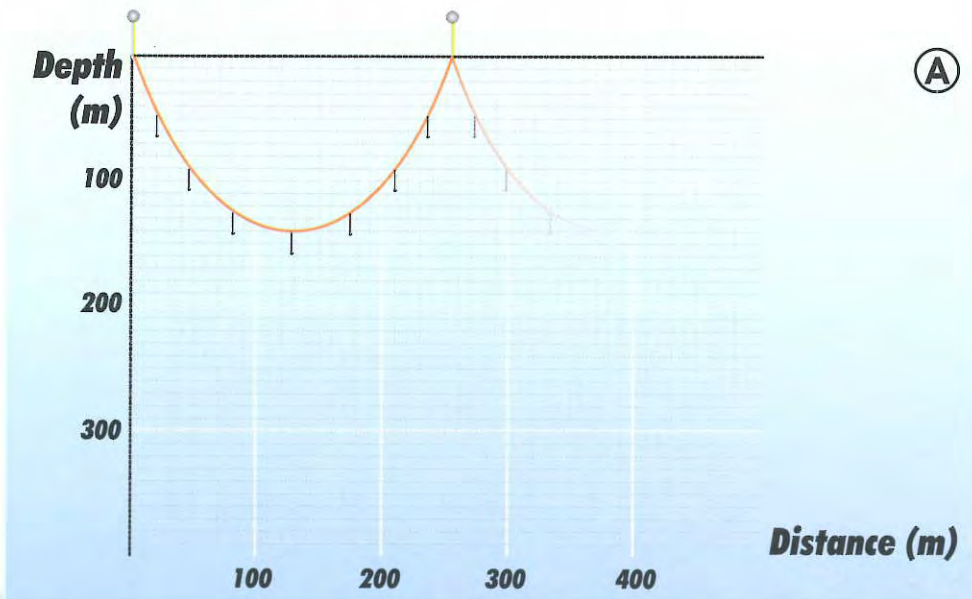
If two sets (baskets) of same designed longline (same length of hook line, length of float line,interval distance between branch line and etc.) was deployed under the same circumstance the only thing made the hook layer different is the number of hook per basket.

Below is a sample of different hook depth in different number of hook per a basket. Hook number of 7, 9, 11 and 13 in each basket are compared. The curves of mainlines are computed assuming the 'Catenary Model'. Gear construction and controlled fishing condition are as followed ;

Length of Float line = 25 m.
Length of Hook line= 15 m.
Hook line interval distance= 50 m.
Boat speed = 7 kt.
Shooting interval time of hook line = 9 sec.

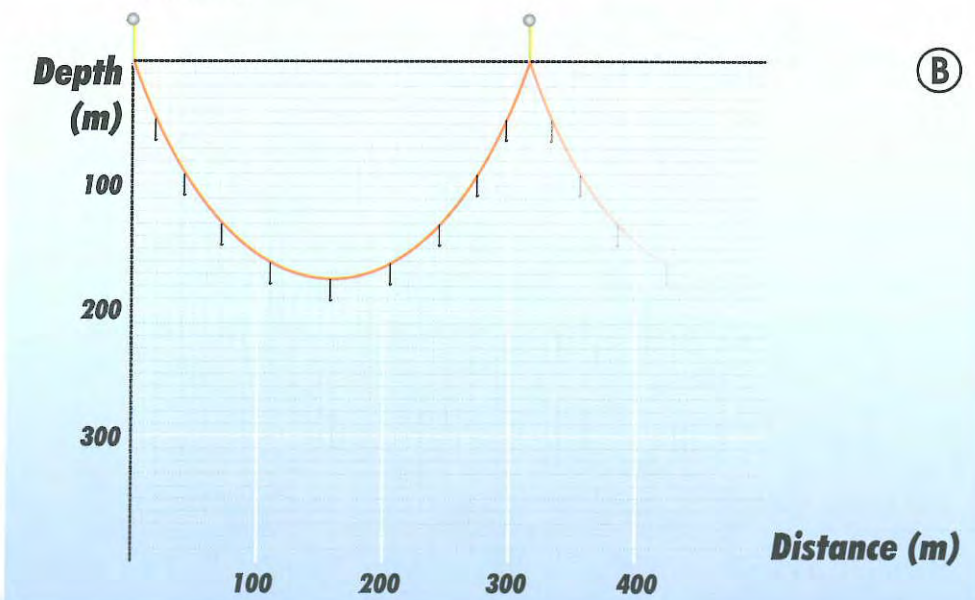


A set composed of 7 hook lines. Total length of mainline = 400 m.
Actual float interval distance = 252 m. Shrinkage = 0.63
Calculated sag of mainline (top to bottom) = 140.3 m.
Therefor, Deepest hook will be at
= Sag depth + Hook line length + Float line length
= 140.3 + 15 +25
= 180.3 m.



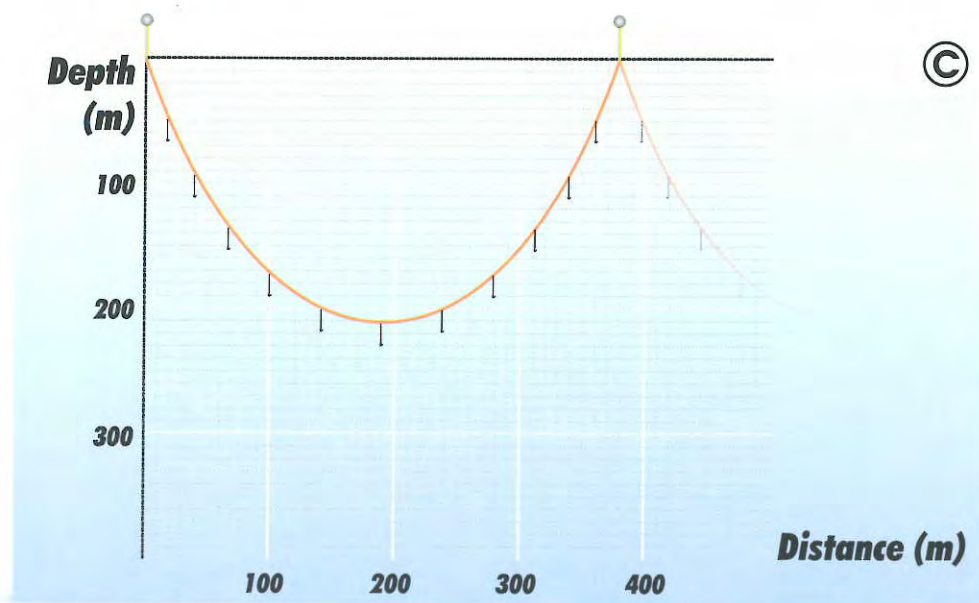
A

A set composed of 9 hook lines. Total length of mainline = 500 m.
Actual float interval distance = 315 m. Shrinkage = 0.63
Calculated sag of mainline (top to bottom) = 175.3 m.
Therefor, Deepest hook will be at
= Sag depth + Hook line length + Float line length
= 175.3 + 15 +25
= 215.3 m.



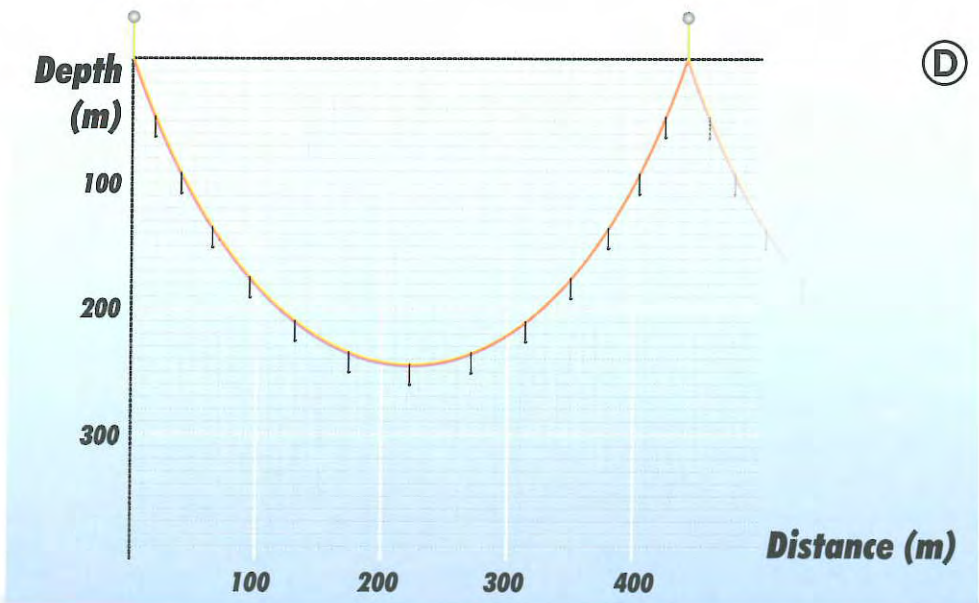
B

A set composed of **11** hook lines. Total length of mainline = 600 m.
Actual float interval distance = 378 m. Shrinkage = 0.63
Calculated sag of mainline (top to bottom) = 210.4 m.
Therefor, Deepest hook will be at
= Sag depth + Hook line length + Float line length
= 210.4 + 15 +25
= 250.4 m.



Ⓒ

A set composed of **13** hook lines. Total length of mainline = 700 m.
Actual float interval distance = 441 m. Shrinkage = 0.63
Calculated sag of mainline (top to bottom) = 245.5 m.
Therefor, Deepest hook will be at
= Sag depth + Hook line length + Float line length
= 245.5 + 15 +25
= 285.5 m.



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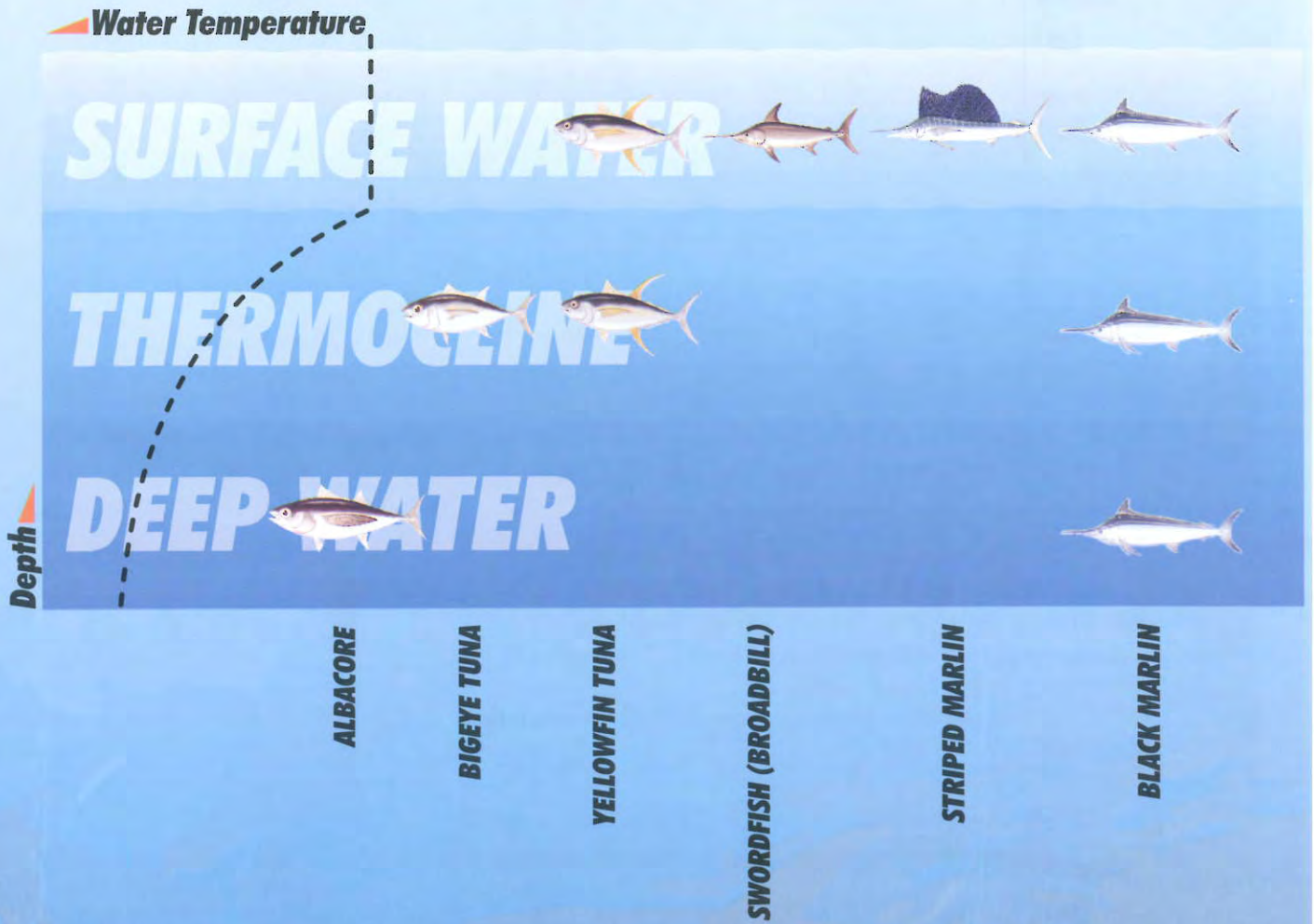
Swimming Layer of Target Species



HANDLING PROCEDURES

Proper Handling Procedures and Descriptions

Quality of tuna will start to decrease as soon as the tuna is caught. The loss of quality in tuna cannot be stopped, it can only be slowed down. With Good Manufacturing Practices, the more care taken, the better the maintenance of the quality of the tuna for the end user. Final product grading is determined by the way the tuna is handled aboard the vessel.

Run- Fight Time

There are several methods which are used for the catching of tuna. Since the outer appearance of the tuna will tell the buyers how the tuna has been handled at time of catching, the crews who are responsible for tuna handling should wear gloves to protect the skin and the scales of the fish.

More runs after hookup mean longer fight time and an increased chance of BTS occurrence. To reduce this possibility, the number of runs should be minimized and tuna should be landed as rapidly as possible--ideally within 6 minutes of hookup.

Gaffing

One method of taking the tuna on board is by the use of a gaff which is placed very carefully through the lower jaw. Another method is the use of a Tuna Missle. This is a multi-jawed griping device which is slid down the line to grip the tuna by the head. It is said to both clam the tuna and ensure it cannot escape

Figure 1. Gaff the fish through the lower jaw.

The best place to gaff a fish is through the lower jaw (*Figure 1.*) because it is strong enough to support the fish when lifted. Also, a gaff through the jaw makes it easy to position the fish for stunning. Gaffs should not be made through the body or heart. A gaff through the body reduces the value of the fish, and an accidental gaff through the heart ruins the chances for proper bleeding.

Taking tuna on board by using tuna missile

"To maintain a food quality product, tuna should be landed as soon as possible after catching...."

Tuna is killed by either a sharp blow to the head or a spike inserted into the brain. The soft spot is found between the two eyes. The brain should be destroyed by placing a sharp object into the brain and pushing down so as to destroy the nervous system. The spinal core should also be destroyed by the use of a short metal rod and a tube. Force the rod through the tube into the brain and down the spinal canal to destroy the spinal core.

Stunning and Killing

Longer struggling time results in increased body temperature, bruising, scale loss, and muscular contractions. Fish should be stunned and killed as quickly as possible. The best place to club a fish is on the soft spot. The soft spot, which is whitish in color, is located on the mid-dorsal line just above the eyes (Taniguchi,1977). The brain is located slighted behind the spot.

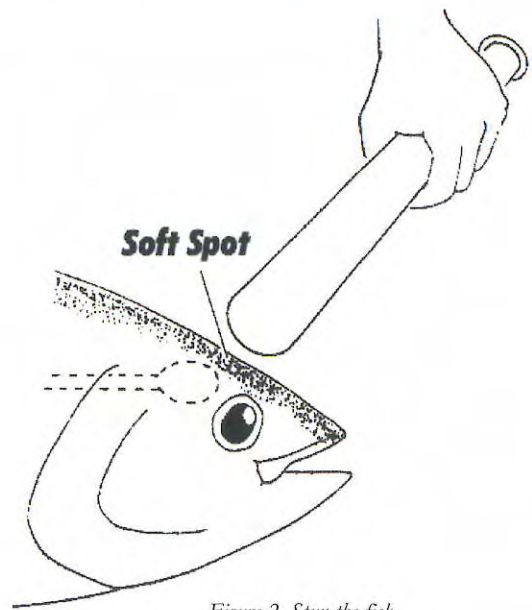


Figure 2. Stun the fish by clubbing the soft spot between the eyes.

Stunning

Fish should be stunned by clubbing immediately after gaffing or as soon as they are brought on board. Clubbing can be accomplished with a bat, mallet, or lead-filled steel pipe (*Figure 2.*)

Killing

Sometimes stunning only temporary renders the fish unconscious. Fish that appear to be dead can recover and start to thrash in the fish box. To prevent this, the fish should be killed immediately after stunning by destroying the brain. Three techniques are described below. When property executed, the fish will shudder once, become limp, and die.

The first technique involves the use of a sharp probe such as an ice pick or a screwdriver. These are simple tools which can be used to quickly and easily kill the fish.

Step 1 Place a sharp probe on either side of the soft spot.

Step 2 Pierce the skin, and then push the probe down until the skull is reached.

Step 3 Apply downward pressure on the probe, and then slide it backward in the direction of the tail until you reach a thin cartilaginous plate at the base of the ridge. The plate will collapse, and the probe will sink about 1 inch deeper into the brain.

Step 4 Move the probe back and forth to destroy the brain (*Figure 3.*)

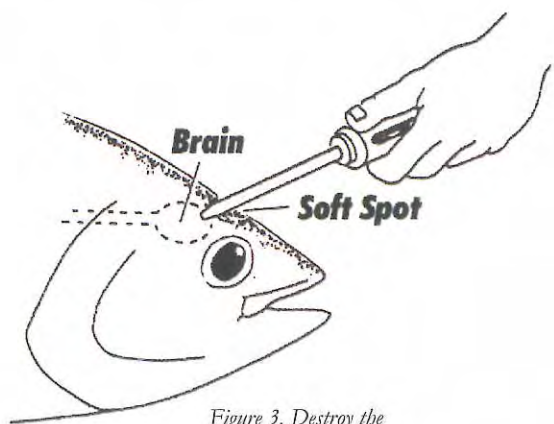


Figure 3. Destroy the brain on either side of the soft spot using an ice pick or screwdriver.

The primary reason for immediate killing is to prevent the tuna from suffering additional stress and struggling during the bleeding process. The reason for the destruction of brain and spinal core is to ensure the tuna's central nervous system which regulates body temperature will not function after death so that the tuna's body temperature will fall more rapidly in cold storage.

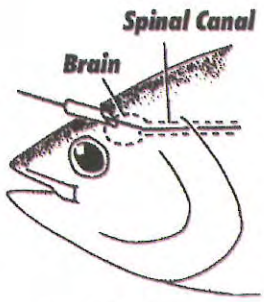


Figure 4. Insert the metal tube through the brain, followed by the rod into the spinal canal to destroy the spinal core.

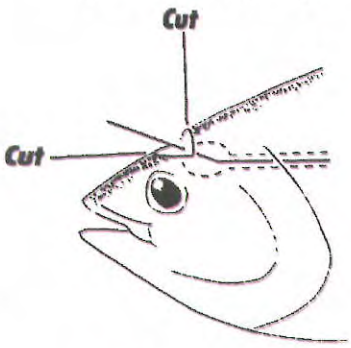


Figure 5. Cut a wedge over the soft spot to expose the brain, and then pass a rod through the brain into the spinal canal.

The second technique involves the use of the Taniguchi tool. Developed in Japan by Dr. H. Taniguchi (1997) and used mainly on longline fishing vessels, this tool consists of a short metal tube and a rod. A welding rod or flexible plastic rod may also be used.

Step 1 Bore a hole into the fish's brain at the soft spot.

Step 2 Force the rod through the tube, into the brain, and down the hollow core of the spinal cord. (*Figure 4.*)

The third technique used to kill fish involves the use of a hacksaw and rod. A sharpknife may be used in place of a hacksaw.

Step 1 Using a hacksaw, cut a wedge from the area over the soft spot to the base of the eyes.

Step 2 Remove the wedge to expose the brain.

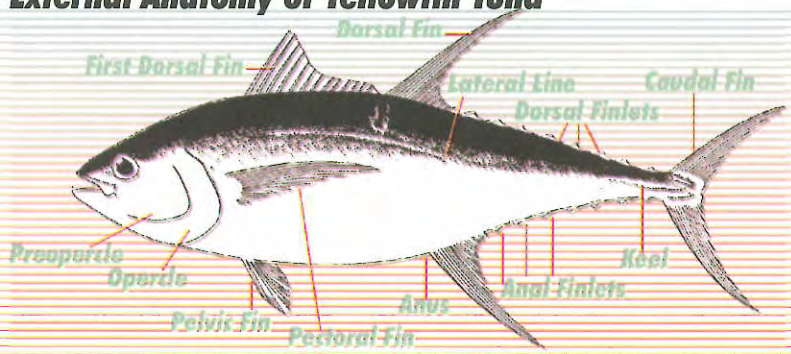
Step 3 Insert the rod through the brain and into the spinal canal to destroy the spinal core. (*Figure 5.*)

Cleaning the Fish

Bleeding

Fish should be bled for 5 minutes immediately after killing. Removal of the "hot" blood allows the fish to cool more rapidly. When heart, which continues to function even after the brain is destroyed, must be kept intact in order for it to pump the blood out of the fish. Threemethods for proper bleeding are given below.

Reference: External Anatomy of Yellowfin Tuna



Tuna must be bled as soon as possible after being taken on board. Removal of the hot blood will allow the tuna to cool much faster, and also reduce acidity.

Pectoral Cut

To make the pectoral cut, a short, narrow knife roughly 2 inches long by ½ inch wideshould be used since the blood vessels (Subcutaneous artery) lies no more than 1inch below the skin surface of the fish. A sharpened oyster shucker or any other similar-sized knife is ideal. The knife should be kept extra clean to prevent bacteria - which may contribute to accelerated spoilage - from being introduced into the fish.

Step 1 Locate a spot the width of three fingers behind the base of the pectoral fin and about 1/4 inch below the lateral median line which extends along the side of the fish (*Figure 6*).

Step 2 To sever the blood vessel, make a 1 to 2 inch cut, 1 inch deep, from the spot towards the base of the pectoral fin.

Step 3 Make this cut on both sides of the fish.

Step 4 To drain the blood from the fish. Position it's head down, on an incline. Shoot water on the fish to prevent blood clot.

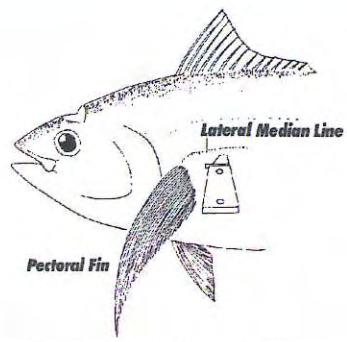


Figure 6. Bleed fish by cutting behind the pectoral fin.

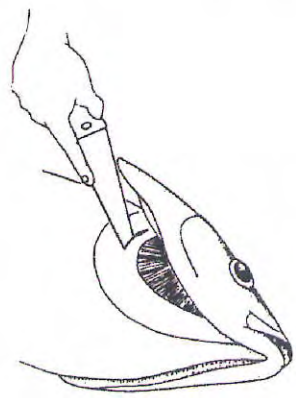


Figure 7. Bleed fish by cutting blood vessel at top of gills.

Gill cut

Step 1 Position the fish so that it is lying on its side.

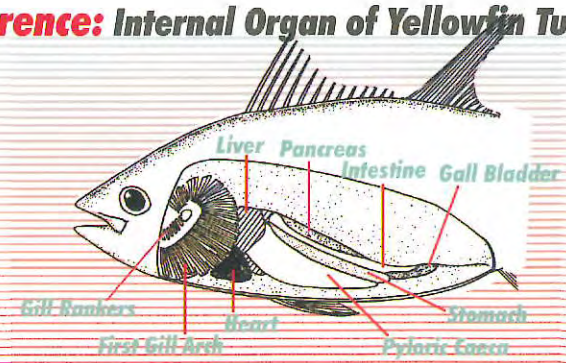
Step 2 Pull open one side of the gill cover, and then insert a knife behind the gills through the membrane (*Figure 7*).

Step 3 Cut upwards towards the spine to sever the blood vessels, being careful not to stab the heart.

Step 4 Make a cut on both sides of the fish.

Step 5 To drain the blood from the fish, position its head down, on an incline. Shoot water on the fish to prevent blood clotting.

Reference: Internal Organ of Yellowfin Tuna



It is very important that all the internal organs are removed from the tuna as quickly as possible after bleeding. Fish posses chemically active protiens known as enzymes which are responsible for the digestion of their food.

Tail Cut

Step 1 Cut the blood vessel vertically between the third and fourth dorsal finlet from the tail (*Figure 8*).

Step 2 Make cuts on both sides of the fish, or remove the tail completely.

Step 3 Drain the blood from the fish. Shoot water on the fish prevent blood clotting.

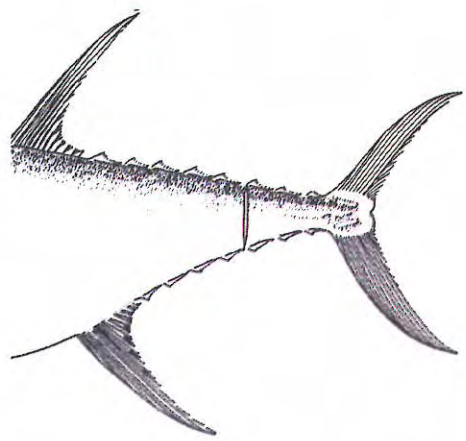


Figure 8. Bleed fish by cutting tail.

Gutting and Gilling

Removing the internal organs and gills is another way to cool the fish faster to prevent spoilage and bacterial growth which can cause BTS. Also, gutted, gilled fish can be processed faster and handled less ay the market. Female and very large fish should be handled more quickly - but carefully - since they are prone to a greater incidence of BTS. Although tuna smaller than 80 pounds rarely develop BTS, those Eighing as little as 5 pounds have been observed with this condition

The sex of the fish can be determined by the presence of testicles of ovaries. During the spawning season - from May to October - the male testicles are smooth, elongated, and noticeably white in appearance; the female ovaries are elongated, rough on texture, and yellow to orange in color, and their surface is lined by prominent veins.

Fish can be gutted and gilled with the head on or off. Both approaches are given below.

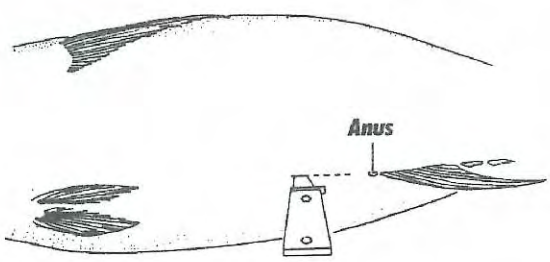


Figure 9. Insert knife 4 inches in front of the anus, and then cut towards it.

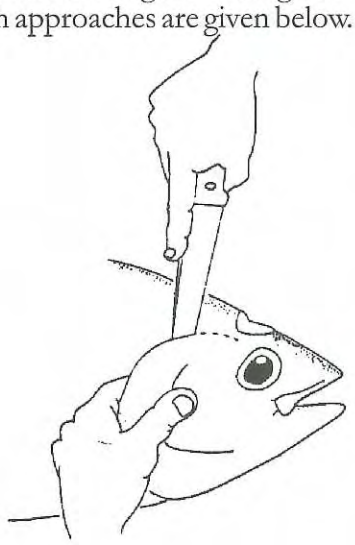


Figure 11. Insert knife at the top of the gill cover and slide it toward the eye.

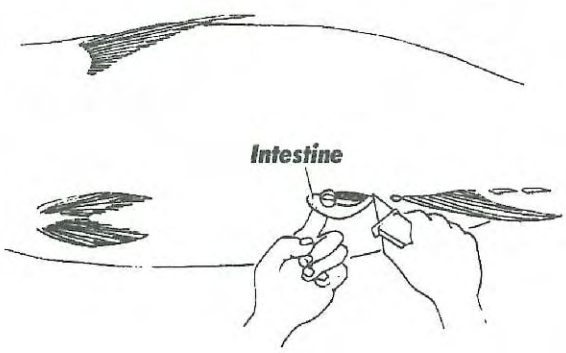


Figure 10. Cut the intestine near the anus.

At death, these enzymes, which include the digestive enqymes of the stomach and intestines, remains active, if they are not removed, they will actually breakdown the tissues of the digestive tract and begin destroying the belly neat, which is very important. The thickest part of the tuna is around the belly area and this is where the highest yield recovery takes place. It must be protected.

Head - on Approach

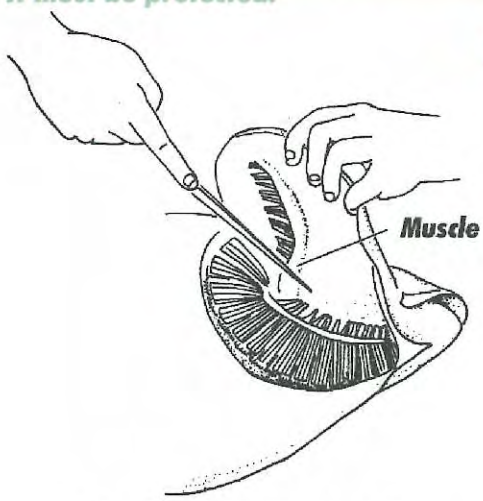


Figure 12. Cut the main muscle attaching the gill cover to the head.

Step 1 Make a straight, 4 inch slit in the belly, cutting towards the anus (*Figure 9*).

Step 2 Reach into the cavity and pull out the intestines attached to the body wall. Cut the intestine near the anus (*Figure 10*).

Step 3 Pull one gill away from the body. Then insert a knife at the top of the gill and slide towards the eye. Make this cut on both sides of the fish (*Figure 11*).

Step 4 Pull the gill cover back, reach inside the cavity with a knife, and thin cut the main muscle attaching the gill cover to the head. Make this cut on both sides of the fish to allow easier access to the gills, which needs to be removed (*Figure 12*).

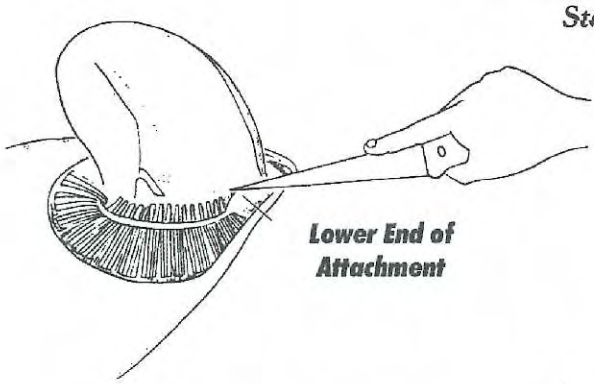


Figure 13. Cut lower end of gill-to-head attachment.

Step 5 Cut the lower end of the gill-to-head attachment and not the entire connection of the lower body to the underside of the mouth(*Figure 13*). If you cut the entire connection, unequal pressure exerted by muscle stiffening will lower the quality of the fish on two ways. First, it will cause the head to lift up and bend backwards, distorting the shape and appearance of the fish. Second, this unequal pressure will cause tearing and gaping of fillets.

Step 6 Pull one gill covet from the body, and thin cut through the membrane behind the gills. Extend the cut through the kidneys as far back and as close to the backbone as possible. Bring the cut down each side of the gill openings. Make this

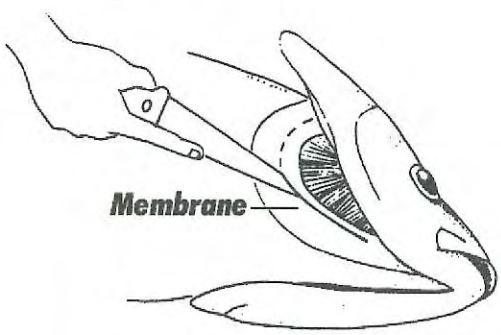


Figure 14. Cut through the membrane behind the gills.

Figure 15. Cut upper end of gill-to-head attachment.

After gills were completely removed, the belly area must be properly cleaned with proper clean safe sea water. Making sure that all gut remnants and blood is removed. The area around where the gills have been removed must also be properly washed and all blood removed.

cut on both sides of the fish (*Figure 14*).

Step 7 Pull one gill cover away from the body. Insert a knife under the gills, close to the spinal column, and cut the upper end of the gill-to-head attachment. Cut on both sides of the fish, and then free gills from the head. (*Figure 15*)

Step 8 Pull open gill cover, and then grab the lower end of the gills. Pull and remove the gills and guts. Remove any remaining attachments (*Figure 16*).

Step 9 Remove the gonads from the cavity by sliding your hand under them and tearing the membranes anchoring them to the stomach.

Step 10 Pop the air bladder.

Step 11 Remove as much of the kidney and coagulated blood as possible from the backbone. Scrub the area with a stiff wire or nylon brush until spine becomes white (*Figure 17*).

Step 12 Remove as much loose skin and hanging attachments as possible from the bone within the gill openings.

Step 13 Remove the membranes from inside gill cover (*Figure 18*).

Step 14 Rinse fish with chilled water and wash away slime from the outside of the skin.

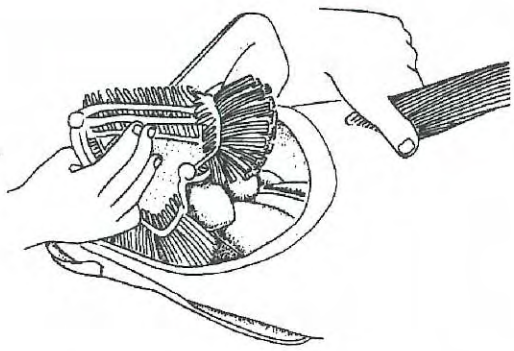


Figure 16. Remove gills and guts and any remaining attachment.

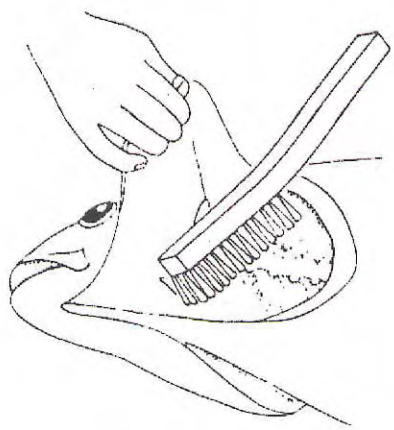


Figure 17. Scrub spine through gill openings to remove the kidney and coagulated blood.

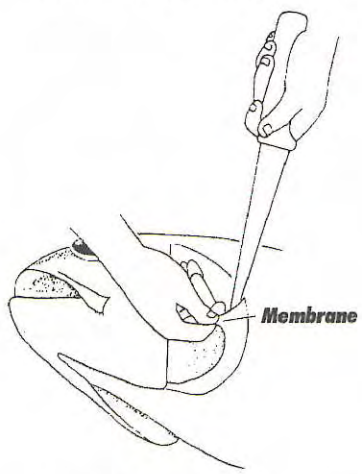


Figure 18. Trim the membranes lining the gill collar.

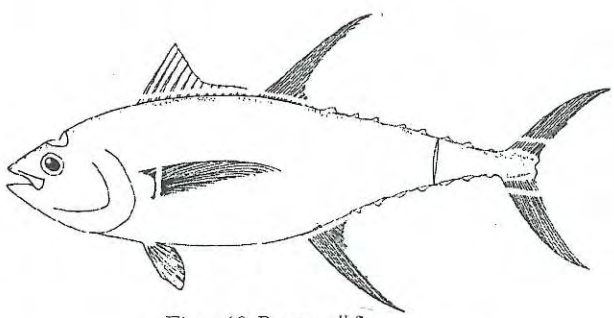


Figure 19. Remove all fins.

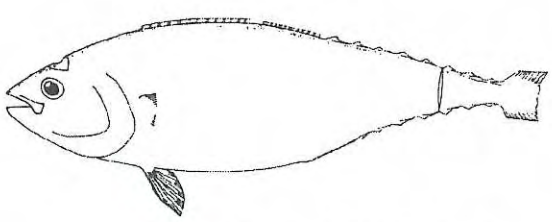


Figure 20. Gilled, gutted fish with head on and fins removed.

Where seawater temperatures are warm, it is recommended that the water be cooled before it comes in contact with the tuna.

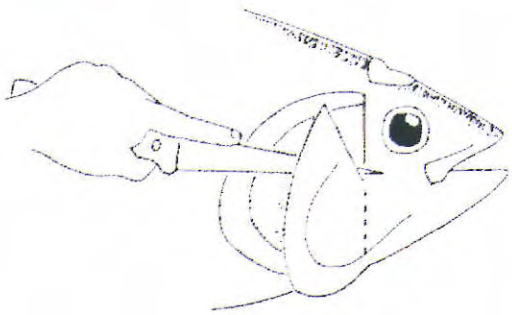


Figure 21. Saw off the gill cover or fold it back and fins removed.

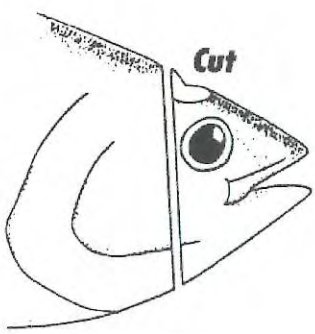


Figure 22. Saw straight down behind the eyes to remove the head.

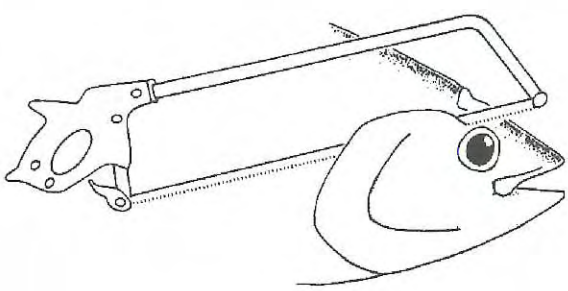


Figure 23. Saw towards snout from behind the gill cover on both sides of fish to achieve a tapered cut.

Step 15 Remove all fins, and even the tail, if desired (*Figure 19 and 20*).

Step 16 Optional. For easier processing, cut off a portion of the gill cover for better access to the gills and guts. Either use a saw or bend the gill plate back until it snaps in half, and then cut along the crease with a knife (*Figure 21*).

Head-off Approach

With the head-off approach, a part or all of the head is sawed off and the gills and guts are removed with the head. the procedure is as follows.

Step 1 Remove the head by sawing straight down behind the eyes. (*Figure 22.*)

Step 2 Alternatively, insert the saw behind the gill cover and saw at an angle towards the snout. Make this tapered cut on both sides of the fish. (*Figure 23.*)

Step 3 For gutting and gilling instruction, follow steps 1, 2 and 6 through 13 in the head-on approach section.

Step 4 Rinse fish with chilled water and wash away slime from the outside of the skin.

Step 5 Remove all fins, and even the tail, if desired. (*Figure 24.*)

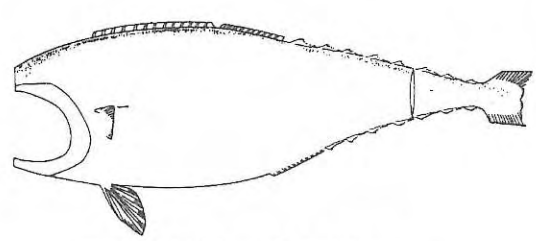


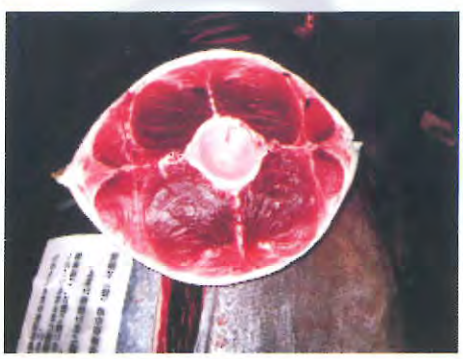
Figure 24. Gilled, gutted fish with head and fins removed.

On-board STORAGE

Tuna are 'warm-blooded' fish, i.e. their internal temperature remains constant (about 28 °C) for their whole life. This temperature can rise for short periods of time to 35 °C or even 40 °C under certain conditions (stress, struggle during capture, etc.). In order to keep the fish in pristine condition, the internal temperature must be lowered as quickly as possible to 0 °C and then maintained during all the following stages (storage on board, unloading, packing, transport). To obtain a top-quality product, two stages of procedure should be followed, they are:

- *Lower the internal temperature of the fish by placing it in brine (a slurry of crushed ice and seawater).*
- *After 24 hours, put the fish in ice and keep it there until arrival in port.*

CHILLED BRINE



To obtain the highest quality, tunas must be properly store.

The main advantage of brine is that the entire surface of the submerged fish (including the abdominal cavity) is in direct contact with the cooling medium. This is the most efficient technique for rapidly lowering the core temperature of the fish

- *How is the brine prepared?*

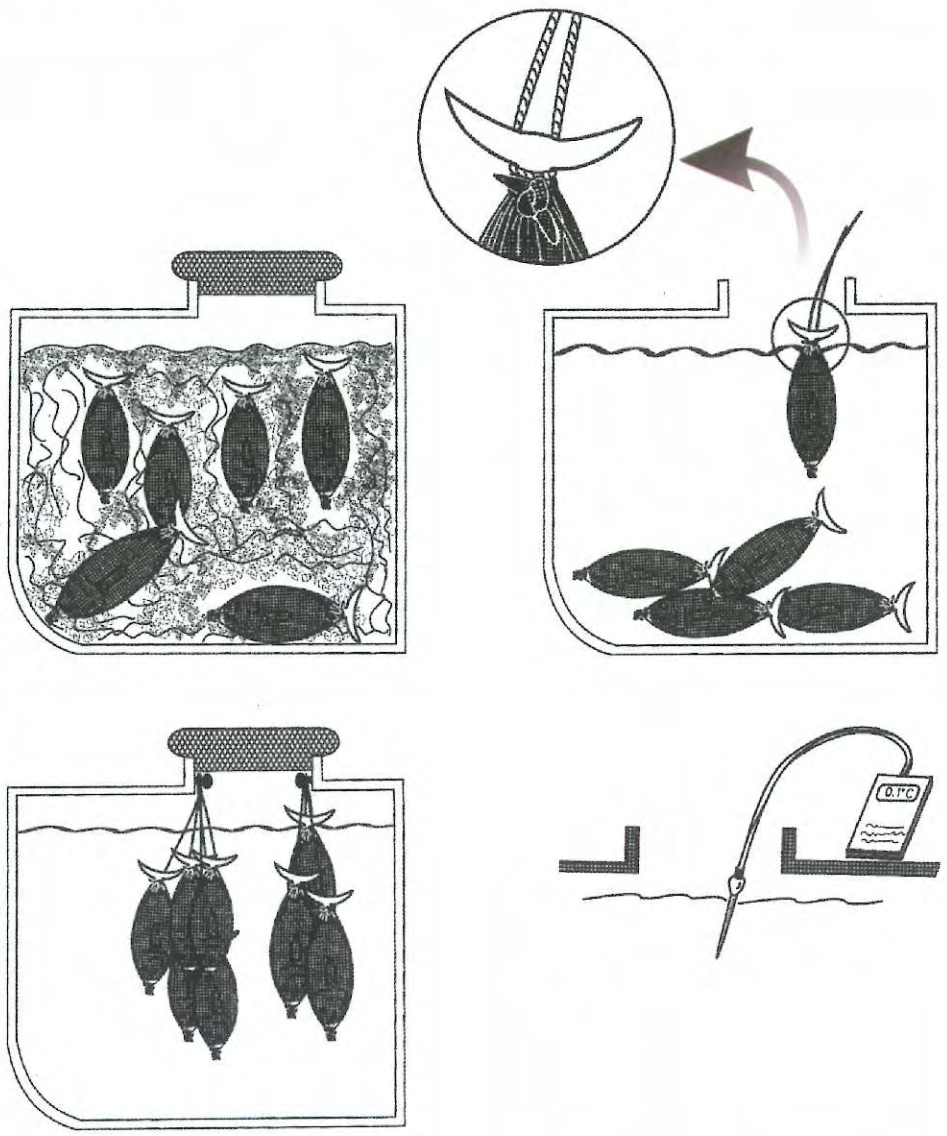
Make a slurry of crushed ice and seawater in a fish box, using a ratio of 2 parts ice to 1 part seawater.

- *How long should the fish stay in the brine?*

The length of time the fish should be left in the brine depends on its size. 6–12 hours is advisable for small sashimi tuna (30 to 40 kg). It is preferable to leave larger fish in the brine longer (up to 24 hours) to be sure that they are chilled to the core. Although fish can be left in the brine for several days, we recommend that they be removed after 24 hours at the most, otherwise their colour will begin to fade and their eyes will go white.

- *What kind of brine box?*

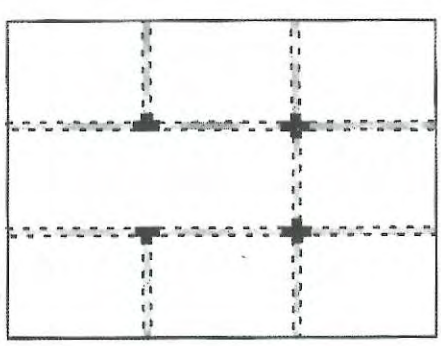
It is preferable to use a large (2 m^3 or more) insulated box with several compartments and a drainage hole. In heavy seas, the compartments will help limit the rocking of the fish inside the box. It is advisable to have two brine boxes on board.



Figures describe Chilled Brine Procedures

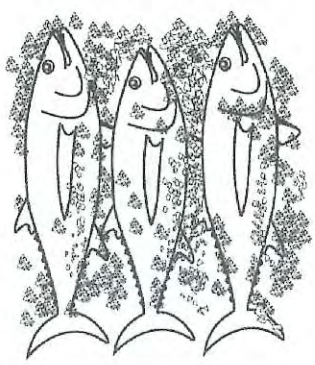
ICING

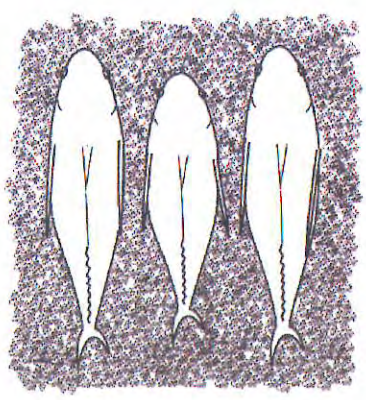
Icing is the most difficult method of chilling fish and requires the most skill, but if done properly, produces a superior product. Fish have to be buried in ice as soon as they are cleaned and dressed. The centre bin in the fish hold, often called the slaughter bin, is usually used for the initial chilling, This is called pre-icing. Alternately, fish can be chilled in an ice slurry before icing. It takes many hours to chill the core of a large fish to 0°C. Fish are usually pre-iced overnight. The bins are usually made with removable pound boards, so that sections of the fish hold can be partitioned off as the hold is filled.

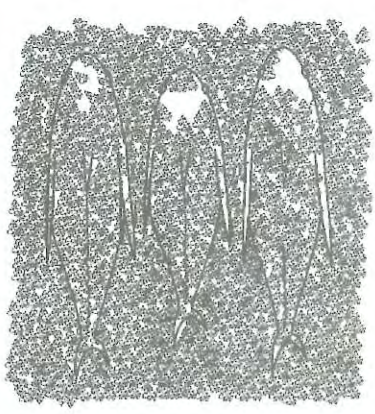


Top view of a fish hold with removable pound boards

Icing (cont.)







The condition of the ice can affect the quality of the fish. Flake ice and shell ice both tend to freeze into clumps after several days. Before fish are buried, all ice has to be chopped into fine pieces. Large clumps or chunks of ice can leave dents and bruises on the fish.

A bed of soft ice several centimetres thick should be made in the bottom of the hold. This is called the starting layer. The thickness of the starting layer depends on the insulating properties of the fish hold and on the trip duration. Experience is the best teacher in this case, and each vessel is a little bit different. Fish are first laid out on the starting layer in a fore and aft orientation on their sides, usually with the heads pointing forward. Finely chopped ice is then shovelled over the fish.

The fish are then turned so that the backs are up and bellies down. Large fish can be turned easily. The tail is grabbed with both hands and the fish is twisted into an upright position. As the fish are turned, some ice will fall under the fish along the sides. This ice will prop the fish up while they are covered with more finely chopped ice.

All air pockets should be filled with ice. Fish should not touch each other or the sides of the fish hold. There should be one or two cm of ice between each fish. Heads and fins can touch but not the body trunks. Finally, there should be four or five cm of ice over the layer of fish before another layer of fish is made. Usually on the pre icing, only one or two layers of fish are made.

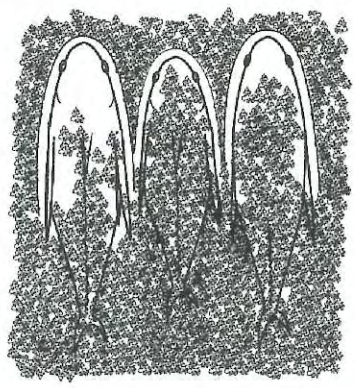
Icing (cont.)

As the fish cools, ice melts and air pockets, called igloos, form around the fish. These air pockets must be removed or the fish will warm up and possibly move around, causing scale loss and bruising.

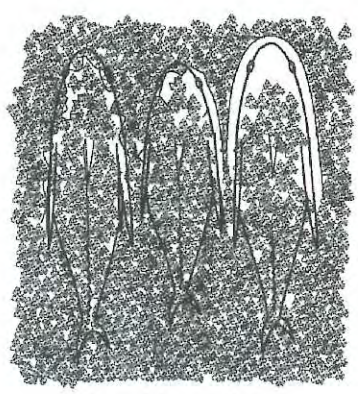
There are two ways to remvoe the igloos from around fish. The igloos can be broken up with a wooden stick or a shovel handle, and ice repacked around the fish. This does not work to well if the fish are already in several layers.

The alternative is to dig the fish out of the slaughter bin and rebury them in another bin. In either case the fish have to be iced twice. After the fish are reburied, they require no more handling, as no more air pickets will form. Small fish can be buried four or five layers deep, larger fish up to three layers deep. Large fish shoud be put in the bottom layer and smaller fish on top. The same thickness of ice around the fish should be used as in the pre-icing. Sharks should not be buried in the same bin with other species, especially sashimi tunas.

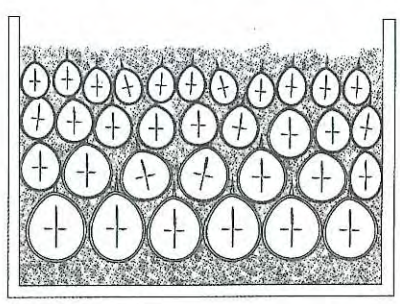
The buried fish should be checked at least once a day. Any melt water should be out of the fish hold and the top layer of fish should get a new cap layer of ice when necessary. There should be no heads or bodies sticking out through the ice - tails and fins are okay, though.



Igloos forming around fish



Breaking up igloos



Layers of fish - large fish on bottom and small fish on top

Adding ice

Packaging PROCEDURES

After the fishing boat alongside at the port, the tubs of fish are unloaded and placed beside the stainless steel processing and packing tables.

The fish are then placed on the tables, with each fish checked for cleanliness with any remaining blood removed from the gut area. A trigger-operated spray unit with chilled water is used in this operation to maintain the coolness of the fish.

Once the fish has been checked, a cut is made in the tail so that the flesh can be seen for grading.

The fish is then slid onto a 'table scale' for weighing, the weight recorded and the fish slid off to the packing end of the 'process line'. The grade of the fish and its size will dictate the market the fish will be sent to.

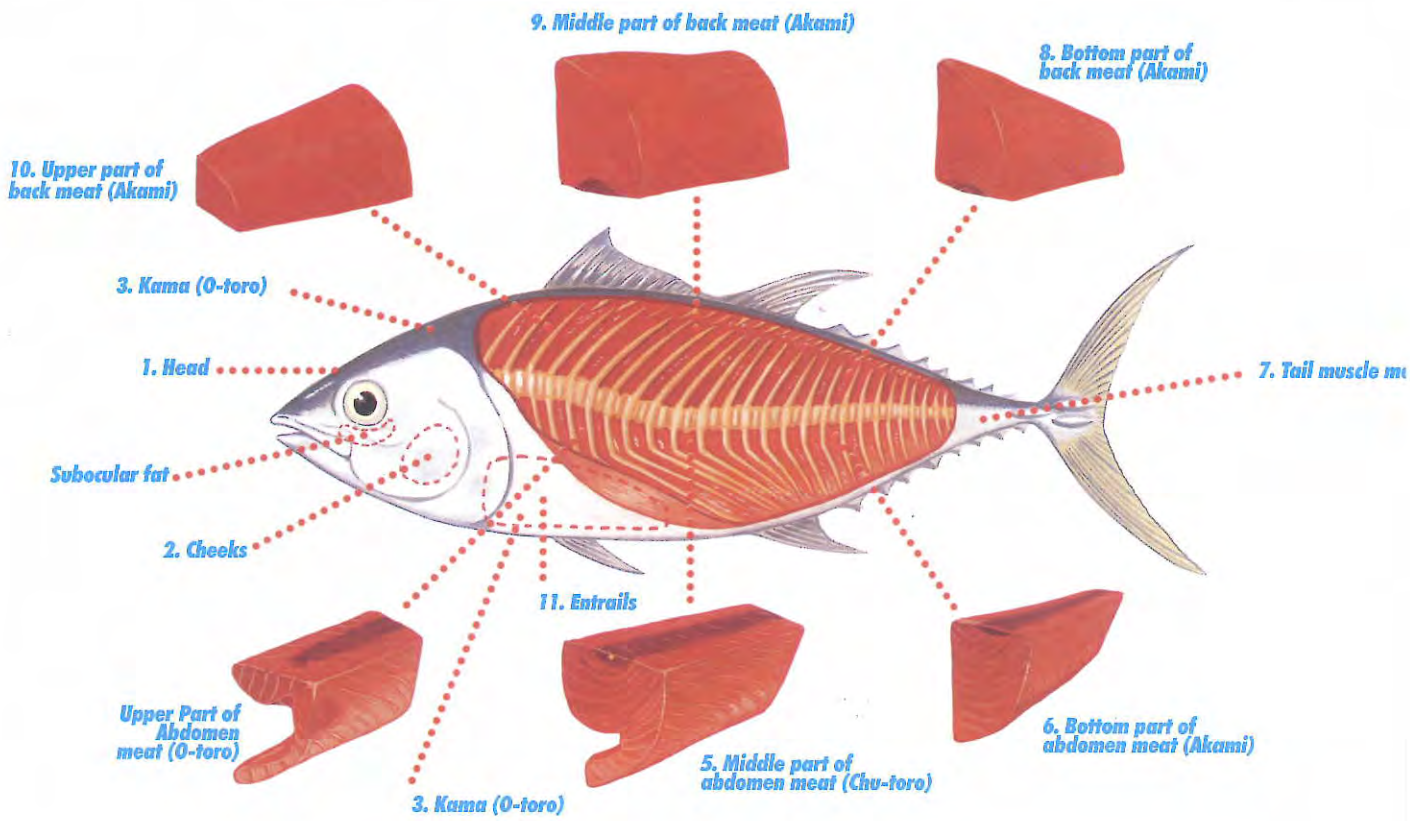
Fish are packed into cardboard inside plastic liners with several dry-ice packs added, one in the gut cavity of each fish and others loose in the carton.

The cartons are then well sealed, well labeled with weight and species of fish as well as destination, and either stored on a pallet in a chill room or placed in an airfreight cargo container, ready for transporting to the airport.

Utilization of fish body

Meat Sections of Tuna and Ways of Serving Them

The tuna is a large fish, ranging from 1.3 to 1.8 meters in length. Its meat can be categorized much in the same way that sections of beef are. Generally speaking, though, the different kinds of tuna meat are: o-toro (very fatty tuna), chu-toro (moderately fatty tuna), akami (lean tuna), and butsu (diced tuna). Also, just as with the various sections of beef, there are various ways to serve tuna. With exception to its tail, gills, and bones, all of the tuna is used for consumption.



1. Head

Broiled tuna head: The entire head is covered with salt and broiled in an oven. The subocular fat of the head is rich in DHA.

2. Cheeks

Steak: Inspite of having much muscle tissue, the cheeks do include fat, and are served as steak and also broiled with soy sauce.

Pictures of Tunas, taken from Tsukiji wholesale market, Tokyo, Japan.

3. Kama (O-toro)

Sashimi and Sushi: The meat of this section, which is attached to the gills, is considered o-toro (very high in fat). It is popularly eaten raw as sashimi, with soy sauce and wasabi (Japanese horseradish). People also cook and broil this part of the tuna as well.

4. Upper part of abdomen meat (O-toro)

Sashimi and Sushi: Known for being the highest in fat content, this part of the tuna is enjoyed raw with soy sauce and wasabi (Japanese horseradish).

5. Middle part of abdomen meat (Chu-toro)

Sashimi, Sushi and minced meat: As a chu-toro (moderately fatty) type of meat, this section of the tuna is still very popular. It can be served raw with soy sauce and wasabi (Japanese horseradish), or cooked like roast beef and minced into smaller pieces.

6. Bottom part of abdomen meat (Akami)

Hot onion dish, salad: With very little fat, this akami, or lean section of meat, is rather sinewy in texture. It is often prepared in a stew with long onions or served as a kind of salad with vinegar and miso dressing.

Pictures of Tunas, taken from Tsukiji wholesale market, Tokyo, Japan.

7. Tail muscle meat

Cooked, broiled: Since this is the muscle that moves the tail, it contains mostly muscle and little fat, it contains mostly muscle and little fat. It is cooked or broiled.

8. Bottom part of back meat (Akami)

Skewered, minced: With little fat, this akami section of meat is cooked, broiled, or minced for dishes.

9. Middle part of back meat (Akami)

Sashimi and sushi: Since this has the smoothest taste of the tuna's lean meat sections, many enjoy eating it raw with soy sauce and wasabi (Japanese horseradish). It is also served in seafood salad.

10. Upper part of back meat (Akami)

Rice dish, tartar steak: This lean meat section has a fresh taste. It can be soaked in soy sauce and served on top of rice, or prepared as tartar steak.

11. Entrails

Cooked, broiled, salted: The tuna's stomach guts are cooked or salted, while its liver is often broiled.

Useful Information

Tuna is rich in DHA

Docosahexaenoic acid (DHA) is one of the essential fatty acids absolutely indispensable for building the human body. In recent years, DHA has generated much interest, especially since research has shown that it has a relation to the growth and development of the brain. This brain-enhancing DHA can be obtained directly and effectively only from fish and shellfish. And tuna is especially rich in DHA. Not only is it good for the development of a child's brain but it also helps slow down the aging process of an elderly person's brain.

Tuna is rich in EPA

Tuna also has an abundance of Eicosapentaenoic acid (EPA), a kind of highly unsaturated fatty acid, which helps prevent such diseases as arteriosclerosis, myocardial infarctions, and cerebral blockage caused by blood clots. EPA fights hard against that demon known as cholestoral, chasing it out of the blood, so to speak. It also cleanses the blood, keeps it running smoothly, and prevents thrombosis from occurring.

Lean Tuna Meat is High in Quality Protien and Low in Fat

Protein, a very important nutrient, is what holds the key to the life force of human being. Compared to the protein in beef and pork, lean tuna meat contains a greater balance of high-quality protein that the human body can utilize to great effect.Since lean tuna meat is low in fat, it is ideal for dieting. We highly recommend it for adults with problems of obesity or for anyone who wants to maintain his or her proper weight.

Lean Tuna Meat is Rich in Iron and Fights Anemia

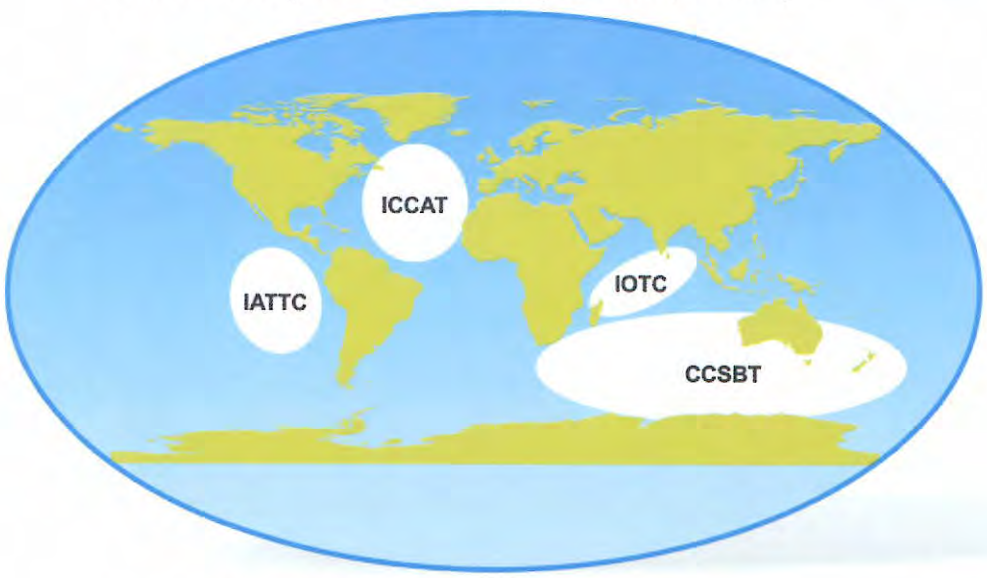
There has been a growing number of people suffering from anemia due to poor, unbalanced eating habits and to iron-deficient diets. One must first replenish his or her body with the appropriate amount of iron to cure anemia. By absorbing iron with protien, the absorption factor will improve. Lean tuna meat is rich in quality protien, iron, Vitamin B12, and other nutrients.

International Organization

Tuna Fishing Industry and International Regulation

International regulations have been established concerning the appropriate catch quotas for tuna, since they are a high speed migratory type of fish that swim through so many regions; not only in the open sea but also through the complex 200-nautical-mile fishing zones within the coastal waters of each nation bordering the sea.

With the Convention of the Law of the Sea and the UNIA, which is adopted in 1995, the world's tuna fishing industries must be operated under the management of regional administrative bodies -- four of which currently "manage" the designated ocean zones. These administrative bodies are: the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Inter-American Tropical Tuna Commission (IATTC), the Indian Ocean Tuna Commission (IOTC), and the Commission for the Conservation of the Southern Bluefin Tuna (CCSBT).



Area of Responsibility among International Commissions and Convention for Management of Tuna Fisheries in the World

ICCAT (International Commission for the Conservation of Atlantic Tunas)
-Launched in 1969
-Comprised of 27 Contracting parties, including Japan, U.S.A., Canada, China, Korea and EU. Sets Regulations for bluefin tunas, juvenile of yellowfin tuna, bigeye tuna and bluefin tunas, vessel registration system, and Action Plan of tuna management.
In 1999, the ICCAT adopted the resolution to boycott tunas caught by FOC* vessels

*FOC**
A "flag-of-convenience" vessels is a fishing vessel that, in order to escape from management measures of regional tuna management organizations, will change its flag to that of a nation either:
a) not a member of any of the regional organizations concerned; or
b) a member, but with little capability of properly managing its fishing vessels.
Unregulated exploitation of tunas by FOC

on a voluntary basis. This resolution includes the following requirements:

1. The importers and transporters of contraction parties should not deal with any tunas caught by FOC vessels.
2. Their manufacturers should not sell any vessels and equipment to those who engage in FOC vessel activities.
3. Their consumers are informed about FOC vessel activities so that they would not purchase any tunas harvested by those FOC vessels.
4. Japan and Taiwan should promote joint programs for scrapping Japan-built FOC vessels.

IATTC (Inter-American Tropical Tuna Commission)

-Launched in 1950.

-Eleven contracting parties, including Japan, U.S.A., Mexico, and Venezuela. Regulates yellowfin tunas and juvenile bigeye tunas

CCSBT (Commission for the Conservation of Southern Bluefin Tuna)

-Launched in 1994.

-Three contracting parties: Japan, Australia and New Zealand. Korea and Indonesia are scheduled to join the commission in 2001 Determines the TAC of Southern bluefin tuna for every year, and allocates for each member nation.

IOTC (Indian Ocean Tuna Commission)

-Launched in 1996.

-Comprised of 14 contracting parties, including Japan, India, Korea, EU and Australia. Establishes the Vessel Regulation System for the basis of effort control of tuna vessels in the area.