Food and Agriculture Organization of the United Nations

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
iotc ctoi

IOTC Regional Observer Scheme

Scientific Field Observer Training

Scientific Field Observer

Training Manual:

Scientific Field Observer Training Course

[IOTC ROS SFO]

Table of Contents

List of Abbreviations

BCM	Bait Casting Machine
CMM	IOTC Conservation and Management Measure
COPEC	Contrôleurs des Pêches
CPCs	Contracting Parties and Cooperating Non-Contracting Parties
CPUE	Catch per Unit Effort
CSW	Chilled Sea Water
DWFN	Distant Water Fishing Nations
EPIRB	Emergency Position Indicating Radio Beacon
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organisation of the United Nations
GMDSS	Global Maritime Distress and Safety System
GRT	Gross Registered Tonnage
GT	Gross Tonnage
HF	High Frequency (radio)
IOTC	Indian Ocean Tuna Commission
IOC	Indian Ocean Commission
IMO	International Maritime Organisation
IUU	Illegal, Unreported and Unregulated (fishing activity)
LME	Large Marine Ecosystem
LOA	Length Overall (of the ship)
LSTLVs	Large Scale Tuna Longline Vessels
MF	Medium Frequency (radio)
MoU	Memorandum of Understanding
OBSPEC	Observateurs des Pêches
RFMO	Regional Fisheries Management Organisation

ROP	Regional Observer Programme (transhipment observers)
ROS	Regional Observer Scheme (scientific observers)
SART	Search and Rescue Transponder
SOLAS	International Convention for the Safety of Life at Sea, 1974
SIOFA	South Indian Ocean Fisheries Agreement
SWIOFC	South West Indian Ocean Fishery Commission
TAAF	Terres Australes et Antarctiques Françaises
UNCLOS	United Nations Convention on Law of the Sea 1982
VHF	Very High Frequency (radio)
VMS	Vessel Monitoring System

INTRODUCTION

This manual has been prepared for the Indian Ocean Tuna Commission (IOTC) Regional Observer Scheme (ROS), as outlined in Resolution 11/04[1] and the report of the expert review workshop on standards for the IOTC Regional Observer Scheme (IOTC–2018–WPDCS-35 Rev_2). The manual will constitute an integral part of the training documentation issued to observers during preparation, and will also be a tool used for reference purposes when they are in the field. Notwithstanding this, observers should be familiar with IOTC Resolution 11/04 *On a Regional Observer Scheme* and all the Conservation and Management Measures (CMMs) linked to this Resolution.

The ROS manual provides reference material along with instructions detailing observer tasks, including observational requirements; sampling protocols; data entry protocols; and reporting procedures for observers deployed in the longline, purse seine, pole-and-line, and gillnet fisheries operating in the IOTC area of competence[2]. This manual should be considered a 'living' document that will change as the Scheme evolves through the incorporation of new recommendations from the Scientific Committee, based on the advice of the Working Parties and observers returning from the field.

1 http://iotc.org/cmm/resolution-1104-regional-observer-scheme
2 http://iotc.org/about-iotc/competence

THE DEVELOPMENT OF REGIONAL OBSERVER SCHEMES

Worldwide, scientific observer schemes are used in fisheries management to provide 'independent' baseline information on fisheries. This is particularly important in the case of Regional Fisheries Management Organisations (RFMOs), like the Indian Ocean Tuna Commission (IOTC), which manage highly migratory species and where member states comprise distant water fleets as well as domestic fleets, which include artisanal fisheries (exploiting coastal waters, within 200 nm of the shore).

Regional observer schemes perform a valuable role in verifying catch and effort data collected through vessels logbooks. However, the observers training and experience also facilitates them providing more detailed scientific information that is not captured in logbooks that can contribute towards the assessment of stocks for management and conservation.

The development of modern-day observer schemes was identified in the United Nations Convention on the Law of the Sea of 10 December 1982, Part 5, and Articles 61 to 65, as contributing to the conservation and management of marine living resources. The 1982 Convention laid the foundation for a new era in international fisheries law that was followed by several major agreements that were drawn up to enhance the legal status of the management and conservation of marine living recourses, the most important of these were (Figure 1):

- 1993 FAO Compliance Agreement;
- 1995 FAO Code of Conduct for Responsible Fisheries; and
- 1995 UN Fish Stocks Agreement (UNFSA).

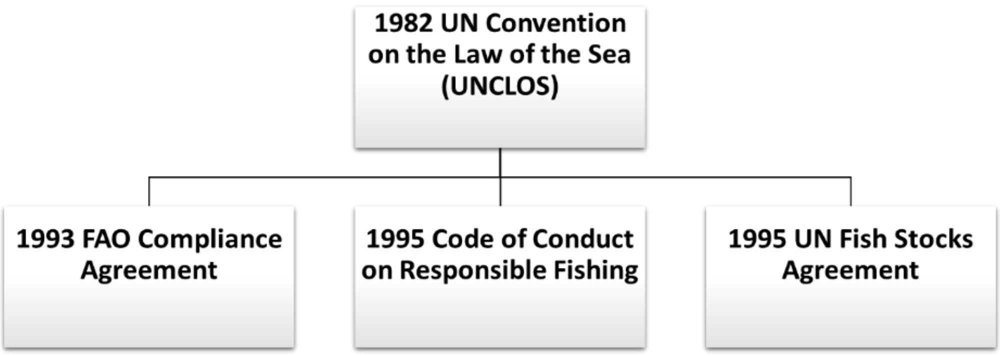

Figure 1 Three primary international instruments under UNCLOS that play a role in RFMOs

"These three instruments complement and mutually reinforce each other, highlighting the pivotal role of Regional Fisheries Management Organisations (RFMOs) in establishing a responsible international fisheries regime to promote and enhance data-collection and the exchange of data for assessing high seas resource potentials and developing profiles of all target and non-target stocks. Within these agreements, the framework was set for meaningful advances in fisheries management and establishing RFMO's and observer schemes for monitoring, control and surveillance and scientific data collection."

UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (UNCLOS)[3]

The Law of the Sea Convention defines the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. Key to managing the world's oceans was defining specific areas and the regulation and responsibility of these areas, these include:

- UNCLOS Part II: TERRITORIAL SEA AND CONTIGUOUS ZONE

It is set at 12 nautical miles (22 224 meters), counted from the baseline (low-water line) or from the archipelagic baseline for archipelagic States. In the territorial sea, the coastal State has sovereign rights, as in its own territory and inland waters, to exercise all its laws, regulate all uses and exploit all resources; the State must however authorize the passage of warships and merchants in transit, provided that they do not harm the State, do not threaten its safety and do not infringe its laws: this is known as the right of innocent passage.

- UNCLOS Part V : EXCLUSIVE ECONOMIC ZONE (EEZ)

Each coastal State may decide whether or not to establish an EEZ; it may then arbitrarily set its width, but the EEZ may not extend beyond 200 nm counted from the baseline. In the exclusive economic zone, the coastal State has:

Article 56: Rights, jurisdiction and duties of the coastal State in the exclusive economic zone

Sovereign rights for the exploration and exploitation, the conservation and management of biological or non-biological natural resources, waters overlying the seabed, seabed and subsoil, as well as other activities aimed at the exploration and exploitation of the area for economic purposes, such as the production of energy from water, currents and winds;

Jurisdiction with respect to the establishment and use of artificial islands, facilities and structures, marine scientific research, protection and preservation of the marine environment.

Article 61: Conservation of the living resources;

Article 62: Utilization of the living resources;

Article 63: Stocks occurring within the exclusive economic zones of two or more coastal States or both within the exclusive economic zone and in an area beyond and adjacent to it;

Article 64: Highly migratory species.

Articles 61 to 64 specify that UNCLOS signatories have an obligation to utilise and conserve living resources, to monitor fisheries, to collect relevant data for their management, to prevent and deter illegal fishing (IUU), as well as provide Observers and specify fisheries research programmes and guidelines. In particular this relates to the UN

[3] The *United Nations Convention on the Law of the Sea (UNCLOS)* is the international agreement that resulted from the third United Nations Conference on the Law of the Sea (UNCLOS III), which took place between 1973 and 1982.

Fish Stocks Agreement on highly migratory species and also on stocks of a transboundary nature (see below).

- UNCLOS PART VI: CONTINENTAL SHELF

The continental shelf of a coastal State includes the seabed and subsoil thereof to the outer edge of the continental margin or up to 200 nautical miles from the baselines when that outer edge is at a shorter distance. In this area coastal States have sovereign rights over the exploitation of the soil and subsoil resources (notably of hydrocarbon resources).

1993 FAO COMPLIANCE AGREEMENT

The 1993 FAO Compliance Agreement [4] applies to all fishing vessels that are used, or intended, for fishing on the high seas. A contracting Party is required to take such measures as may be necessary to ensure that fishing vessels entitled to fly its flag do not engage in any activity that undermines the effectiveness of international conservation and management measures. In particular, no Party shall allow any fishing vessel entitled to fly its flag to be used for fishing on the high seas unless it has been authorized to be so used by the appropriate authority or authorities of that Party. A fishing vessel so authorized shall fish in accordance with the conditions of the authorization.

FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES[5]

The United Nations Food and Agriculture Organization (FAO) adopted the FAO Code of Conduct for Responsible Fisheries on 31 October 19956 "with a view to ensuring the effective conservation, management and development of bio-aquatic resources with respect for ecosystems and biodiversity". The code of conduct serves as the basis for ecosystem-based fisheries management. Within the framework of this agreement, International Action Plans (IAPs) have been developed for the protection of seabirds and sharks, as well as for the fight against IUU fishing.

UN FISH STOCKS AGREEMENT (UNFSA)[7]

The Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks[8] and Highly Migratory Fish Stocks[9] is a multilateral treaty created by the United Nations to enhance the cooperative management of fisheries resources that span wide areas, and are of economic and environmental concern to a number of nations. The Agreement adopted in 1995, came into force in 2001 and has been ratified, of December 2016, by 84 parties, which includes 83 states and the European Union.

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[4] Is a binding agreement.

[5] http://www.fao.org/fi/agreem/codecond/codecon.asp

[6] Is a voluntary agreement

[7] https://en.wikipedia.org/wiki/Straddling_Fish_Stocks_Agreement

[8] Straddling stocks are fish stocks that migrate through, or occur in, more than one exclusive economic zone. Straddling fish stocks are especially vulnerable to overexploitation because of ineffective management regimes and noncompliance by fishing interests.

[9] Highly migratory fish refers to fish species which undertake ocean migrations and also have wide geographic distributions, and usually denotes tuna and tuna-like species, shark, marlin and swordfish.

The Agreement under Article 18: Duties of the flag State, includes the basis for the establishment of observer programs.

Articles under the UNFSA relevant to Scientific Observer Programmes include:

- *Article 5:* *Agreement General Principles;*

The duties and responsibilities of States in relation to the conservation and management of straddling and highly migratory fish stocks, Sub-paragraphs;

(f) minimize pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, (hereinafter referred to as non-target species) and impacts on associated or dependent species, in particular endangered species, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques;

(g) protect biodiversity in the marine environment;

(j) collect and share, in a timely manner, complete and accurate data concerning fishing activities on, inter alia, vessel position, catch of target and non-target species and fishing effort, as set out in Annex I, as well as information from national and international research programmes; and

(l) implement and enforce conservation and management measures through effective monitoring, control and surveillance.

- *Article 18:* *Duties of the flag State;*

Paragraph 1. A State whose vessels fish on the high seas shall take such measures as may be necessary to ensure that vessels flying its flag comply with sub-regional and regional conservation and management measures and that such vessel do not engage in any activity which undermines the effectiveness of such measures;

Paragraph 2. A State shall authorize the use of vessels flying its flag for fishing on the high seas only where it is able to exercise effectively its responsibilities in respect of such vessels under the Convention and this Agreement;

Paragraph 3. Measures to be taken by a State in respect of vessels flying its flag shall include:

(i) to apply terms and conditions to the licence, authorization or permit sufficient to fulfil any sub-regional, regional or global obligations of the flag State;

(g) monitoring, control and surveillance of such vessels, their fishing operations and related activities by, inter alia:

(ii) the implementation of national observer programmes and sub-regional and regional observer programmes in which the flag State is a participant, including requirements for such vessels to permit access by observers from other States to carry out the functions agreed under the programmes.

RATIONALE FOR THE IOTC-REGIONAL OBSERVER SCHEME

Taking into account the objectives of the agreements above and in terms of its mission as an intergovernmental organisation under Article XIV of the FAO constitution, the mandate of the IOTC is to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. In order to achieve these objectives, the Commission has identified the following functions and responsibilities, in accordance with the principles expressed in the relevant provisions of the United Nations Convention on the Law of the Sea:

1. to keep under review the conditions and trends of the stocks;

2. to gather, analyse and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks and fisheries based on the stocks covered by the IOTC Agreement;

3. to encourage, recommend, and coordinate research and development activities in respect of the stocks and fisheries covered by this Agreement, and such other activities as the Commission may decide appropriate, including activities connected with transfer of technology, training and enhancement, having due regard to the need to ensure the equitable participation of Members of the Commission in the fisheries and the special interests and needs of members in the region that are developing countries;

4. to adopt, on the basis of scientific evidence, conservation and management measures (CMMs) to ensure the conservation of the stocks covered by this Agreement and to promote the objective of their optimum utilisation throughout the Area; and

5. to keep under review the economic and social aspects of the fisheries based on the stocks covered by this Agreement bearing in mind, in particular, the interests of developing coastal states.

The aim of the IOTC ROS is to *"collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence[10]".* This will provide independent, reliable, verified and accurate information on catch, effort, fishing practices and the fate of non-target species for a sample of all types of vessel operating within the IOTC area of competence. This information is essential to fisheries managers, research organisations and environmental agencies for stock assessments and the responsible management and conservation of living marine resources. The IOTC Regional Observer Scheme was adopted in Resolution 11/04 to support the Commission in meeting these obligations and functions.

The framework of the IOTC ROS, is centred around five key components that aim to tackle each of the key issues that currently undermine the collection and analysis of high-quality data to contribute to stock assessment and management advice. The five components seek to resolve these issues through the development of new technologies, tools, standards and processes and their operationalisation in selected voluntary CPCs.

[10] Paragraph 1 of IOTC Resolution 11/04 *On a regional observer scheme*.

- Component 1: addresses the problem of establishing observer programmes where there are few resources, expertise and experiences to draw on through the development of a full observer training programme package.
- Component 2: aims to tackle the issues with poor data reporting through the development of an electronic reporting tool which will facilitate the submission of data at both the national and regional level, improving the quality of data through error-checking procedures and creating time-saving efficiencies for CPCs and the IOTC Secretariat.
- Component 3: consists on the development of a regional database to host observer data and the population of this database with historic data that has been submitted in non-standard formats or has not yet been submitted at all due to various reasons.
- Component 4: entails the development of Electronic Monitoring Systems (EMS) for small-scale fisheries, specifically gillnet fleets, in the Indian Ocean.
- Component 5: involves the development of data collection protocols for port sampling to complement data collected by EMS and onboard observers.

Components 1 and 2 of the IOTC ROS will be met through the development of a full observer training programme package (Co-ordinators and Field Observers), establishment of observer programmes and training, and the piloting of IOTC ROS Electronic tools and methods in voluntary CPCs. Components 3, 4 and 5 will be met through complementary programmes managed by the IOTC and implemented by participating CPCs.

PART A: ENSURING FISHERIES SUSTAINABLE MANAGEMENT

BACKGROUND TO TROPICAL TUNA FISHING IN THE INDIAN OCEAN

The Indian Ocean is the world's third largest ocean, covering over 70 million square kilometres, from east Africa to the southern tip of Asia, and along the western Australian coast. It is one of the world's most economically important fishing areas accounting for up to 20 percent of the world's production of tuna, making it the second largest region for tuna fishing after the western and Central Pacific Ocean[11].

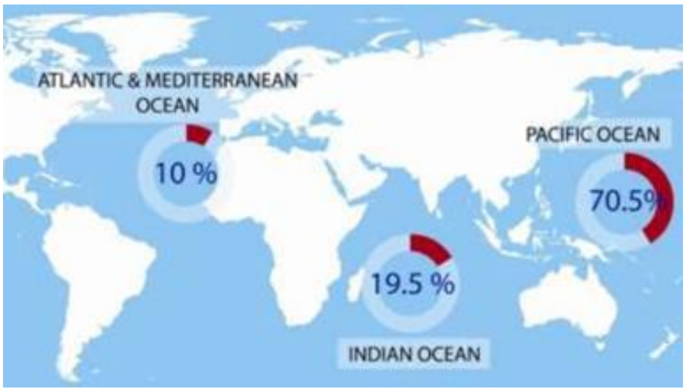


Figure 2- World map of large pelagic fishing (© OVPOI)

Tuna and tuna-like species represent the most widely shared marine resource in the Indian Ocean basin and are among the most important marine species for the global economy. As a result, the Indian Ocean region harbours abundant and highly prized fishery resources intensively harvested by Asian and European fleets as well as artisanal fisheries from coastal countries. In general, the production of coastal species is much higher than that of oceanic species, such as tunas, yet the southwestern Indian Ocean has the peculiarity that oceanic and coastal fisheries contribute to production roughly to the same extent.

Neritic or coastal species generally predominate in coastal country catches (with some notable exceptions of the Maldives, Sri Lanka and Indonesia), while the distant water fishing nations target tropical and temperate oceanic tunas and, to a lesser extent, billfish (mainly swordfish). Two industrial fleets share the catches of these large pelagic fish: the tropical tuna purse-seine fleet (mainly European) and the industrial tuna longline fleet (mainly Asian).

Despite lower coastal catches, fisheries and related economic activities are often important to local economies where tuna is of major importance for food security and constitutes a major socio-economic pillar. It is estimated that 60% of the industrial tuna fishery in the Indian Ocean is carried out on the high seas outside the control (EEZ) of a given country. For this reason, several international and regional agreements exist to promote the sustainable management of the resources of the Indian Ocean:

- The 1982 United Nations Convention on the Law of the Sea (UNCLOS);
- The FAO Code of Conduct for Responsible Fisheries in 1995;
- The 1994 Convention for the establishment of a Regional Fisheries Body to manage Southern Bluefin Tuna (SBT), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT);
- The 1996 Agreement for the establishment of a Regional Fisheries Organisation to manage Tuna and Tuna-like Resources in the Indian Ocean, the Indian Ocean Tuna Commission (IOTC);

[11] ISSF. 2019. Status of the world fisheries for tuna. Mar. 2019. ISSF Technical Report 2019-07. International Seafood Sustainability Foundation, Washington, D.C., USA.

BASIC CONCEPTS OF FISHERIES MANAGEMENT

To understand the objectives of the IOTC in the management of the tuna fishery in the Indian Ocean it is necessary to understand the basic principles of fisheries management.

General concepts

What is a "Fishery"[12]?

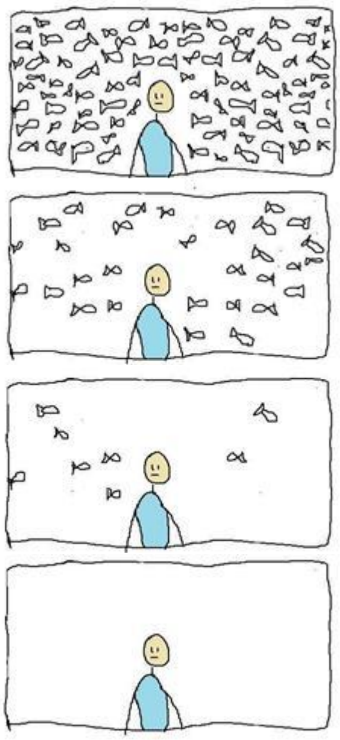
A fishery is an organized effort by humans to catch fish or other aquatic species, an activity known as fishing.

Depending on the scale, degree of sophistication of gears, and on the method of fishing used, fisheries can be subdivided into:

- artisanal;
- semi-industrial; and
- industrial fisheries.

Fisheries are a huge global business and provide income for millions of people and continue to be culturally important for many communities.

How many fish are there?



Unlike trees, which can be counted, fish are effectively invisible. Initially it was thought that the resources of the sea were unlimited and fishing was done without control. Over time, the reduction in catches and in the average size of the fish made it possible to highlight problems of:

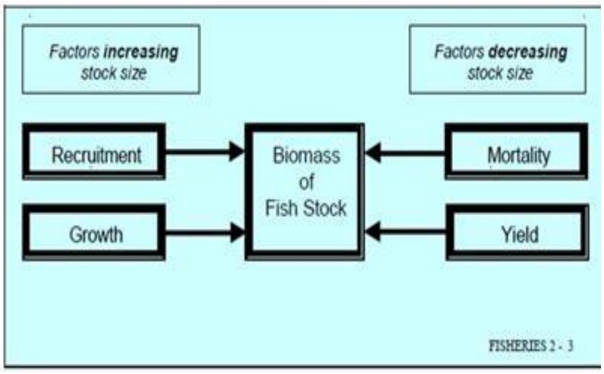
- overfishing;
- the impacts of fishing on the ecosystem; and
- economic and social impacts.

In order to improve knowledge on the catches, size and distribution of fish populations, governments (Ministries of Fisheries), universities, public research, and private and international research companies collect information through the use of commercial fishing logs, research vessels, or the deployment of Fisheries Observers. Scientists use these data to conduct ***Fishery Research***.

[12] Groeneveld, J. and Heinecken, C. SWIOFP Observer Manual. SWIOFP, 2010

What is "Fishery Research"?

Fisheries studies allow us to understand the factors that influence the biomass (*total biological weight of a certain species in in a managed stock*) of fish populations (recruitment, growth, natural mortality / fishing, etc.), to try to give an integrated picture of the fishery and how it affects fish populations.



Scientists use statistical methods and models to analyse the data collected and assess the status of fish stocks. These assessments require precise information since poor or falsified data can have an extremely serious impact on the management of a certain fishery and may lead to erroneous decisions in the implementation of the rules of ***"Fishery Management".***

What is "Fisheries Science"?

Fisheries science is the academic discipline of understanding and managing fisheries. It draws on the disciplines of ***biology, ecology, oceanography, economics*** and ***management*** to provide an integrated picture of fisheries, and how it affects fish populations.

It focuses on the different modes of exploitation and management (fishing, aquaculture) of living species (plant or animal) in all aquatic environments (sea and fresh water). It tends gradually to integrate new dimensions such as:

- the availability of fish to catch (***overfishing***);
- development of ***sustainable fisheries***;
- the ***management of the resource*** or even its restoration;
- ***fisheries management*** (economic impact) and
- the ***impact of fishing on the environment***, such as by-catch.

What is "Fisheries Management"?

Fisheries Management is often referred to as a governmental system of management rules based on defined objectives and a mix of management means to implement these rules. Fisheries management involves regulating when, where, how, and how much fishermen are allowed to catch to ensure that there will be fish in the future. The objectives of fisheries management may include the following:

- secure and increase employment in certain regions;
- secure protein production and food supply;
- maximise sustainable biomass yield and /or economic yield;
- increase income from export;
- prevent overfishing while achieving optimum yield;
- be based upon the best scientific information available;

- manage individual stocks as a unit throughout their range;
- minimize bycatch or mortality from bycatch;
- promote ecosystem-based management (EAF); and
- promote safety of human life at sea.

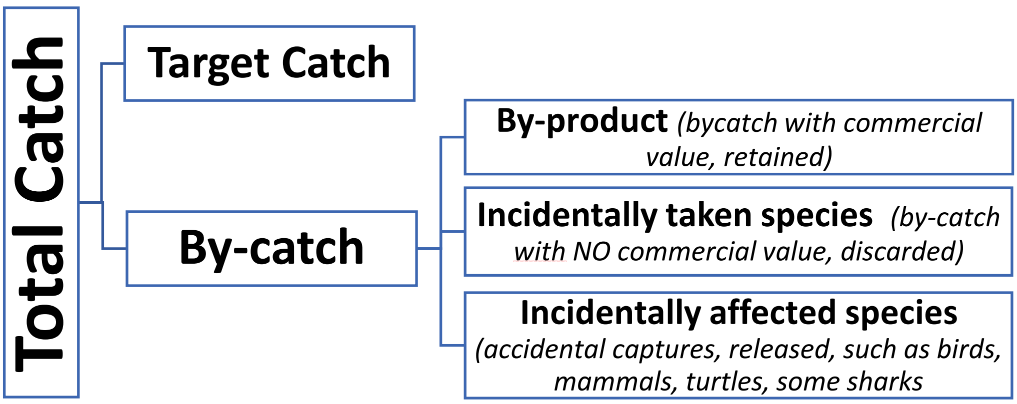
In most countries, fisheries departments are responsible for fisheries management within their "Exclusive Economic Zone" (EEZ) and use *POLICIES* and *REGULATIONS* as tools for managing their fisheries. These are often based on the internationally agreed codes such as the United Nations "Code of Conduct for Responsible Fisheries" and the United Nations Convention on the Law of the Sea (UNCLOS).

International agreements are also required to regulate fisheries taking place in areas outside national control known as ***high seas areas***. These are undertaken by Regional Fisheries Management Organisations (RFMOs). International protocols and the basis from which RFMOs and other maritime issues are managed are described in the Law of the Sea, in the treaty known as the UNCLOS, 1995, New York Treaty. In turn, RFMOs give rise to a range of conventions establishing conditions for fisheries management, incidental catches of seabirds, cetaceans, turtles and sharks, and combating IUU (Illegal, Unregulated and Unreported) fishing.

IOTC fisheries concepts relevant to scientific observer work[13]

Certain fisheries concepts vary from country to country and sometimes even in country, from one organisation to another. Here we list fisheries concepts relevant to Scientific Observer work as defined by the IOTC. These include the concept of:

- catch;
- target catch (and species);
- bycatch (and species); and
- by-product (or retained catch)



Target species

A species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery. The target species will be listed in the permit provided by its flag State (vessels authorisation to fish).

[13] IOTC glossary of scientific terms, acronyms and abbreviations, 2015

Bycatch species

All species, other than the 16 species listed in Annex B of the IOTC Agreement, caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence. A bycatch species includes those non-IOTC species which are (a) retained (by-product), (b) incidentally taken in a fishery and returned to the sea (discarded); or (c) incidentally affected by interacting with fishing equipment in the fishery, but not taken.

By-product

Bycatch with commercial value are non-target species which are retained. These can be sent to the kitchen, prepared by crew members, given to dockers, discarded, sold to specialized companies. They can include marlins, dorado dolphinfish, juvenile tunas, etc. and can represent an important part of the global catch.

Incidentally taken species

Bycatch species of no commercial value such as fish species, crustaceans or other non-target organisms without commercial interest, not marketable for reasons of size (immature, juvenile), prohibited from fishing, or from being hauled on-board.

Incidentally affected species

Bycatch species that accidentally interact with fishing equipment in the fishery, that are not taken but released to the sea (cetaceans, seals, turtles, birds, etc.). Some of these species may be considered protected, endangered or threatened (PET).

IOTC Species of Special Interest (SSI)

Species of Special Interest include all marine turtles, all marine mammals, all seabirds, shark species with a retention ban: whale sharks (Res 13/05), oceanic white tip sharks (Res 13/06) and thresher sharks (Res 12/09.); and billfish species included in Res 18/05: striped, black and blue marlin and Indo-Pacific sailfish (IOTC–2018–SC21–R[E]).

THE INDIAN OCEAN TUNA COMMISSION (IOTC)[14]

Geography and political dimension of the Indian Ocean Region

The Indian Ocean Tuna Commission (IOTC) is the main body responsible for the management of tuna and tuna-like species in the Indian Ocean and shares these objectives with four other tuna RFMOs covering the ocean regions of the world (Figure 3).

Its main objective is to promote the sustainable use of all tuna and tuna like fishery resources in the Indian Ocean.

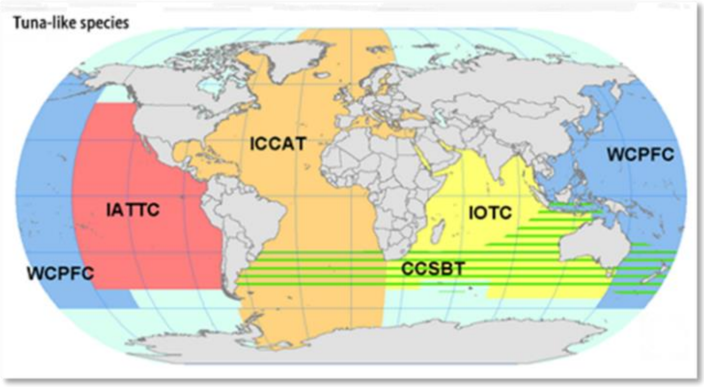


Figure 3 The six RFMOs that manage tuna and tuna like species.

Another tuna regional fisheries management body that co-exists with the IOTC in the Indian Ocean is the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) with its main objective is to ensure, through appropriate management the conservation and optimum utilisation of southern bluefin tuna.

IOTC Area of competence[14]

The area of competence of the Commission extends over national waters and the high seas of the Indian Ocean, defined for the purpose of the Agreement as being FAO Statistical Areas 51 and 57, and adjacent seas, north of the Antarctic Convergence, insofar as it is necessary to cover such seas for the purpose of conserving and managing stocks that migrate into or out of the Indian Ocean. In 1999, the Commission extended the western boundary of the IOTC statistical area from 30ºE to 20ºE, thus eliminating the gap in between the areas covered by the IOTC and ICCAT.

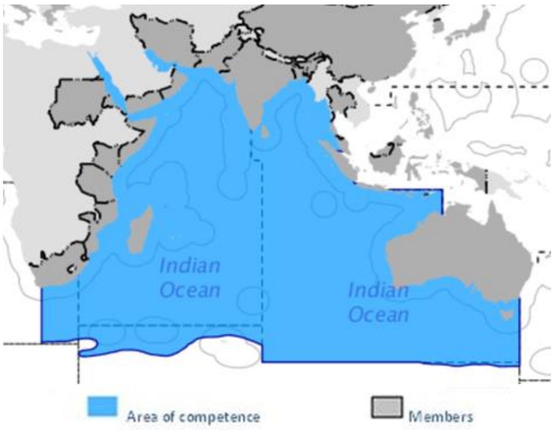


Figure 4: IOTC area of competence

CCSBT Area of competence

The CCSBT area of competence extends over all national waters and the high seas, where southern Bluefin tuna are found. Members of the Extended Commission comprise: Australia, the European Union, the Fishing Entity of Taiwan, Indonesia, Japan, Republic of Korea, New Zealand and South Africa. Cooperating Non-Members comprise: the Philippines.

Background to IOTC, structure, members and dynamics

[14] http://www.fao.org/fishery/rfb/iotc/en

Establishment

The IOTC is an intergovernmental organisation that was established by the FAO Council in Rome in 1993 and came into force in 1996. The objective of the Commission is to promote cooperation among its Members with a view to ensuring, through appropriate management, the conservation and optimum utilisation of tuna and tuna-like stocks covered by the IOTC Agreement and encouraging sustainable development of fisheries based on such stocks (*IOTC ROS OM v1.2l, 2015*).

IOTC Membership

The Commission is open to any Indian Ocean coastal countries and to countries or regional economic integration organisations which are members of the United Nations (UN) or one of its specialised agencies, and are fishing for tunas or tuna-like species in the Indian Ocean. Currently (August 2019), there are 31 Contracting Parties (**Error! Reference source not found.**) and two Cooperating Non-Contracting Parties, collectively termed CPCs.

Table 1: Current membership of the IOTC Commission

IOTC Cooperating Contracting Parties (CCP)		Philippines
Australia	Japan	Seychelles
Bangladesh	Kenya	Sierra Leone
China	Korea, Republic of	Somalia
Comoros	Madagascar	South Africa
Eritrea	Malaysia	Sri Lanka
European Union	Maldives	Sudan
France	Mauritius	Tanzania
India	Mozambique	Thailand
Indonesia	Oman, Sultanate of	United Kingdom
Iran, Islamic Rep. of	Pakistan	Yemen

IOTC Cooperating Non-Contracting Parties (CNCP)		
Liberia	Senegal	

Organisational structure of the IOTC

The IOTC Commission is supported by three committees that include representatives of each Member State and a permanent Secretariat (Figure 5). The Commission is the primary decision-making body and supporting committees include the:

- Scientific Committee (supported by a number of specialised working parties);
- Compliance Committee; and
- Standing Committee on Administration and Finance.

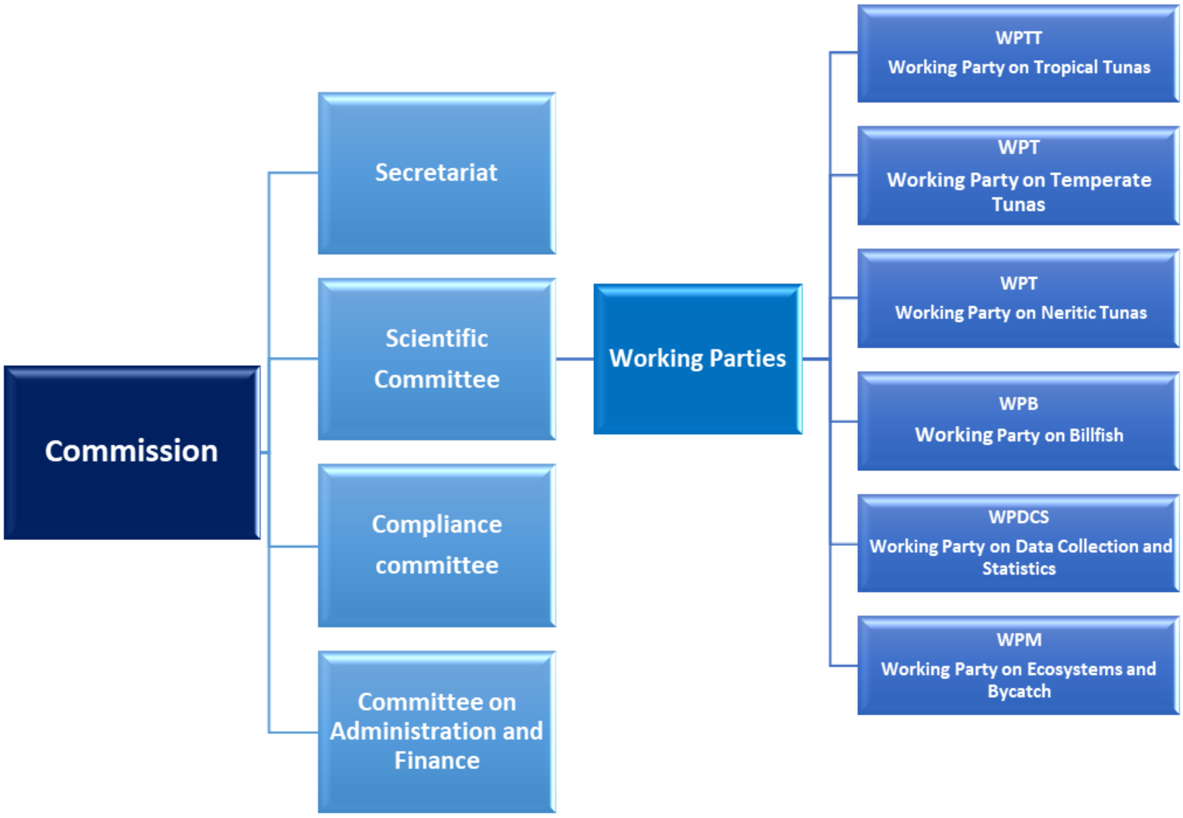


Figure 5: Schematic diagram of the IOTC organisation.

The Commission

Representatives of the Contracting Parties make up the Commission at its annual meetings and this is the main decision-making body. Subsidiary bodies set up by the Commission (Figure 5) analyse different types of data and information. These associated bodies have specific functions and are responsible to the Commission and refer their conclusions and recommendations back to the Commission for final decision-making.

At each Session of the Commission, Members may adopt Conservation and Management Measures (CMMs) concerning the management of tuna and tuna-like species under the IOTC mandate as well as the fisheries which target them. These decisions are passed in the form of either Resolutions or Recommendations.

The Commission is the only body authorised to take decisions that are published as IOTC Resolutions, which are binding on Members. It is the responsibility of Members to ensure that action is taken under their national legislation to implement CMMs, which become binding on it.

Recommendations adopted by the Commission concerning conservation and management of the stocks for furthering the objectives of the IOTC Agreement, are not binding and are acceded to on a voluntary basis by Members. The Members of the Commission are also expected to cooperate in the exchange of information regarding any fishing for stocks covered by the Agreement by nationals of any State or entity, which is not a Member of the Commission.

A permanent Secretariat provides the administrative support for the Commission and its subsidiary bodies. The IOTC Secretariat consists of the Executive Secretary, appointed by the Director-General of the Food and Agriculture Organisation (FAO) with the approval of the Commission, and staff appointed by him/her to support the Commission in the implementation of policies through administration activities, data management, capacity building, scientific and other support activities as requested by the Commission, the Scientific Committee and the Working Parties.

Function and responsibilities[15]

The Commission has four key functions and responsibilities which enable it to achieve its objectives. They are drawn from the United Nations Convention on the Law of the Sea (UNCLOS), and are:

- to keep under review the conditions and trends of the stocks and to gather, analyse and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks and to fisheries based on the stocks;
- to encourage, recommend, and coordinate research and development activities in respect of the stocks and fisheries covered by the IOTC, and such other activities as the Commission may decide appropriate, such as transfer of technology, training and enhancement, having due regard to the need to ensure the equitable participation of Members of the Commission in the fisheries and the special interests and needs of Members in the region that are developing countries
- to adopt – on the basis of scientific evidence – Conservation and Management Measures (CMM) to ensure the conservation of the stocks covered by the Agreement and to promote the objective of their optimum utilisation throughout the Area;
- to keep under review the economic and social aspects of the fisheries based on the stocks covered by the Agreement bearing in mind, in particular, the interests of developing coastal States.

The Scientific Committee

The Scientific Committee (SC) advises the Commission on research and data collection and, on management issues and the status of stocks. The meetings of the Scientific Committee are held some months prior to the meetings of the Commission. In addition, the Commission has established a number of Working Parties for specific purposes (Figure 5).

The most common objective of the Working Parties is to provide the Scientific Committee with analyses of the status of the stocks and possible management actions, while some Working Parties (such as the Working Party on Data Collection and Statistics) were established to analyse and provide recommendations on specific technical problems.

The Secretariat

The Secretariat is a fully staffed office that is run throughout the year. The Executive Secretary, who is appointed by the Commission manages the Secretariat on a day to day basis. The offices of the IOTC Secretariat are located in Victoria, Seychelles.

[15] http://www.iotc.org

The mission of the Secretariat is to facilitate the processes required to implement the policies and activities of the Commission whose goal is to achieve the objectives stated in the IOTC Agreement. In essence, these processes include the acquisition, processing and dissemination of information that constitutes the basis for the Commission's decisions, as well as supporting the actions taken by the Members and Cooperating Parties to implement those decisions effectively.

In order to provide support to the scientific activities of the Commission and its subsidiary bodies there is close cooperation between the data section and the science section in the production of datasets and analyses that will assist the Scientific Committee and its Working Parties to formulate its advices to the Commission.

Similarly, the data section and the compliance section cooperate in the maintenance of the databases needed to monitor the effectiveness in the implementation of the measures adopted by the Members.

The Secretariat is also involved in the implementation of projects that further the objectives of the Commission. With respect to providing public information, the Secretariat has developed a website in which comprehensive information resources converge.

The website, which is found under www.iotc.org pools resources such as reports, and databases (complete with web-based query interfaces), in order to provide CPCs with all the information they may use in order to honour their duties under the agreement.

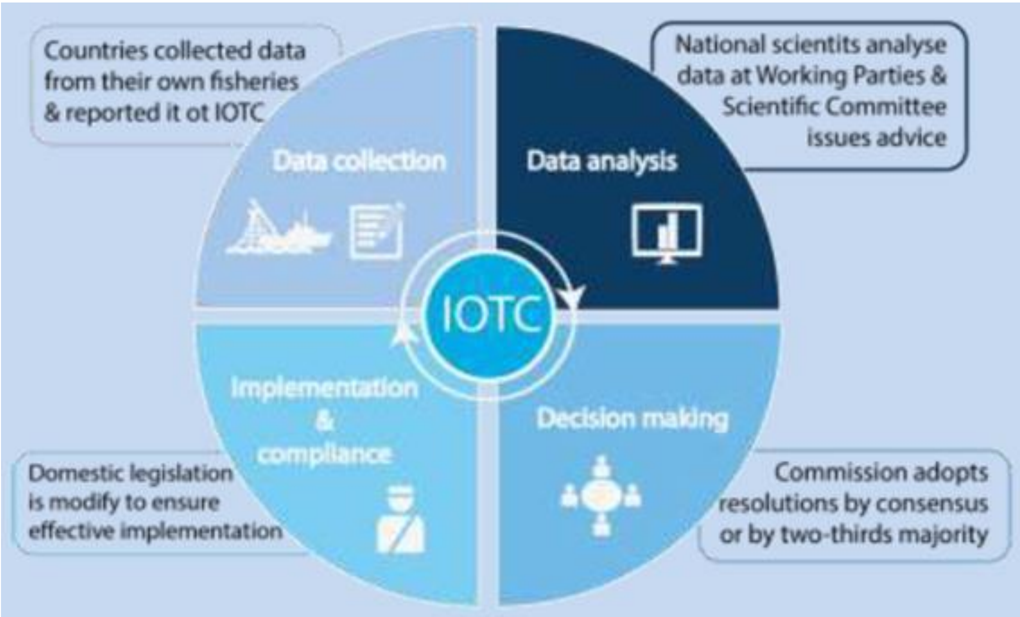


Figure 6 – Process for the establishment and implementation of IOTC Conservation and Management Measures (© OVPOI)

MAIN SPECIES UNDER IOTC MANAGEMENT

Sixteen (16) species are under the management mandate of the IOTC. In addition, the Commission has instructed the IOTC Secretariat to collate data on non-target, associated and dependent species affected by fisheries targeting tuna and tuna-like species in the IOTC area of competence. Note that one of the 16 species (Southern Bluefin tuna) was signed over to the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) for management purposes.

Conservation and management measures relevant to scientific Observers

The full compendium of IOTC CMMs can be downloaded from the website at: http://www.iotc.org/cmms and may be subject to change by the IOTC at future meetings of the Commission. Observers need to have access to these and review the most recent CMM's as they become available.

Below are a number of resolutions, the content thereof that observers should be aware of.

General resolutions

IOTC Resolution 11/04: On a Regional Observer Scheme

IOTC Resolution 11/04 *On a Regional Observer Scheme* is the mandate that provides the foundations of the development IOTC Regional Observer Scheme and covers the requirements which are binding on all CPCs. It is important for observers to be fully conversant with this Resolution as it provides the mandate for them to be onboard a vessel and specifies their role and tasks that have to be accomplished in meeting the objective of the Resolution.

At the 13th Session of the Commission (S13), the IOTC Commission adopted Resolution 09/04 *on a Regional Observer Scheme*, which was superseded in 2010 by Resolution 10/04, and again in 2011 by Resolution 11/04. In the adoption of *Resolution 11/04* on a *Regional Observer Scheme*, the IOTC Commission recognised that observer programs are used successfully at both the national and Regional Fisheries Management Organization (RFMO) level for the purposes of collecting scientific information.

It further acknowledged the United Nations General Assembly Sustainable Fisheries Resolution 63/112, which encourages the development of observer programs by regional fisheries management organizations and arrangements to improve data collection in their area of management.

The Commission also emphasised that in terms of Articles IX and XI of the IOTC Agreement, Contracting Parties and Cooperating Non-Contracting Parties (hereinafter CPCs) have the obligation to fully comply with the IOTC Conservation and Management Measures and are required to furnish, on the request of the Commission, any available statistical, biological and other scientific information needed for the purposes of the Agreement in maintaining the resources of tuna and tuna-like fishes of the Indian Ocean.

Further acknowledging, that the adoption of this measure is intended to assist in the increase of information to help support IOTC scientific research for tuna and tuna-like species and the implementation of Conservation and Management Measures in order to improve the management of the tuna and tuna-like species fished in the Indian Ocean.

Paragraph 2 of the Resolution requires specifically "*that each CPC is to implement a national observer program in order to improve the collection of scientific data, on at least 5-% of the number of operations/sets for each gear type by their fleet while fishing in the IOTC area of competence, on* *vessels of 24 meters overall length and over (within both the their Exclusive Economic Zone (EEZ) and on the high seas), and for vessels under 24 meters if they fish outside their EEZ."*

Paragraph 5 of the resolution requires that "*CPCs shall:*

- *a) Have the primary responsibility to obtain qualified observers. Each CPC may choose to use either deployed national or non-national of the flag State of the vessel on which they are deployed;*
- *b) Endeavour that the minimum level of coverage is met and that the observed vessels are a representative sample of the gear types active in their fleet;*
- *c) Take all necessary measures to ensure that observers are able to carry out their duties in a competent and safe manner;*
- *d) Endeavour to ensure that the observers' alternate vessels between their assignments. Observers are not to perform duties, other than those described in paragraphs 10 and 11 below;*
- e) *Ensure that the vessel on which an observer is placed shall provide suitable food and lodging during the observer's deployment at the same level as the officers, where possible. Vessel masters shall ensure that all necessary cooperation is extended to observers in order for them to carry out their duties safely including providing access, as required, to the retained catch, and catch which is intended to be discarded."*

Paragraph 9 requires that *"CPCs shall provide to the IOTC Executive Secretary and the IOTC Scientific Committee annually a report of the number of vessels monitored and the coverage achieved by gear type in accordance with the provisions of this Resolution."*

Paragraph 10 outlines the tasks of the observer while onboard and include specifically:

"Observers shall:

- *a) Record and report fishing activities, verify positions of the vessel;*
- *b) Observe and estimate catches as far as possible with a view to identifying catch composition and monitoring discards, by-catches and size frequency;*
- *c) Record the gear type, mesh size and attachments employed by the master;*
- *d) Collect information to enable the cross-checking of entries made to the logbooks (species composition and quantities, live and processed weight and location, where available); and*
- *e) Carry out such scientific work (for example, collecting samples), as requested by the IOTC Scientific Committee."*

It is important that the training provides comprehensively the observer with the skills to achieve these objectives.

Paragraph 11 requires *"The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel."*

Observers must be fully aware of the need to prepare and write these reports at the completion of each trip and requires them to maintain a continuous record of events that occur throughout a trip to meet this requirement.

In order for the observer to fully achieve the objectives of Resolution 11/04 it is highly recommended that observers are also aware and conversant with the Resolutions outlined below and are at any time confident in consulting most up to date IOTC - Compendium of ACTIVE CMMs and where relevant can accurately cross reference these in their reports. Although observer are not deployed as compliance officers in terms of this scheme, awareness of these Resolutions will assist in their reporting on the vessels compliance or non-compliance and the effectiveness of vessels conforming to the Resolutions.

IOTC Resolution 15/03: On the Vessel Monitoring System (VMS) Programme

Paragraph 4: Each Contracting Party and Cooperating Non-Contracting Party (CPC) shall adopt a satellite-based vessel monitoring system (VMS) for all vessels flying its flag 24 metres in length overall or above or in case of vessels less than 24 meters, those operating in waters outside the Economic Exclusive Zone of the Flag State fishing for species covered by the IOTC Agreement within the IOTC area of competence.

IOTC Resolution 16/07: On the use of artificial lights to attract fish to drifting fish aggregating devices

***Paragraph 1:** Fishing Vessels including support and supply vessels flying the flag of an IOTC Contracting Parties or Cooperating Non-Contracting Party (collectively CPCs) are prohibited from installing or operating surface or submerged artificial lights for the purpose of aggregating tuna and tuna-like species or non-target, associated or dependent species on drifting Fish Aggregating Devices (DFADs).*

***Paragraph 2:** CPCs shall prohibit their flagged vessels from intentionally setting a purse seine net around a DFAD equipped with artificial light for the purpose of attracting fish under the mandate of IOTC and in the IOTC area of competence.*

***Paragraph 3:** DFADs equipped with artificial lights, which are encountered by fishing vessels operating in the IOTC area of competence, should as far as possible be removed and brought back to port.*

IOTC Resolution 17/07: To prohibit the use of large-scale driftnets on the high seas in the IOTC area

***Paragraph 2:** The use of large-scale driftnets[16] on the high seas within the IOTC area of competence shall be prohibited. The use of large-scale driftnets in the entire IOTC area of competence shall be prohibited by 1 January 2022.*

IOTC Resolution 18/03: On Establishing a List of Vessels Presumed to Have Carried out Illegal, Unreported and Unregulated Fishing in the IOTC Area of Competence.

Observers should be on the lookout for any vessel suspected of IUU fishing activity or any vessel currently listed on the IUU vessel list. Any information regarding those activities or those vessels can be reported to the IOTC Secretariat through the national observer program coordinator.

[16] “Large-scale driftnets” are defined as gillnets or other nets or a combination of nets that are more than 2.5 kilometres in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column.

IOTC Resolution 19/02: Procedures on a Fish Aggregating Devices (FADs) Management Plan

Paragraph 1: *Definitions*

For the purpose of this Resolution:

a) Fish Aggregating Device (FAD) means a permanent, semi-permanent or temporary object, structure or device of any material, man-made or natural, which is deployed and/or tracked, for the purpose of aggregating target tuna species for consequent capture.

b) Drifting Fish Aggregating Devices (DFADs) means a FAD not tethered to the bottom of the ocean. A DFAD typically has a floating structure (such as a bamboo or metal raft with buoyancy provided by buoys, corks, etc.) and a submerged structure (made of old netting, canvass, ropes, etc.).

c) Anchored Fish Aggregating Devices (AFADs) means a FAD tethered to the bottom of the ocean. It usually consists of a very large buoy and anchored to the bottom of the ocean with a chain.

d) Instrumented buoy means a buoy with a clearly marked with a unique reference number allowing identification of its owner and equipped with a satellite tracking system to monitor its position.

e) Operational buoy means any instrumented buoy, previously activated, switched on and deployed at sea on a drifting FAD or log, which transmit position and any other available information such as eco-sounder estimates.

f) Activation of a buoy means the act of initializing satellite communication service, which is done by the buoy supplier company at the request of the vessel owner or manager.

g) Deactivation of a buoy means the act of cancelling satellite communications service, which is done by the buoy supplier company at the request of the vessel owner or manager.

h) Buoy owner means any legal or natural person, entity or branch, who is paying for the communication service for the buoy associated with a FAD, and/or who is authorized to receive information from the satellite buoy, as well as to request its activation and/or deactivation.

i) Reactivation: the act of re-enabling satellite communications services by the buoy supplier company at the request of the buoy owner or manager.

j) Buoy in stock means an instrumented buoy acquired by the owner which has not been made operational.

Paragraph 2: *This Resolution shall apply to CPCs having purse seine vessels and fishing on Drifting Fish Aggregating Devices (DFADs), equipped with instrumented buoys for the purpose of aggregating target tuna species, in the IOTC area of competence. Only purse seiners and associated supply or support vessels are allowed to deploy DFADs in the IOTC Area of Competence.*

Paragraph 3: *This resolution requires the use of instrumented buoy, as per the above definition, on all DFADs and prohibits the use of any other buoys, such as radio buoys, not meeting this definition.*

Non-entangling and biodegradable FADs

Paragraph 17: *To reduce the entanglement of sharks, marine turtles or any other species, CPCs shall require their flagged vessels to use non-entangling designs and materials in the construction of FADs as outlined in Annex V.*

Paragraph 18: *To reduce the amount of synthetic marine debris, the use of natural or biodegradable materials in FAD construction should be promoted. CPCs shall encourage their flag vessels to use biodegradable FADs in accordance with the guidelines at Annex V with a view to transitioning to the use of biodegradable FADs, with the exception of materials used for the instrumented buoys, by their flag vessel from 1 January 2022. CPCs shall, from 1 January 2022, encourage their flag vessels to remove from the water, retain onboard and only dispose of in port, all traditional FADs encountered (e.g. those made of entangling materials or designs). The reference year prescribed above shall be reviewed in light of the Scientific Committee's recommendation pursuant to Resolution 18/04 On BioFAD experimental project.*

FAD Marking

Paragraph 20: *A new marking scheme shall be developed by the ad-hoc FAD working group and shall be considered by the Commission at its regular annual session in 2020.*

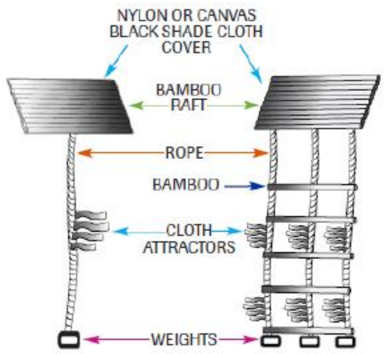
Paragraph 21: *Until the marking scheme referred to in paragraph 20 is adopted, CPCs shall ensure that the instrumented buoy attached to the DFAD contain a physical, unique reference number marking (ID provided by the manufacturer of the instrumented buoy) and the vessel unique IOTC registration number clearly visible.*

ANNEX V PRINCIPLES FOR DESIGN AND DEPLOYMENT OF FADS

EXAMPLE OF NON-ENTANGLING FAD

1. *The surface structure of the FAD shall not be covered, or only covered with non-meshed material*

2. *If a sub-surface component is used, it shall not be made from netting but from non-meshed materials such as ropes or canvas sheets.*



IOTC Resolution 19/06: On Establishing a Programme for Transhipment by Large-Scale Fishing Vessels

Paragraph 1: *Except under the programme to monitor transhipments at sea outlined below in Section 2, all transhipment operations of tuna and tuna-like species and sharks caught in association with tuna and tuna-like fisheries in the IOTC area of competence (hereinafter referred to as "tuna and tuna like species and sharks") must take place in port[17].*

[17] Port includes offshore terminals and other installations for landing, transhipping, packaging, processing, refuelling or resupplying (as defined by FAO Port State Measures Agreement)

Paragraph 2: *The flag Contracting Parties and Cooperating Non-Contracting Parties (collectively termed CPCs) shall take the necessary measures to ensure that large scale tuna vessels[18] (hereafter referred as the "LSTVs") flying their flag comply with the obligations set out in Annex I when transhipping in port.*

Paragraph 3: *Transhipment operations within the Maldives between pole and line fishing vessels, and collector vessels flagged in the Maldives and registered on the IOTC Record of Authorized Vessels shall be exempted from the data reporting requirements specified in Annex I and Annex III. Such transhipment operations shall conform to the criteria set forth in Annex II of this resolution.*

SECTION 2. PROGRAMME TO MONITOR TRANSHIPMENTS AT SEA

Paragraph 4: *The Commission hereby establishes a programme to monitor transhipment at sea which applies only to largescale tuna longline fishing vessels (hereafter referred to as the "LSTLVs") and to carrier vessels authorised to receive transhipments from these vessels at sea. No at-sea transhipment of tuna and tuna-like species and sharks by fishing vessels other than LSTLVs shall be allowed. The Commission shall review and, as appropriate, revise this Resolution.*

SECTION 4. AT-SEA TRANSHIPMENT

Paragraph 11: *Transhipments by LSTLVs in waters under the jurisdiction of the CPCs are subject to prior authorisation from the Coastal State concerned. (…).*

Regional Observer Programme:

Paragraph 19: *Vessels shall be prohibited from commencing or continuing at-sea transhipping in the IOTC area of competence without an IOTC regional observer on board, except in cases of "force majeure" duly notified to the IOTC Secretariat.*

Paragraph 19: *In the case of the eight Indonesian wooden carrier vessels listed on the IOTC Record of Authorised Vessel prior to 2015 and listed in Annex V, a national observer programme may be used in place of an observer from the regional observer programme. (…)*

RAYS

IOTC Resolution 19/03: On the conservation of *mobulid* rays caught in association with fisheries in the IOTC area of competence

Paragraph 1: *This Resolution shall apply to all fishing vessels flying the flag of a Contracting Party or Cooperating Non-Contracting Party (hereinafter referred to collectively as CPCs), and on the IOTC record of fishing vessels or authorized to fish for tuna and tuna like species managed by the IOTC.*

Paragraph 2: *CPCs shall prohibit all vessels from intentionally setting any gear type for targeted fishing of mobulid rays in the IOTC Area of Competence, if the animal is sighted prior to commencement of the set.*

[18] Large Scale Tuna Vessel (LSTV) – fishing vessels targeting tuna and tuna like species that are over 24m LoA and are on the IOTC Record of Authorized Vessels.

Paragraph 3: *CPCs shall prohibit all vessels retaining onboard, transhipping, landing, storing, any part or whole carcass of mobulid rays caught in the IOTC Area of Competence.*

Paragraph 5: *CPCs shall require all their fishing vessels, other than those carrying out subsistence fishery, to promptly release alive and unharmed, to the extent practicable, mobulid rays as soon as they are seen in the net, on the hook, or on the deck, and do it in a manner that will result in the least possible harm to the individuals captured. The handling procedures detailed in Annex I, while taking into consideration the safety of the crew shall be implemented and followed.*

Paragraph 6: *Notwithstanding paragraph 3, in the case of mobulid rays that are unintentionally caught by and frozen as part of a purse seine vessel's operation, the vessel must surrender the whole mobulid ray to the responsible governmental authorities, or other competent authority, or discard them at the point of landing. Mobulid rays surrendered in this manner may not be sold or bartered but may be donated for purposes of domestic human consumption.*

Paragraph 8: *CPCs shall report the information and data collected on interactions (i.e. number of discards and releases) with mobulid rays by vessels through logbooks and/or through observer programs. The data shall be provided to the IOTC Secretariat by 30 June of the following year, and according to the timelines specified in Resolution 15/02 (or any subsequent revision).*

Paragraph 9: *CPCs shall ensure that fishermen are aware of and use proper mitigation, identification, handling and releasing techniques and keep on board all necessary equipment for the release of mobulid rays in accordance with the handling guidelines of Annex 1.*

Paragraph 14: *Scientific observers shall be allowed to collect biological samples of mobulid rays caught in the IOTC Area of Competence that are dead at haul-back, provided that the samples are a part of a research project approved by the IOTC Scientific Committee. (…)*

ANNEX 1

Live release handling procedures

1. *Prohibit the gaffing of rays.*
2. *Prohibit the lifting of rays by the gill slits or spiracles.*
3. *Prohibit the punching of holes through the bodies of rays (e.g. to pass a cable through for lifting the ray).*
4. *Rays too large to be lifted safely by hand shall be, to the extent possible, brailed out of the net using best available method such as those recommended in document IOTC-2012-WPEB08-INF07.*
5. *Large rays that cannot be released safely before being landed on deck, shall be returned to the water as soon as possible, preferably utilizing a ramp from the deck connecting to an opening on the side of the boat, or if no such ramp is available, lowered with a sling or net.*

SHARKS

IOTC Resolution 12/09: On the conservation of thresher sharks (family *Alopiidea*) caught in association with fisheries in the IOTC area of competence

Paragraph 2: *Fishing Vessels flying the flag of an IOTC Member or Cooperating Non-Contracting Party (CPCs) are prohibited from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae, with the exception of paragraph 7.*

Paragraph 7: *Scientific observers shall be allowed to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs, skin samples, spiral valves, jaws, whole and skeletonised specimens for taxonomic works and museum collections) from thresher sharks that are dead at haul-back, provided that the samples are part of the research project approved by the IOTC Scientific Committee (or IOTC Working Party on Ecosystems and Bycatch (WPEB)). In order to obtain the approval, a detailed document outlining the purpose of the work, number and type of samples intended to be collected and the spatiotemporal distribution of the sampling work must be included in the proposal. Annual progress of the work and a final report on completion of the project shall be presented to the IOTC WPEB and the IOTC Scientific Committee.*

IOTC Resolution 13/05: On the conservation of whale sharks (*Rhinocodon typus*)

Paragraph 3: *CPCs shall require that, in the event that a whale shark is unintentionally encircled in the purse seine net, the master of the vessel shall:*

a) take all reasonable steps to ensure its safe release, while taking into consideration the safety of the crew. These steps shall follow the best practice guidelines for the safe release and handling of whale sharks developed by the IOTC Scientific Committee;

b) report the incident to the relevant authority of the flag State, with the following information:

i) the number of individuals;

ii) a short description of the interaction, including details of how and why the interaction occurred, if possible;

iii) the location of the encirclement;

iv) the steps taken to ensure safe release;

v) an assessment of the life status of the animal on release, including whether the whale shark was released alive but subsequently died.

Paragraph 7: *CPCs shall report the information and data collected under paragraph 3(b) and paragraph 4 through logbooks, or when an observer is on-board through observer programs, and provide to the IOTC Secretariat by 30 June of the following year and according to the timelines specified in Resolution 10/02 [superseded by Resolution 15/02] (or any subsequent revision).*

IOTC Resolution 13/06: On a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries

Paragraph 4: *CPCs shall require fishing vessels flying their flag and on the IOTC Record of Authorised Vessels or authorised to fish for tuna and tuna-like species managed by the IOTC on the high seas to promptly release unharmed, to the extent practicable, of oceanic whitetip sharks when brought alongside for taking on-board the vessel. However, CPCs should encourage their fishers to release this species if recognised on the line before bringing them on-board the vessels.*

Paragraph 5*. CPCs shall encourage their fishers to record incidental catches as well as live releases of oceanic whitetip sharks. These data shall be kept at the IOTC Secretariat.*

Paragraph 7: *Scientific observers shall be allowed to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs, skin samples, spiral valves, jaws, whole and skeletonised specimens for taxonomic works and museum collections) from oceanic whitetip sharks taken in the IOTC area of competence that are dead at haulback, provided that the samples are a part of a research project approved by the IOTC Scientific Committee (SC)/the IOTC Working Party on Ecosystems and Bycatch (WPEB). In order to obtain the approval, a detailed document outlining the purpose of the work, number of samples intended to be collected and the spatio-temporal distribution of the sampling effect must be included in the proposal. Annual progress of the work and a final report on completion shall be presented to the SC/WPEB.*

IOTC Resolution 17/05: On the conservation of sharks caught in association with fisheries managed by IOTC:

Paragraph 2: *CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks, with the exception of species prohibited by the IOTC. Full utilisation is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.*

Paragraph 3b: *Sharks landed frozen: (…). CPCs that currently do not require fins and carcasses to be offloaded together at the point of first landing shall take the necessary measures to ensure compliance with the 5 % ratio through certification, monitoring by an observer or other appropriate measures.*

Paragraph 4: *In fisheries in which sharks are unwanted species, CPCs shall, to the extent possible, encourage the release of live sharks, especially juveniles and pregnant sharks that are caught incidentally and are not used for food and/or subsistence. CPCs shall require that fishers are aware of and use identification guides (e.g. IOTC Shark and Ray Identification in Indian Ocean Fisheries) and handling practices.*

IOTC Resolution 18/02: On management measures for the conservation of blue shark caught in association with IOTC fisheries

"CPCs shall implement data collection programmes that ensure improved reporting of accurate blue shark catch, effort, size and discard data to IOTC in full accordance with the Resolution 15/02 on the Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs), or any Resolution superseding it."

Seabirds

IOTC Resolution 12/06: On reducing the incidental bycatch of seabirds in longline fisheries

Paragraph 1: *CPCs shall record data on seabird incidental bycatch by species, notably through scientific observers in accordance with Resolution 11/04 and report these annually. Observers shall to the extent possible take photographs of seabirds caught by fishing vessels and transmit them to national seabird experts or to the IOTC Secretariat, for confirmation of identification.*

Turtles

IOTC Resolution 12/04: On the conservation of marine turtles

Paragraph 3: *CPCs shall collect (including through logbooks and observer programs) and provide to the IOTC Secretariat no later than 30 June of the following year in accordance with Resolution 10/02 (or any subsequent revision), all data on their vessels' interactions with marine turtles. The data shall include the level of logbook or observer coverage and an estimation of total mortality of marine turtles incidentally caught in their fisheries.*

Paragraph 6: *CPCs shall require fishermen on vessels targeting species covered by the IOTC Agreement to bring aboard, if practicable, any captured marine turtle that is comatose or inactive as soon as possible and foster its recovery, including aiding in its resuscitation, before safely returning it to the water. CPCs shall ensure that fishermen are aware of and use proper mitigation, identification, handling and de-hooking techniques and keep on board all necessary equipment for the release of marine turtles, in accordance with handling guidelines in the IOTC Marine Turtle Identification Cards.*

Paragraph 7: *CPCs with gillnet vessels that fish for species covered by the IOTC Agreement shall:*

a) Require that operators of such vessels record all incidents involving marine turtles during fishing operations in their logbooks1 and report such incidents to the appropriate authorities of the CPC.

Paragraph 8: *CPCs with longline vessels that fish for species covered by the IOTC Agreement shall:*

a) Ensure that the operators of all longline vessels carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled, and that they do so in accordance with IOTC Guidelines. CPCs shall also ensure that operators of such vessels follow the handling guidelines in the IOTC Marine Turtle Identification Cards;

Paragraph 9: *CPCs with purse seine vessels that fish for species covered by the IOTC Agreement shall:*

a) Ensure that operators of such vessels, while fishing in the IOTC area:

i. To the extent practicable, avoid encirclement of marine turtles, and if a marine turtle is encircled or entangled, take practicable measures to safely release the turtle in accordance with the handling guidelines in the IOTC Marine Turtle Identification Cards;

ii. To the extent practicable, release all marine turtles observed entangled in fish aggregating devices (FADs) or other fishing gear;

iii. *If a marine turtle is entangled in the net, stop net roll as soon as the turtle comes out of the water; disentangle the turtle without injuring it before resuming the net roll; and to the extent practicable, assist the recovery of the turtle before returning it to the water;*

iv. *Carry and employ dip nets, when appropriate, to handle marine turtles.*

CETACEANS

IOTC Resolution 13/04: On the conservation of cetaceans

Paragraph 2: *Contracting Parties and Cooperating Non-Contracting Parties (collectively, CPCs) shall prohibit their flagged vessels from intentionally setting a purse seine net around a cetacean in the IOTC area of competence, if the animal is sighted prior to the commencement of the set.*

Paragraph 3: *CPCs shall require that, in the event that a cetacean is unintentionally encircled in a purse seine net, the master of the vessels shall:*

a) *take all reasonable steps to ensure the safe release of the cetacean, while taking into consideration the safety of the crew. These steps shall include following the best practice guidelines for the safe release and handling of cetaceans developed by the IOTC Scientific Committee;*

b) *report the incident to the relevant authority of the flag State, with the following information:*

   i) *the species (if known);*

   ii) *the number of individuals;*

   iii) *a short description of the interaction, including details of how and why the interaction occurred, if possible;*

   iv) *the location of the encirclement;*

   v) *the steps taken to ensure safe release;*

   vi) *an assessment of the life status of the animal on release, including whether the cetacean was released alive but subsequently died.*

Paragraph 4: *CPCs using other gear types fishing for tuna and tuna-like species associated with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State and include all the information outlined in paragraph 3b(i–vi).*

Paragraph 7: *CPCs shall report the information and data collected under paragraph 3(b) and paragraph 4, through logbooks, or when an observer is on-board through observer programs, and provide to the IOTC Secretariat by 30 June of the following year and according to the timelines specified in Resolution 10/02 (or any subsequent revision).*

MARLINS

IOTC Resolution 18/05: On conservation measures for striped marlin, black marlin and blue marlin

Paragraph 1: *To ensure the conservation of the striped marlin (Tetrapturus audax), black marlin (Makaira indica), blue marlin (Makaira nigricans) and Indo-Pacific sailfish (Istiophorus platypterus) stocks in the Indian Ocean, Contracting Parties and Cooperating non-Contracting Parties, (CPCs) whose vessels catch those species in the IOTC Area of Competence undertake at least the following national management measures as described below are in place to support the sustainable exploitation of these stocks in line with the IOTC Agreement objectives of ensuring the conservation and optimum utilization of stocks by undertaking the following:*

Other Management Measures

Paragraph 5: *Pending advice from the Scientific Committee on a joint and/or a species specific minimum conservation size, notwithstanding Resolution 17/04, CPCs shall not retain on board, trans-ship, land, any specimen smaller than 60 cm Lower Jaw Fork Length (LJFL) of any of the species referred to in paragraph 2, but shall return them immediately to the sea in a manner that maximizes post-release survival potential without compromising the safety of crew[19].*

Paragraph 6: *In addition, CPCs may consider the adoption of additional fisheries management measures to limit fishing mortality such as: releasing any specimen brought alive on-board or alongside for taking on board the vessel; modify fishing practices and/or fishing gears to reduce juveniles catches; adopting spatial/temporal management measures to reduce fishing in nursery grounds; limiting days at sea and/or fishing vessels exploiting billfishes.*

Recording, Reporting, and Use of the Catch Information

Paragraph 7: *CPCs shall ensure that their vessels catching Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish in the IOTC Area of Competence record their catch in accordance with the requirements set out in Resolution 15/01 on the recording of catch and effort data by fishing vessels in the IOTC area of competence or any Resolution superseding it.*

Paragraph 8: *CPCs shall implement data collection programmes to ensure accurate reporting of Striped Marlin, Black Marlin, Blue Marlin and Indo-pacific Sailfish catches, released alive and/or discarded, together with effort, size and discard data to IOTC in full accordance with the Resolution 15/02 on the Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non Contracting Parties (CPCs), or any Resolution superseding it.*

Tuna Discards

[19] Notwithstanding paragraph 5, in the case of billfish, when purse seiners unintentionally catch such small fish and freeze them as a part of a purse seine fishing operation, this does not constitute non-compliance as long as such fish are not sold.

IOTC Resolution 19/05: On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence;

RETENTION OF TARGETED TUNA SPECIES

Paragraph 1: *Contracting Parties and Cooperating Non-Contracting Parties shall require all purse seine vessels to retain on board and then land all bigeye tuna, skipjack tuna, and yellowfin tuna caught, except fish considered unfit for human consumption as defined in paragraph 4b (i).*

RETENTION OF NON-TARGETED SPECIES

Paragraph 2: *Contracting Parties and Cooperating Non-Contracting Parties shall require all purse seine vessels to retain on board and then land, to the extent practicable, the following non-targeted species or species group; other tunas, rainbow runner, dolphinfish, triggerfish, billfish, wahoo, and barracuda, except fish considered unfit for human consumption as defined in paragraph 4b (i), and/or species which are prohibited from retention, consumption, or trade through domestic legislations and international obligations.*

Paragraph 3: *Contracting Parties and Cooperating Non-Contracting Parties using other gear types not provided for in paragraph 1 and 2 of this resolution, which are targeting tuna and tuna like species in the IOTC area of competence should encourage their vessel to:*

a) take all reasonable steps to ensure the safe release of non-targeted species taken alive, to the extent possible, while taking into consideration the safety of the crew;

b) retain on board and then land all dead non-targeted species except those considered unfit for human consumption as defined in paragraph 4b(i) and/or are prohibited from retention through domestic legislations and international obligations.

Paragraph 4: *Procedures for the implementation of full retention requirements include:*

a) No bigeye tuna, skipjack tuna, and/or yellowfin tuna caught by purse seine vessels may be discarded after the point in the set when the net is fully pursed and more than one half of the net has been retrieved. If equipment malfunctions affect the process of pursing and retrieving the net in such a way that this rule cannot be complied with, the crew must make efforts to release the tuna as soon as possible.

b) The following two exceptions to the above rule shall apply:

i) Where it is determined by the captain of the vessel that tuna (bigeye tuna, skipjack tuna or yellowfin tuna) and the non-targeted species as listed in Para 2 caught are unfit for human consumption, the following definitions shall be applied:

- *"unfit for human consumption" are fish that:*
  - *is meshed or crushed in the purse seine; or*
  - *is damaged due to depredation; or*

    - *has died and spoiled in the net where a gear failure has prevented both the normal retrieval of the net and catch, and efforts to release the fish alive;*

- *"unfit for human consumption" does not include fish that:*

    - *is considered undesirable in terms of size, marketability, or species composition; or*

    - *is spoiled or contaminated as the result of an act or omission of the crew of the fishing vessel.*

ii) Where the captain of a vessel determines that tuna (bigeye tuna, skipjack tuna or yellowfin tuna) and the non-targeted species as listed in Para 2 were caught during the final set of a trip and there is insufficient storage capacity to accommodate all tuna (bigeye tuna, skipjack tuna or yellowfin tuna) and the non-targeted species caught in that set. This fish may only be discarded if:

- *the captain and crew attempt to release the tuna (bigeye tuna, skipjack tuna or yellowfin tuna) alive as soon as possible; and*

- *no further fishing is undertaken after the discard until the tuna (bigeye tuna, skipjack tuna, and/or yellowfin tuna) and the non-targeted species on board the vessel has been landed or transhipped.*

NON-RETENTION

Paragraph 5*: Where the captain of the vessel determines that fish should not be retained on board in accordance with Clause 4.b (i) and (ii), the captain shall record the event in the relevant logbook including estimated tonnage.*

OBSERVER PROGRAMS IN FISHERIES MANAGEMENT

Observer Programmes include:

1) Monitoring Control and Surveillance (MCS) that include sea Inspection and control programmes;
2) Fisheries programmes (science and compliance); and
3) Scientific programmes.

There are some fundamental differences in the objective and legislative mandate of each of these programmes that include differences in the role, appointment, training, responsibilities and tasks on-board between compliance officers/inspectors, controllers, fisheries Observers (science and surveillance) and scientific Observers (Figure 7).

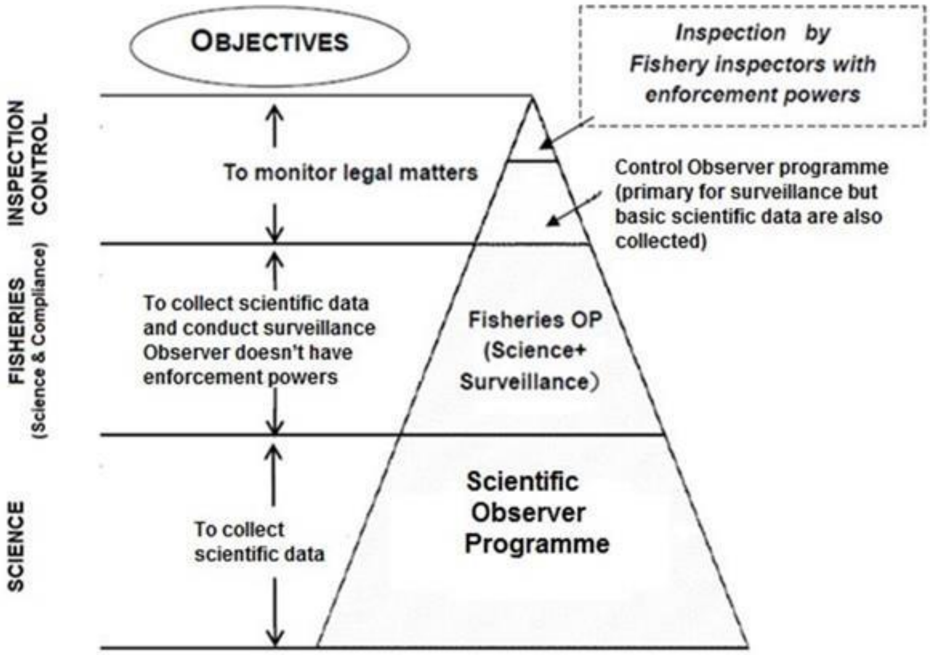


Figure 7 Comparative description of different objectives between scientific and compliance observers.

Sea based inspection and control programmes (MCS)

Sea based inspection and control programmes have a primary objective to enforce fishery governance and to monitor fisheries from a legal aspect. Inspection programmes are restricted to the reporting on adherence to compliance measures stipulated in licence conditions (e.g.: quotas/species limitation, fishing areas, gear size and usage), while Control programmes collect control data and fisheries data (mainly catch and effort information).

Fisheries Inspectors (also called compliance officers) and *controllers* are appointed by the countries fisheries authorities and have a legal mandate to enforce the fisheries laws of the country. Inspectors are also referred to as Fishery Control Officers (FCO) and are not therefore defined as Observers herein. Inspectors have the authority to collect evidence and take legal action against a vessel acting in contravention to fishing methods; gear used or landed catches, in terms of its fishing permit conditions issued to it by its flag state. When justified, inspectors may have the power to arrest a vessel at sea and have it return to port. FCOs may be deployed onto vessels for the duration of the trip to monitor fishing activities directly and report on adherence to compliance measures stipulated in licence conditions issued by the State. Alternatively, Inspectors may operate independently from a patrol vessel and board and inspect fishing vessels at sea or on land. At-sea inspection includes monitoring gear and catch on-board.

Fisheries Controllers are also appointed by the countries fisheries authorities and are generally "sworn in"[20] . They are deployed onto vessels for the duration of the trip to report on adherence to compliance measures stipulated in licence conditions, and also collect fisheries data. *Controllers* generally do not have the power to arrest a vessel at sea and have it return to port.

Fisheries Observer Programmes (science & compliance)

Fisheries Observer programmes have the primary objective to collect fisheries information at sea (mainly catch and effort). Additional tasks often include monitoring and reporting on the environmental impacts of the fishery on other marine fauna such as bycatch, seabird, marine mammals and, Endangered, Threatened and Protected (ETP) species.

Fisheries Observers are generally appointed by the countries' fisheries authorities, but can also be supplied by private Observer Service Providers (OSP). Fisheries Observers do not have any powers to enforce or arrest. While they may report on compliance issues, they have **no legal mandate to enforce these**.

Scientific Observer Programmes

Scientific Observer programmes are restricted to the collection of scientific data required for fisheries management. *Scientific Observers* are generally appointed by research and fisheries management institutes or supplied by independent Observer Service Providers (OSP). A scientific Observer also records catch, bycatch, discards and effort information but in addition, conducts biometric sampling. For example, catch, bycatch, discards composition of species, length-frequency, weight, sex, maturity stage, stomach content and the collection of otoliths and biological samples.

The accuracy of data collected by Scientific Observers is of paramount importance to the success of good fisheries management. Inadequate or falsified data are at the root of poor fisheries management measures and can have a very serious impact on decisions made by scientists on fisheries management.

Thus, falsifying data is much more serious than not recording it.

[20] When someone is sworn in, they make a formal promise to be honest or loyal, in a court of law.

PART B: GENERIC OBSERVER TRAINING

DEFINING "THE OBSERVER"

Scientific (fisheries) observers are independent specialist, deployed on-board commercial fishing vessels in accordance with a mandated regional fisheries observer programme. Within this mandate observers can be used to record unbiased data and report on technical, regulatory, scientific and economic aspects relating to the operational side of the fishing industry. [21]

Scientific observers working on fishing vessels during normal operations are in a position to verify and record accurate, in situ data on the location, catch composition and gear configuration of fishing operations, and are usually the only independent source of this information.

Scientific observers are not employed in an enforcement role, as their main purpose is to collect accurate data to support effective management of the marine resources, which is to the long-term advantage of the fishing industry. However, as this takes place alongside the standard data collection protocols, the presence of the observer on-board inherently allows recording the level of compliance within the fishery.

An individual is only considered an IOTC recognised observer when employed by a service provider approved by the CPC to provide observer services. CPCs will provide a list of observers to the IOTC Secretariat and each observer will be allocated an IOTC registration number that must be included on reported data. This will lead to the development of a regional pool of observers trained according to IOTC standards.

Qualifications and prerequisites

Scientific observers working at sea are in a unique position, as they are not affiliated with the vessels personal and are required to work alone often for long periods, without direct supervision or assistance from their controlling organisation. To be successful in this environment, they required a high level of integrity and personal self-motivation and will need the academic qualifications and training to optimally accomplish the detailed tasks and responsibilities assigned to them.

IOTC minimum pre-requisites for the registration of Observes standards should apply as prerequisites prior to employment and training of observers. These include:

1. Minimum age of 21 years
2. Physically capable of carrying out observer duties attested by a valid Certificate of Medical Fitness (STCW or equivalent) issued by an authorised medical practitioner.
3. Clear police record. History of strong socially acceptable ethical standards in the areas of honesty and public behaviour.
4. Evidence of proficiency in literacy and numeric competency in the languages of the national project (holder of a Secondary School Certificate or equivalent)

[21] As per IOTC ROS Observer Manual (Version 1.2 2015)

5. Valid passport

6. Valid STCW Basic Safety Training Certificate (or equivalent)

7. Certificate of successful completion of a Basic Observer Training Course based on IOTC training guidelines and curriculum.

8. Acceptance of the code of conduct.

CPCs must ensure that their observers are trained and their certificates of fitness and safety & survival training meet the requirements of foreign vessels on which they may be deployed.

Observer duties and required competencies

Scientific Observers are able to accurately verify and record in situ data on the location, composition of catches and configuration of gear during fishing operations. Their role is to collect accurate data for the effective management of marine resources, the aim of which is to ensure the sustainability of the fishing industry. The duties of the Scientific Observer are to:

- ensure their own safety at sea;
- collect information and data needed to complete the observation forms;
    - nature of the fishing operations;
    - catch composition of fish brought onboard;
    - size composition, sex ratio and reproductive status of target species (if requested);
    - by-catch mortality and discard component;
    - general trip details describing the target species, permit holder and areas fished;
    - vessel specifications, fishing and electronic equipment;
    - additional data on oceanography, weather and interactions with seabirds and marine mammals;
    - information on vessel transhipments; and
    - record adherence to MarPol regulations;
- enter observation data into database (if required) to be provided to their responsible authorities, who will forward it to the IOTC Secretariat; and
- writing deployment, weekly, preliminary and final trip reports to be sent to the responsible authorities.

To achieve the broad range of tasks assigned to an observer, Scientific Observers will need to acquired / maintain a standard level of basic competency.

As Scientific Observer competency should be standard throughout the IOTC ROS, independently of the organisation(s) in charge of training and manage CPCs observers. The following list of basic observer competency standards has been approved:

1. Understand the importance of personal physical and mental well-being to safety and morale and of maintaining effective communication and good working relationships on the vessel.

2. Able to comply with emergency procedures and to correctly use different types of life-saving appliances. Demonstrate knowledge of abandon ship procedures and sea survival techniques. Able to operate an EPIRB or equivalent.

3. Capable to identify common health issues experienced onboard and fishing operation risks. Understand the importance of following safe working practices and wearing appropriate protective clothing and equipment as well as of following safety protocols and of being aware of emergency communication procedures.

4. Able to use vessel electronic equipment to fix a vessel position, to calculate vessel estimated position and time of arrival at a given point; and to collect parameters of meteorology and oceanography. Practical knowledge of the Beaufort scale.

5. Capable of using VHF/HF radios and send distress messages.

6. Understand the concept of target species; bycatch species; non-target species, retained catch, discarded catch, overfishing, FAD, associated and free school, improper for human consumption as defined by the IOTC.

7. Have satisfactory knowledge of the IOTC CMMs relevant to scientific observers;

8. Understand observer duties, code of conduct, status and procedures to follow onboard. Aware of the role & importance of the fisheries observer for the monitoring and management of tuna fisheries in the Indian Ocean.

9. Understands common nautical terminology. Recognises industrial tuna fishing vessels basic layout. Familiar with working and observation areas and common fishing operational scenarios for the fisheries in question.

10. Familiar with the species of special interest that interact with industrial tuna fisheries, most common inter-actions and strategies to avoid and mitigate such interactions.

11. Capable of identifying and distinguishing between the main tuna species, in their adult and juvenile forms and to use standard identification guides to identify species of billfish, sharks and other bycatch including marine turtles, seabirds and sea mammals.

12. Able to accurately measure and weight fish and to collect biological samples accordingly to IOTC ROS standard procedures.

13. Aware of IOTC ROS data gathering processes and priorities.

14. Capable of collecting and estimating catch weight, volumes, ratios according to ROS standard procedures. Conscious of the need to check consistency with entries made in the logbook and assist with logbook fulfilment.

15. Capable of collecting, formatting and accurately recording mandatory and recommended information as prescribed under the scheme.

16. Familiar with IOTC trip report data requirements and timelines for submission.

OBSERVER CODE OF CONDUCT

Observers are required to conform to a Code of Conduct approved by the Commission to become certified and should sign an affidavit with their service provider that they understand and will conform to the Code.

Code of conduct

1) Observers may not participate in any activity which would cause a reasonable person to question the impartiality or objectivity with which the Regional Observer Scheme is administered;
    - observers may not have direct financial interest in the observed fishery, other than the provision of observer services including, but not limited to, vessels or shore-side facilities involved in the catching or processing of the products of the fishery, companies selling supplies or services to those vessels or shore-side facilities, or companies purchasing raw or processed products from these vessels or shore-side facilities. the interests of a spouse or minor child are considered those of the observer;
    - observers may not solicit or accept, directly or indirectly, any gratuity, gift, favour, entertainment, loan or anything of monetary value from anyone who conducts activities that are regulated by IOTC, or who has interests that may be substantially affected by the performance or non-performance of the observers' official duties;
    - observers may not solicit or accept employment as a crew member or an employee of the vessel or shore-side processor in any fishery while employed as an observer;
    - observers may not serve as observers on any vessel or at any shore-side facility owned or operated by a person who previously employed the observer in any capacity; and
    - a person may not serve as an observer in a fishery during the 3 consecutive months following the last day of his/her employment as a paid crew member or employee in that fishery.
2) Observers may not participate in any activity which could impair the observer's ability to perform his/her duties. This includes, but is not limited to:
    - engaging in drinking of alcoholic beverages while on duty;
    - engaging in the use or distribution of illegal substances; and
    - becoming physically or emotionally involved with vessel personnel.
3) Observers may not participate in any activity which could adversely affect the efficient accomplishment of the Scheme's mission:
    - observers must refrain from engaging in any illegal actions according to the laws and regulations of the flag State that exercises jurisdiction over the vessel to which the observer is assigned;
    - observers must avoid any behaviour that could adversely affect the confidence of the public in the integrity of observers, the IOTC Regional Observer Scheme or the IOTC;
    - observers must record all scientific data accurately and honestly;
    - if the observer chooses to report any suspected violations of regulations relevant to conservation of marine resources or their environment that they observe, it must be done honestly; and

- observers must preserve the confidentiality of the collected data and observations made on board the fishing vessels, in accordance with Resolution 12/02, and shall treat as confidential all information with respect to the fishing operations of the vessel on which they are deployed.

4 Observer protocol while onboard a vessel include:

- observers shall respect the hierarchy and general rules of behaviour which apply to all vessel personnel, provided such rules do not interfere with the duties of the observer under this scheme;
- in all aspects involving vessel operations and safety at sea the observer will fall under the authority of the captain;
- scientific observers will have no authority to advice or direct any of the vessel operational activities or have any authority over any of the vessel personnel;
- scientific observers should have access to all operational areas of the vessel necessary to complete their work including the bridge, navigation and communication equipment, however, the observer should attempt to secure co-operation with officers to ensure that their work does not interfere with normal fishing and operational activities.

Observer status and conventions

Observer status

The status of the Observer on board the fishing vessels should be the same as that of the officers on-board. Observers should be allowed on the bridge and on the work-bridges so they can conduct the missions they've been allocated. Observer actions should not, however, interrupt or interfere with normal fishing operations and the observer should abide by the rules and pace of work of the vessel.

The attitude and conduct of the observer will have a major influence on both its reception on board the fishing vessel, and the results and value of its work. The master of the fishing vessel and crew will quickly asses you by your actions and conduct. If they see they are dealing with a professional they will both respect you and be more willing to voluntary provide assistance.

Observer must always conduct itself in a courteous, polite and professional manner with all members of the crew. Naturally, the crew and the captain must respect the functions and culture of the Observer, who must inform his superior of any difficulty he may encounter or any unpleasant behaviour to which he might be subjected. Observer must be able to behave correctly in all situations, in particular concerning questions of hierarchy, work and confidentiality, presentation and culture. The Observer must be aware of and sensitive to the cultural practices of crew members.

Observer conventions

The Observer shall respect the following conventions while on-board.

1. Unless specified, Scientific Observers are not employed in an enforcement role and their overall function is to collect information to assist in the efficient management of fisheries

resources. However, the nature of the work and the information collected will inherently include compliance related data. At no stage the Observer should confront the vessel master or any of the crew about any compliance issues or advise them or provide consent to any operation that may have compliance implications.

2. The Observer will have no authority to advise or direct any of the vessels operational activities or have any authority over any of the vessels personnel.
3. The Observer should have access to all operational areas of the vessel necessary to complete their work including the bridge, navigation and communication equipment, however, the observer should attempt to secure co-operation with the officers to ensure that their work does not interfere with the normal fishing and operational activities.
4. The Observer shall treat as confidential all information with respect to the fishing operations of the vessel on which they are deployed. All information collected on-board a vessel must be treated in the strictest confidence. In no case shall he make copies of it or report it to any person other than the master of the boat on which he is embarked and the persons in charge of the data collection program. In particular, the Observer shall not share any information [*especially catch information from other vessels*] and never discuss particulars of other vessels with any of the personal on-board or communicate any information on the position of the vessel or its catches to another vessel or to an observer on board another ship.
5. The Observer shall keep himself, its accommodation and work-place clean and neat at all times:
    a. never wear foul weather or protective clothing on the bridge or in the accommodation. [boots, oil-skins or dirty overalls];
    b. change into clean or appropriate clothing for meals and if you sit at the officers table ask permission before sitting down, [every time] and excuse yourself when leaving;
    c. always be on time for meals and it you cannot make a formal meal time due to your sampling work then advice the galley of this;
    d. keep your accommodation clean and neat at all times and do not leave clothing or any of your personal items lying around as besides this being a safety issue it is not expected of a professional;
    e. keep your work space clean and pack away your computer and papers when you are not working with them;
    f. when sampling, keep your space tidy and if using any bins or gear then wash and stow these securely when you finished; and
    g. never leave any equipment unsecured as lose equipment is quickly damaged and can be a safety hazard to crew and the vessel.
6. The observer should never forget that:
    a. the accuracy of data collected by fishery observers is of paramount importance to the success of good fisheries management;

b. inadequate or falsified data are at the root of poor fisheries management measures and can have a very serious impact on decisions made by scientists on fisheries management; and
c. thus, falsifying data is much more serious than not recording it.

HEALTH, ACCIDENT AND INJURY

Internationally the sea fishing sector is recognised worldwide as the most hazardous industry to work in, accounting for significantly higher rates of fatal and/or serious accidents when compared to other sectors such as agriculture or construction.[22] As such Observers are also exposed to these risks onboard fishing vessels and need to be constantly aware of the dangers around them while working onboard.

Compulsory outsourced STCW training Safety training includes:

- SURVIVAL AT SEA;
- FIRST AID; and
- FIRE FIGHTING

These all emphasise the reactionary procedures to be followed when there is an accident or imminent danger to the crew and vessel. The objective of this section in observer training is to emphasise pre-emptive measures to prevent accidents from occurring in the first place. More importantly is the need to develop a positive and responsible attitude to health and safety when it comes to wearing safety apparel such as a hard hat and personal floatation device (PFD) when working on the upper deck.

It is also important for observers to maintain a high standard of health at all times. Observers must have in-date inoculations for tetanus, typhoid and, in some areas, yellow fever. Carry malaria prophylactics on board in case the vessel docks in a port in the tropics. Observers must be able assist themselves if they get ill or sustain a minor injury while on-board. Each observer should be issued a personal first aid kit to meet these incidents. The observers should initially attempt some self-diagnosis and utilise the remedies available to them.

> Survival and firefighting training provide instruction on how to deal with an emergency. Equally important is ***awareness*** and ***attitude*** towards safe working practices.
>
> *PREVENTATIVE ACTIONS* = TO PREVENT ACCIDENTS FROM HAPPENING IN THE FIRST PLACE

Observers are issued with equipment to maximize their chances of survival in an emergency situation. In most instances these should be provided by the vessel operators. However, due to variable safety standards maintained in different countries, unless it can be positively ascertained

[22] Extract from the Irish Sea Fisheries Board Health and Safety Authority.

that the vessel is fully equipped with all the compulsory survival equipment, it is always advisable for observer controlling authorities to issue observers with the following survival equipment:

- Immersion Suit (a);
- Personal Floatation device (b);
- Personal Emergency Position Indicating Radio Beacon (406 MHz EPIRB with integral GPS navigation receiver) (c);
- Strobe Light (d);
- Signal Mirror (e);
- Personal First Aid Kit; and
- A satellite phone that will allow the observer to make emergency calls is also highly recommended.


a.


b.


c.


d.


e.

Health and Safety when working onboard

The tasks and duties assigned to observers will require them to be either monitoring fishing activities or undertaking biometric sampling from various vantage points both on the upper deck and between decks. These are likely to expose them to a wide range of dangers that include *inter alia:*

- falling overboard
- injury from moving equipment, line haulers, overhead derricks, or winch cables;
- fish or sharks on the deck; and
- other crew working with knives, gaffs or harpoons.

When sampling in a processing area below decks, risks include:

- machinery and moving conveyor belts;
- crew manoeuvring heave crates; and
- open hatches

All these risks are further accentuated from the continuous vessel movement, which can become severe in adverse weather conditions.

Risk Assessment

The first responsibility of the observer would be to do a risk assessment of the areas they will be standing or working. Initially this will be a conscious process, especially when moving to a new vessel, but with time will become almost a unconscious process. However, it is always important to then avoid the risk of complacency and not following a dedicated risk assessment process.

A Risk Assessment is a careful examination of what, in the workplace, could cause harm to people so that preventive measures can be taken. The aim is to reduce the risk of injury and illness associated with work. There are three steps to carrying out a Risk Assessment:

Step 1: Identify the Hazards

The observer must consider all the possible hazards in and around the areas they may have to work

A hazard is anything with the potential to cause harm in terms of human injury or ill health, such as moving machinery, work methods/practices, overhead objects, cables or ropes under tension, or exposure to harm such as live sharks or fish just landed and slippery decks.

Step 2: Assess the Risk – how or what is the likely hood on an injury

The observer must assess what is the likelihood of an injury occurring, the possible severity, and how it may occur.

A risk is the likelihood that somebody will be harmed by the hazard and how serious the harm might be.

Step 3: Put Control Measures in Place

Taking into consideration the observers' tasks, they must consider measures to prevent or reduce a risk to prevent an accident. This process may entail setting up protective barriers against moving fish or machinery or selecting a safer working area. Note wearing safety clothing or a PFD does not necessarily reduce the risk, it may only reduce the danger of injury.

Control measures or controls are the precautions taken to ensure a hazard will not injure someone

Protective Clothing

Observer should be issued with adequate protective clothing and must wear the appropriate gear for working on the upper deck or in the factory deck when the vessel is steaming or engaged in fishing operations. These include:

- Hard Hat ("Industrial Safety Helmet" to European Standard EN397) (a);
- Safety Boots with protective steel toe and ankle guard(b);
- Reflective Jacket (d)
- Protective eyewear (e)
- Working Gloves (f)
- Safety Harness and Safety line (c)

a.

b.

c.

d.

e.

f.

Don't become a statistic

Drowning and hypothermia are the most common causes of work-related death to fishermen

Always wear a Personal Flotation Device or lifejacket and be safe

Health and Injury

Observers must report any accident, no matter how minor or sickness to their controlling authorities immediately. The progress of recovery or continuation of any symptoms must be reported to the Captain and the observers controlling authority with any deterioration of condition or at least every 24 hours.

Common illnesses and injuries are:

- sea sickness;
- diarrhoea and food poisoning;
- flues and colds; and
- cuts, bleeding and aberrations.

Sea Sickness

Observers with prior experience of working at sea will know if they are prone to motion sickness and need to take a supply of motion sickness medication with them.

Sea Sickness occurs when the body, inner ear and eyes all send different signals to the brain. Agitated by this perceptual incongruity the brain responds by releasing stress-related hormones that can lead to a cold perspiration, headaches, dizziness, nausea and vomiting. Seasickness usually occurs in the first 12 to 24 hours after sailing and can also be weather dependant. Should symptoms persist for longer than 24 hours together with vomiting be aware of dehydration and drink sufficient water to replenish lost fluids.

Methods to prevent or alleviate sea sickness include:

- avoiding alcohol and fatty and spicy foods and try eating dry crackers or plain toast or cereals;
- drink plain bottled water or natural low acid juices with a low sugar content and avoid citrus juices, milk and coffee;
- avoid confined spaces and stay in fresh air and breathe deeply;
- focus on the horizon as it helps to stabilize the visual conflict in your brain;
- stay busy and keep your mind occupied.

Colds and Flues

Colds and flues often occur within a week or so after sailing. New crew joining the vessel after being flown in from other parts of the world and although not showing symptoms can carry infectious bacteria or viruses against which other persons on-board have no resistance. Although uncomfortable the symptoms of a cold or flu can be overcome within a few days without having to resort to antibiotics. Although observers are issued with a personal first aid kit they are also encouraged to take extra flu remedies, pain pills and vitamin supplements. Should flu symptoms persist there is always the danger of developing pneumonia and observers are cautioned to report immediately if they are not showing any signs of recovering from flu symptoms and continue coughing.

Diarrhoea and food poisoning

Diarrhoea is an abnormal increase in the frequency and liquidity of the stools and can be caused by a virus or bacteria or from food poisoning. Symptoms can be acute lasting for only one or two days or chronic lasting for a week or more. These symptoms are not uncommon, but if they persist for more than 24 hours specific diagnosis and treatment may be required. In this event it is important to report your condition to both the Captain of the vessel and your controlling agency. Warning signs where medical assistance will be necessary are:

- if symptoms persist for longer than a week;
- blood, pus or yellow mucus appears in the stools;
- inability to dink or hold down water due to vomiting; and
- advent of dehydration which symptoms include excreting small amounts of dark urine, dry mucus membranes and drowsiness and the skin also starts to lose its elasticity.

Diarrhoea can be treated by:

- medications are available and a supply of “Imodium” tablets should be added to your first aid kit;
- drinking extra fluids with small amounts of salt and sugar added to replace lost salts;
- maintain a high standard of hygiene; and
- try to eat normally as soon as you feel better and your appetite returns.

Accidents

Always get medical attention, no matter how small the injury. Observers should be able to assist themselves for small injuries using their own first aid kit however, be aware of the possibility of infection. All wounds should be thoroughly and regularly cleaned with an antiseptic solution (or with soap and water) and dressed with clean plasters or bandages to prevent infection. All accidents and or injuries must immediately be reported to the Captain and the observer-controlling agency. In the event of a serious injury or when injuries fail to respond to early treatment it is important to communicate all the details to the captain and your controlling agency.

In extreme situations of illness or injury it may be necessary to arrange for the evacuation of the observer to the nearest port or onto a suitable vessel returning to Port. In these situations, the necessary logistics will be taken over by the controlling agency ashore.

Fatigue

Lack of sleep can be extremely dangerous and cause serious problems for an observer. Fatigue can result in poor decisions and slow reactions that greatly increase the risk of accidents and or injury. The only solution is to attempt to sleep uninterrupted for between six to twelve hours.

To prevent fatigue, it is suggested that observers plan their work schedules to be able to sleep uninterrupted for at least one four to six-hour period out of every 24 hours.

Other health risks that observers should be aware of are: prolonged exposure to sunlight (sunburn); hypothermia (working in refrigerated holds); and noise

How can I Tell if I'm Suffering with Fatigue? Here are a few questions to ask yourself:

Alertness/Sleepiness

- Do I feel tired and/or yawn all the time?
- Do I fall asleep for small amounts of time?
- Do I work on automatic and without thinking?
- Am I having difficulty concentrating?
- Am I forgetting to do things more and more?
- Am I finding it increasingly difficult to perform more than one task at once?

Mood

- Do I feel stressed?
- Am I more irritable than usual?
- Am I easily frustrated by tasks?
- Do I feel that I just can't be bothered?
- Do I feel that I just don't want to cooperate with others?

Remember though that people are poor judges of their own level of fatigue.

Personal Hygiene (Customs onboard vessels)

Observers are expected to be aware of their own personal hygiene on-board vessels. Adequate washing and shower facilities are expected to be available on all vessels. In tropical conditions it may be necessary to change your clothes daily. Enquire as to the washing and drying facilities on-board and make use of these. Washing clothes and hanging them out to dry in your cabin is not hygienic. Washing and hanging clothes up in the showers or bathrooms may also be offensive to others.

PART C: NAVIGATION, WEATHER AND ELECTRONICS

BASIC NOTIONS ON NAVIGATION, NAVIGATION EQUIPMENT AND ELECTRONIC FISHING AIDS

Most of the information collected by observers requires the geographical position where it was recorded. Observers, therefore, need to know where to get this information and have a clear understanding of how positions are determined, the format in which they are recorded and be sure that recorded positions are correct (verified). In addition, observers record the use of electronic aids used in finding fish that can affect the effort used to locate and catch fish.

This section provides a brief description of the range of electronic navigation systems that are all or partly found on a vessel. It is important for the observer to recognise the electronic navigation equipment and understand their function. However, it is advised that at no stage should an observer ever attempt to personally operate any of the vessels equipment and always solicit one of the vessels officers to assist if they require information from any of the equipment.

Navigation and positioning

Recording accurate positions are an essential component to support sampling data collected at sea. To understand what a position is and how to record it an observer requires some basic understanding of the practical elements of navigation. The requirements to achieve this standard include:

- a knowledge of the standard units of measurements for length and speed for both the metric and imperial units;
- be able to understand and view the division of the earth's sphere into coordinates of latitude and longitude measured in degrees; and
- the basic mathematical theory relating to working with circles and angles and measurements in degrees and minutes.

STANDARD UNITS OF MEASUREMENTS

Determining and recording geographic positions and catch, effort and sampling requires an understanding of units of measurement and their abbreviated symbols.

Symbols

- Millimetres = mm
- Centimetres = cm
- Meter = m
- Kilometres = km
- Kilometres per hour = km / h
- Inches = in
- Feet = ft
- Fathom = fm
- Nautical miles = Nm
- Nautical miles per hour = knot
- Grams = g
- Kilograms = kg
- Tonnes = t
- Hours = h

Length Units and Conversion Factors

- 1 centimetre = 10 millimetres
  1cm = 10mm
- 1 meter = 100 centimetres
  1m = 100cm
- 1 kilometre = 1000 metres
  1km = 1000m
- 1 nautical mile = 1852m = 1,852km
  1mn = 1852m = 1.852km

Weight Units

- Thousand grams = One kilogram
  1000g = 1 Kg
- Thousand kilograms = One tonne (metric)
  1000 Kg = 1 t

Speed Units

- Knot = Nautical mile per hour
  Nm/h
- Kilometre per hour
  km/h

Circles & Angles

A circle is a line equidistant from a fixed central point. The centre point is the centre of the circle. When two straight lines are drawn from the centre to the outside, they form an angle and its size is measured in degrees from 0 ° to 360 ° Note:

- a circle is divided into 360 degrees (°);
- one degree is divided into 60 minutes ('); and
- one minute is divided into 60 seconds (").

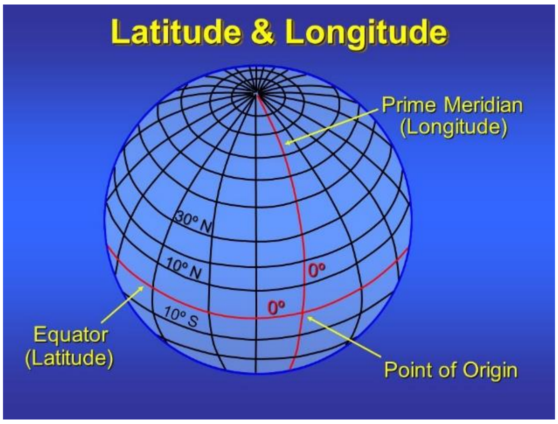
Position Latitude and Longitude

The earth has the shape of a sphere (ball) which revolves around a central axis through the *North* and *South Poles*. The earth rotates around its axis once every 24 hours in relation to the sun.

Any position, anywhere on the earth's surface, can be referenced in degrees of Latitude and Longitude.

Principals that must be understood are:

- the axis of rotation of the earth passing through the North and South Poles;
- the *equator* is a line around the earth exactly half way between the North and South poles, which divide the earth into a northern and southern hemisphere;
- *parallels* are circles parallel to the equator and perpendicular to the line of the Poles;
- *meridians* are half circles passing through the poles and perpendicular to the equator; and

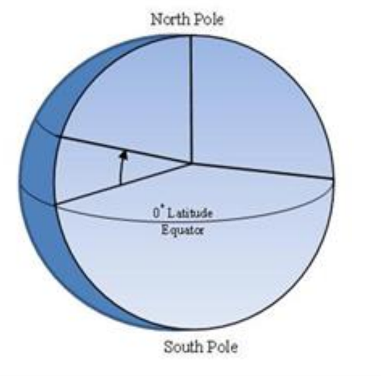


- *the prime meridian,* also called *Greenwich meridian or meridian zero*: serves as a reference to locate the other meridians. It passes through Greenwich (London Observatory).

Latitude

The Equator (0° Latitude) is exactly halfway between the North and South poles, dividing the earth into two equal halves, the Northern Hemisphere and the Southern Hemisphere.

The lines of latitude on the earth's surface are circles parallel to the equator and are used to record a position north or south of the equator. *On a chart the lines of latitude are the imaginary horizontal lines shown running east-to-west.*



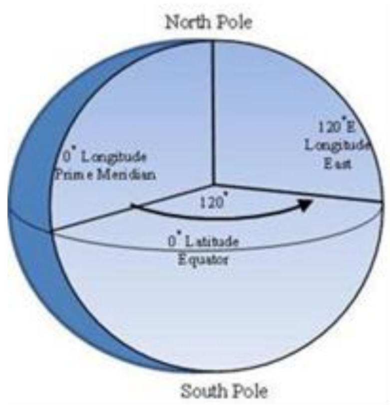
The measurement of latitude is an angle measured in degrees ranging from 0° at the equator (low latitude) to 90° (high latitude) at the north and south poles.

The poles are 90° from the plane of the equator and maximum latitude that can be recorded

Longitude

Longitude-meridians, are lines that run north to south from pole to pole. All lines of longitude cross at the poles. In navigation lines of longitude record a position east or west from the prime meridian. On a chart the lines of longitude are the imaginary vertical lines shown running north to south.

The prime meridian (Greenwich Meridian), is the line of longitude that passes through the Royal Observatory, Greenwich, in England, has been internationally chosen as the 0o Longitude.



Longitude can be measured East (E) or West (W) of the prime meridian (0° Longitude) to a maximum of 180° longitude. The 180° longitude is also called the International date line. The Greenwich Meridian and 180° line of longitude divides the earth into an Eastern and Western half.

(0° to180° East and 0° to 180° West =360° covering the full circumference of the earth's surface.)

Remember latitude and longitude are measured in degrees and minutes (and points of minutes). For example: 40° 21.52' N (latitude) 050° 30.37' W (Longitude)

Navigation Charts

A navigation chart shows a small part of the earth's surface. All charts are orientated so that the top of the chart points towards the North. Lines of latitude and longitude are straight lines, with lines of latitude running horizontal across the chart and lines of longitude running vertical up and down. Lines of latitude and longitude are therefore perpendicular (90°) to each other.

The units of Latitude (degrees) are shown on the sides of the chart with the Latitude *increasing* towards the poles.

Units of Longitude (degrees) are shown along the top and bottom of a chart with the angle increasing from the East to West (towards the right) in the Indian Ocean region.

Determining the scale of a chart and using chart graduations

The scale of a chart is indicated under the chart heading. It is given in the form of a fraction whose numerator is 1. In the example opposite the scale of the map is 1: 375 000, that is to say that 1 cm on the map represents 375 000 cm or 3750 m on the earth.

To record a position on a chart (e.g.: 19°00'S; 035°00'E)

- For latitude; draw a line across horizontally from the 19º S latitude graduation on the side of the chart.
- For longitude draw a vertical line from the 035°00'E graduation on the top of the chart.

The position (19°00'S; 035°00'E) is at the intersection of the two lines.

Some navigation terms

Course

A line drawn between two positions plotted on a chart will be the course from the start position to the end position. The course of a vessel is the direction towards which it is steering on the compass. A course is referenced in the three-figure notation from 000 to 360 and is read off the compass rose that is marked on the chart.

Distance

In nautical terms distance is measured in "nautical miles" (nm) and speed in "nautical miles per hour" (knots). One nautical mile equals 1.852 kilometres.

By definition one (1) nautical mile is equal to one (1) minute of latitude and can be measured using the latitude scale on the side of the chart. However, it is important to note that due to the projection (Mercator projection) of a standard chart, distance cannot be measured from the longitude scale.

Speed

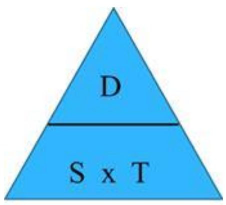
A vessels speed is measured in ***knot***s: *Nautical Miles per Hour.*

One Knot = One Nautical Miles per Hour (One nautical Mile equals 1.852 Kilometres)

Speed times Distance

The distance covered by a vessel, its speed or the time that it will take to travel from one position to another, can be calculated from **(speed time distance)** equations.

If		Then
Speed	**S**	Speed S = D / T nautical miles per hour (knots)
Time	**T**	Time T = D / S Time in hours and /or/ minutes (hr:min)
Distance	**D**	Distance D = S x T Nautical miles (nm)



If you have information of any two of these factors you can calculate the third factor.

For example: if you have the distance travelled and the time it took to cover that distance you can calculate your speed.

It takes you 5 hours to travel 100 nm. What was your speed?

Speed	=	Distance/Time
	=	100 km / 5 hours
	=	20 nm/hr (knots)

It is unlikely that for observers to be involved in exact navigation calculations. However, in their verification of vessel recorded information, if the difference in coordinates of two positions compared to the times recorded indicates that the vessel had to travel at impossible speeds then it would need to be questioned.

For example; a purse-seiner shoots its net in a position 14º 20' S and 080º 40E at 1800 and 6-hours later makes a second set in a position 18º 00 S and 081º 00'E at 2400.

The difference in latitude between the two positions is 3º 40' which is approximately 220 nautical miles. To cover this distance in six hours the vessel would have travelled at over 36 knots. Is this possible?

Time and Time Zones

UTC / GMT

Greenwich Mean Time (GMT) is the mean solar time at the Royal Observatory in Greenwich, London. GMT was formerly used as the international civil time standard, now superseded in that function by Coordinated Universal Time (UTC), defined by a whole number of hours (UTC−12 to UTC+14).

The IOTC now requires that all times recorded on data forms or in the electronic database must be UTC time. The best method to make sure you using the correct UTC time is to always wear, while on-board, a watch synchronized with the UTC time.

Standard time

Standard time is the synchronization of clocks within a geographical area or region to a single time standard.

The world is divided up into 24 time zones. A time zone is a specific number of whole hours from UTC. These time zones are either 0 to 12 hours ahead of Greenwich or 0 to 12 hours behind Greenwich.

A time zone is basically 15o of longitude that is equal to 1 hour of the suns passage around the earth. The rotation of the earth relative to the sun determines time zones. This comes down to the earth rotating 1° in 4-min and 15°- in one hour. However, to accommodate the varying East West dimensions of different countries the "standard time" of a country can exceed 15o of longitude.

Ships time

On some vessels all the times recorded of fishing events relate to the zone time of their flag State or company headquarters.

When inspecting logbooks and fishing event times, check or query the time zone that the vessel is working in and if the vessel changed time zones. This would have to be taken into account when comparing fishing times at different positions.

Local time

Local time is also determined by the rotation of the earth and is based on the sun passing your meridian exactly at 1200 (midday) also called "Sundial Noon".

Local time and the difference between local and ships time can have implications on some of the seabird mitigation measures with respect to line setting operations

Time and Mitigation

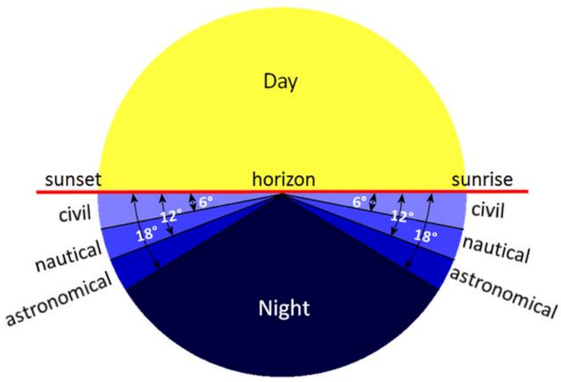
In some fisheries there are seabird mitigation requirements that require the vessel to only set lines at night. Normally stipulated between "*Nautical Dusk and Nautical Dawn*" There are therefore three more terms to learn:

- sunset and sunrise
- civil twilight;
- nautical twilight; and
- astronomical twilight.

Sunrise is the time in the morning when the first part of the sun appears above the horizon.

Sunset is the time in the evening when last part of the sun disappears below the horizon.

Civil Twilight at dawn (in the morning) starts when the sun's disk is 6 degrees below the horizon and ends at sunrise. At dusk (In evening) civil twilight starts when the sun sets and ends when the sun is 6 degrees below the horizon



Nautical Twilight at dawn starts when the sun is 12 degrees below the horizon and ends when the sun is 6 degrees below the horizon. In the evening nautical twilight starts when the sun is 6 degrees below the horizon and ends when the sun is 12 degrees below the horizon.

Astronomical Twilight at dawn starts when the sun is 18 degrees below the horizon, and ends when the sun is 12 degrees below the horizon. In the evening it starts when the sun is 12 degrees below the horizon and ends when the sun is 18 degrees below the horizon.

To comply with a measure that stipulates line setting may only take place between nautical dusk and nautical dawn would therefore mean that the sun must be more than 12 degrees below the horizon before start of setting in the evening or that the setting operation must be completed before the sun is 12 degrees below the horizon be completed before nautical dawn in the morning. However, as this is determined by the suns position it is based on *local time* (i.e. with reference to the suns position to the longitude of the vessel), which may differ significantly from the time the vessel is working on.

There are various means to determine the actual ship time for nautical dawn and dusk. A simple calculation using the vessels exact longitude position can be used to determining the time difference from the ships time or zone time.

To determine ship time for Nautical Dawn and Dusk

The time for nautical dawn and dusk together with sunrise and sun set times are displayed in the nautical almanac, in *local time* units for a specific date and latitude, anywhere in the world. Unless a vessel is working on local time, *which is highly unlikely*, these times need to be converted to the zone time used by the vessel. [*All vessels should have onboard a nautical almanac*].

Basic theory: The earth rotates 360 degrees (of Longitude) in 24 hours, 15 degrees in 1 hour or 1 degree in 4 minutes.

If you take your ***longitude*** for any position on the earths it can be converted to time ahead or behind Greenwich in minutes for up to a maximum of 180 degrees or 720 minutes (12 hours). By either adding or subtracting this time from the local time extracted from the nautical almanac you would, in theory, have converted the local time to GMT. To convert from GMT to the standard time used by the vessel you must add or subtract the whole number of hours to get back to the ships time used by the vessel.

For example: Position: On 1 October 2019 you are fishing in position 35° South and 40° East.

- *Local Time Nautical Dusk* The local time for Nautical dusk from the almanac is **18:32**
- *Convert your Longitude to Time* 40° x 4min of time = 160 minutes (2 hours 40 minutes (02:40)
- *Convert local time to Greenwich time*: Your position is East: so, you are ahead of Greenwich so you must subtract to get to GMT

  18:32 – 02:40 = 15:52

The vessel is working on South African Standard time that is GMT +2: therefore, the time of Nautical Dusk on the ships clock will be:

15:52 + 02:00 = 17:52

Note this is 40 minutes earlier than the time given in the nautical almanac, which for an impatient shipper is a long time.

Bridge and Electronic Navigation Systems

Essentially all information collected by observers requires the geographical position where it was recorded. Observers, therefore, need to know where to get this information and have a clear understanding of the format in which they are recorded and be sure they are correct. In addition, observers record the use of electronic aids used in finding fish that can affect the effort used to locate and catch fish.

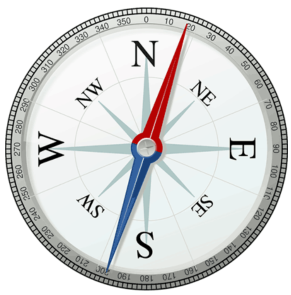
This section provides a brief description of the range of electronic navigation systems that are all or partly found on a vessel. It is important for the observer to recognise the electronic navigation equipment and understand their function. However, it is advised that at no stage should an observer ever attempt to personally operate any of the vessels equipment and always solicit one of the vessels officers to assist if they require information from any of the equipment.

Learning Objectives

To understand how a position is determined an observer requires a basic understanding of the practical elements of navigation. The requirements to achieve this standard include:

- Identify the functions of, and principal information provided by: GPS; chart plotter; gyro compass; magnetic compass;
- Understands the dangers associated with misinterpreting information obtained from navigational aids.

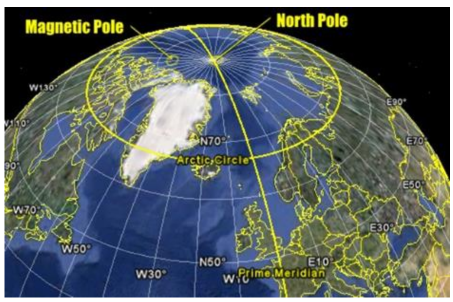
Compass and Direction



The compass gives a basic value for the direction of the magnetic or the real north. The compass is graduated in degrees from 0 to 360, (0 ° and 360 ° constitute the same point), and is also divided into cardinal points, North, South, East, West, SE SW NW NE.

- North (N) = 000°
- East (E) = 090°
- South (S) = 180°
- West (W) = 270°
- Northeast (NE) = 045°
- Northwest (NW) = 315°
- Southeast (SE) = 135°
- Southwest (SW) = 225°

Observers must cross-reference the information of these two systems according to the data to be described. For greater clarity, when referring to a vessels' heading, the three-digit degree notation is used. However, wind direction of the sea is often referred using the cardinal system except when entering the direction into an electronic data base.



Remember, there are two main types of compasses, electronic compass and magnetic compass.

An electronic compass relies on a powers supply and is set to always indicate True North which is the point through which the earths axes passes. Most vessels electronic navigation equipment, are integrated to an electronic compass and reference true north.

A magnetic compass is dependent on the earth's magnetic field, and will point to the Magnetic North. To some extent the magnetic fields of the vessel and equipment surrounding a magnetic compass also affect the direction shown by a magnetic compass.

Global Positioning System (GPS)

Satellites in orbit around the earth are used to determine exact positions on the surface of the earth using the Global Positioning System (GPS).

Note: GPS units record the positions in degrees, minutes and tenths of minutes. The tenths of a minute can be converted to seconds by multiplying by 60. Otherwise, the seconds can be converted into tenths of a minute by dividing them by 60.

<u>*For example*</u>

- *30 '' = 30/60 = 0.500 of one minute*
- *20 "= 20/60 = 0.333 of one minute*
- *50 "= 50/60 = 0.833 of one minute*

GPS Plotter

A GPS chart plotter is an electronic chart. The position of the ship is shown on the map and moves as the ship navigates from one point to another. In addition, a (+) cursor on the map can be moved on the map to display the Latitude and Longitude of a selected point or a plotted position. Note that it is then the position of the cursor that is displayed on the screen, and NOT THE POSITION OF THE VESSEL.

A common source of errors recorded in positions occur when an observer records a position from a plotter and has not verified if it is the vessels position or a plotted position.

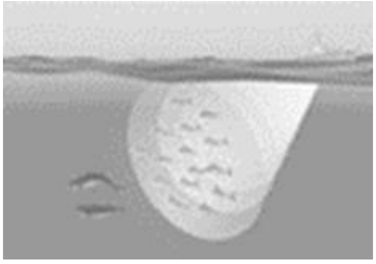
Note: If the decimals do not change and the ship is moving, you are probably looking at the cursor position.

Echosonder

Transducer located beneath the hull transmits a sound wave downwards which is reflected on the bottom (echo) to return to the hull and indicate the depth of water. The sound waves are reflected also from fish and can help the captain to spot the schools of fish. The depth on an echo sounder can be measured either in meters (m) or fathoms (fm) and it is very important to note in which units the depth is recorded.
Remember: 1 fathoms = 1.83 m

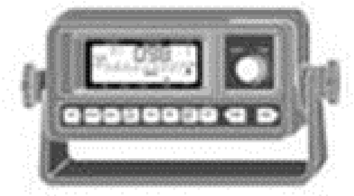
Sonar

Sonar [similar to an echo-sounder] uses sound waves that are directed horizontally from the boat to detect shoals of fish around the vessel. The sonar direction can be controlled to detect shoals of fish relative to the vessel and by angling the sonar beam up and down the depth of the shoal can be determined.



Auto Pilot

The auto pilot is used to steer the vessel on a specified course. The auto pilot electronically reads the compass or direction from a GPS and controls the steering mechanism that controls the rudder.



Radar

Radar sends out and receives radio waves horizontally from the vessel. When the radio waves reflect off objects the reflection is shown on the radar screen. These can show the real-time position of objects around a vessel in darkness of in fog when they cannot normally be seen visually

BASICS OF RADIO AND SATELLITE COMMUNICATIONS

For observers to be able to communication is an essential tool required in modern day observer programs having several vital functions:

- health and safety;
- observer well-being;
- operational requirements; and
- emergency situations.

Observers work alone at sea without direct supervision or support from their controlling agencies. Reliable communication allows the controlling agency to monitor the wellbeing of the observer and at the same time keep up to date on their work. Similarly, the observer can report back to their controlling agency if they have any personal or safety issues onboard and request guidance in achieving their tasks.

Clearly the prime function of communication is to be able to send out a distress signal in the event of an emergency that threatens the vessel and lives of personal onboard.

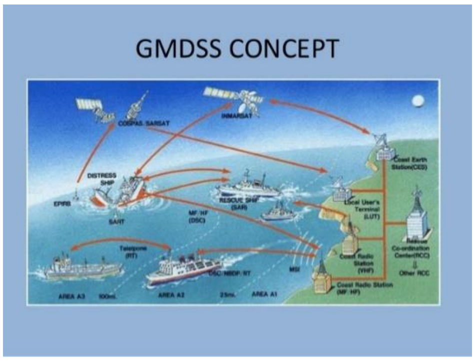
The Global Maritime Distress and Safety System (GMDSS)

The Global Maritime Distress and Safety System (GMDSS) is the technical, operational and administrative structure for maritime distress and safety communications worldwide. It was established in 1988 by the International Maritime Organization (IMO) which adopted a revised text of Chapter IV of the International Convention for the Safety of Life at Sea, 1974, (SOLAS) - dealing with Radiocommunications - and was implemented globally between 1992 and 1997.

The GMDSS establishes the radiocommunications equipment that all vessels from counties aligned to the United Nations and IMO are required to carry, how this equipment shall be maintained and how it is used, and provides the context within which governments should establish the appropriate shore-based facilities to support GMDSS communications.
GMDSS is therefore an international system which uses improved terrestrial and satellite technology and ship-board radio systems. It ensures rapid alerting of shore-based rescue and communications authorities in the event of an emergency.
From 1st February 1999 all commercial vessels over 300 tonnes and fishing vessels operating on the High Seas are required to comply with international GMDSS standards.

The main components for GMDSS are:

- EPIRBs Emergency Position-Indicating Radio Beacon - 406 MHz;
- NAVTEX an international, automated system for instantly distributing maritime navigational warnings, weather forecasts and warnings, search and rescue notices and similar information to ships;
- Inmarsat Inmarsat Satellite systems operated by the Inmarsat, overseen by IMSO, International Mobile Satellite Organization are important elements of the GMDSS. The types of Inmarsat ship earth station terminals recognized by the GMDSS are: Inmarsat B, C and F77;
- HF Radio The GMDSS includes High Frequency (HF) radiotelephone and radio telex (narrow-band direct printing) equipment, with calls initiated by digital selective calling (DSC). Worldwide broadcasts of maritime safety information are also made on HF narrow-band direct printing channels;
- SART These devices may be either a radar-SART (Search and Rescue Transponder), or an AIS-SART (AIS Search and Rescue Transmitter) are used to locate survival craft or distressed vessels by creating a series of dots on a rescuing ship's 3 cm radar display; and
- DSC The IMO also introduced Digital Selective Calling (DSC) on MF, HF and VHF maritime radios as part of the GMDSS system. Each DSC-equipped ship, shore station and group is assigned a unique 9-digit Maritime Mobile Service Identity.



GMDSS sea areas have been defined to describe areas where GMDSS services are available, and to define what GMDSS ships must carry. Prior to the GMDSS, the number and type of radio safety equipment ships had to carry depended upon its tonnage. With GMDSS, the number and type of radio safety equipment ships have to carry depend upon the areas in which they operate. The maritime authorities of a vessel’s Flag State define the GMDSS sea areas applicable to their vessels.

Sea Area A1: An area within the radiotelephone coverage of at least one VHF coast station in which continuous digital selective calling (ch70) alerting and radiotelephony services are available. Such an area could extend typically 30 to 50 Nautical miles from the Coast Station.

Sea Area A2: An area, excluding Sea Area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC (2187.5 kHz) alerting and radiotelephony services are available. For planning purpose this area typically extends to up to 150 nautical miles offshore, but would exclude any A1 designated areas. In practice, satisfactory coverage may often be achieved out to around 400 Nautical miles offshore.

Sea Area A3: An area, excluding sea areas A1 and A2, within the coverage of an INMARSAT geostationary satellite in which continuous alerting is available. This area lies between about latitude 76 Degree NORTH and SOUTH, but excludes A1 and/or A2 designated areas.

Sea Area A4: An area outside sea area A1, A2 and A3 is called Sea Area A4. This is essentially the POLAR Region, NORTH and SOUTH of about 76 Degree of Latitude, but excludes any other areas.

GMDSS Communication Equipment and Use

Radio VHF

Radio HF

As part of their GMDSS requirements the vessel will be fitted with several types of radios that transmit at different frequencies. Two main types of radios are used:

1. VHF (Very High Frequency) has limited range used for local communications up to approximately 25 miles; and

2. MF & HF (Medium & High Frequency) for communication over longer distances over 1000 miles.

Fleet 77, satellite telephone

NAVTEX, Marine Safety Information Receipt, including Meteorological Bulletins

MF / HF transmitter for radio communications from 2 to 25 MHz

VHF DSC transmitter-receiver metric wave (range: about 20 miles)

Inmarsat B: Satellite communication telephone,

Inmarsat C: Telex satellite communication,

telex, Email

Email and fax transmission

Emergency Position Indicating Radio Beacon (EPIRB)

The EPIRB are managed by the COSPAS-SARSAT satellite system. This system operates offshore and over the entire surface of the globe. They transmit, via satellite, a distress alert to ground stations connected to control and mission centres that validate and distribute alert data to competent rescue centres.

They exist in two versions:

- A handheld Personal Locator Beacon (PLB): portable, with manual start

- Emergency position-indicating radio beacon stations (EPIRS): housed in a container with a hydrostatic width, which can be switched on manually or automatically.

Emergency Communication

On-board foreign flagged vessels the chances are that in an emergency situation your knowledge of English or local conditions may put you in the situation where you will be the most qualified to send off a distress message or communicate with rescue vessels. It is therefore important that you familiarize yourself with the Global Maritime Distress Safety Systems (GMDSS) equipment. Take specific note of where the radios are situated and how to operate them. The emergency frequencies that must be remembered are:

- VHF Channel 16;
- SSB High Frequency 2182.0 kHz; and
- SSB Medium Frequency 4125.0 kHz

Inmarsat Terminals have a "single press" distress button that must be held down for 7 seconds to send out an automatic distress signal.

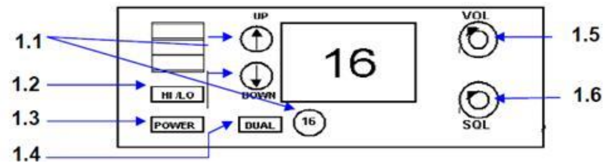
Note listening times or silent periods on distress frequencies specifically to allow for the maximum opportunity of a MAYDAY being picked up by a listening vessel.

Also keep in mind that as a listening vessel a distress call received on VHF or HF may mean that due to the limited range of these frequencies you are the closest vessel to the vessel in distress and as such are obliged to respond.

PRACTICAL USE

The Observer shall not use radiotelephony or make adjustments without the permission of an officer of the ship, but the Observer should understand the practical use of the equipment, follow the communication procedures, and if necessary ensure the transmission and reception of messages relating to the safeguarding of human life at sea (in the event that no other person can do so).

VHF CONTROLS



1.1 Selection and control of channels. This can be a rotary knob, "Up" and "Down" keys or keys

.

1.2 Output power control. A button, usually called "Hi / Lo" (High / Low).

16 A button or key with marker 16 for direct access to channel 16.

1.3 Connection. A "ON / OFF" button (POWER) is used to activate and deactivate the device.

1.4 Dual standby devices and controls. A button called "DUAL" or "DW" (DualWatch) makes it possible to watch over the distress channel while being positioned on another chosen channel.

1.5 Volume control. A generally rotary knob adjusts the BF reception level (volume).

1.6 Squelch control. Device for adjusting the sensitivity of reception of the VHF. It forces the receiver to be silent when it receives no signal.

1.7 Alternating control. The handset connected to the fixed telephone has a PTT (Push To Talk) key that allows you to alternate send and receive. While holding down this key, the machine is in the transmit mode and it is possible to talk; By releasing this button, the unit is in the receiving mode and it is possible to listen.

How to adjust:

- move to the channel 16
- set the squelch to a minimum: high blast noise
- gently resume the adjustment in reverse order until complete silence
- turn back slightly
- when the loudspeaker emits only a "cloc" from time to time, the setting is perfect
- keep watch on channel 16
- respond to communications (no distress) on other paths
- ***To facilitate the reception of messages relating to the safeguarding of human life at sea (SVH), emissions on the international call and distress frequency (channel 16) shall be reduced to a minimum.***

Communication procedures

Use of the International Phonetic Alphabet

The International Phonetic Alphabet makes it possible to reinforce the understanding of words (name of ship, indicative, abbreviation) transmitted by radiotelephony. One spells out words or

numbers by matching each letter to an agreed word whose first letter is the same as that of the word to be spelled.
Example: the word "MARTIN" will be spelled "MIKE, ALFA, ROMEO, TANGO, INDIA, NOVEMBER".

Table 1 - Table of spelling of the International Phonetic Alphabet

	code	en API	intuitivement
A	alpha	[ˈælfɑ]	alfâ
B	bravo	[brɑˈvo]	brâvô
C	charie	[ˈʧɑli]	chârli
D	delta	[ˈdɛltɑ]	dèltâ
E	echo	[ˈɛko]	èkô
F	foxtrot	[ˈfɔkstrɔt]	foxtrot
G	golf	[gɔlf]	golf
H	hotel	[hoˈtɛl]	hôtèl
I	india	[ˈɪndi.ɑ]	inndïâ
J	juliett	[dʒuliˈɛt]	djulïèt
K	kilo	[ˈkilo]	kilô
L	lima	[ˈlimɑ]	limâ
M	mike	[mɑjk]	maïk
N	november	[noˈvɛmbə]	nôvemmb
O	oscar	[ˈɔsk]	oscâ
P	papa	[pəˈpɑ]	pepâ
Q	quebec	[kɛˈbɛk]	kèbèk
R	romeo	[ˈromi.o]	rômïô
S	sierra	[siˈɛrɑ]	sïèrâ
T	tango	[ˈtaŋgo]	tanngô

	code	en API	intuitiveme
U	uniform	[ˈjunɪfɔm]	younifom
V	victor	[ˈvɪktɑ]	vitâ
W	whiskey	[ˈwɪski]	ouiski
X	x-ray	[ɛksˈre]	èksré
Y	yakee	[ˈjaŋki]	yannki
Z	zulu	[ˈzulu]	Zoulou
0	zero	[ziro]	zirô
1	one	[wʌn]	ouann
2	two	[tu]	tou
3	three	[tri]	tri
4	four	[foə]	fôë
5	five	[fɑjf]	faïf
6	six	[sɪks]	siks
7	seve	[ˈsɛvɛn]	sèvenn
8	eight	[et]	eït
9	nine	[ˈnajə]	naïneu
virgule	comma	[coma]	komeu
100	hundred	[ˈhʌndrɛd]	hanndrèd
1000	thousand	[taʊˈsand]	Taoussannd

Distress Call Procedure

(Remain calm and speak slowly and clearly)

- MAYDAY – MAYDAY – MAYDAY (repeated three times)
- Vessel Name (repeated three times)
- Position (check the GPS if possible)
- Nature of Emergency
- Number of Crew
- Vessel Description
- Transmitting frequency

Repeat as often as possible allowing a reasonable time interval for a reply.

PARAMETERS OF METEOROLOGY AND OCEANOGRAPHY RELEVANT TO SCIENTIFIC FISHERIES OBSERVERS

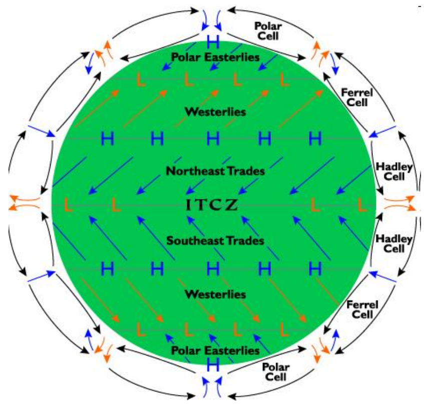
Wind Direction and Speed

Wind has a large effect on conditions at sea that that affect fishing operations and large number of oceanic conditions such as currents and water temperature. Essentially wind is the horizontal movement of air from a high-pressure system to a low-pressure system.

The atmospheric pressure (barometric pressure) at any location on the Earth, caused by the weight of the column of air above it. Pressure is and is measured in millibars (mbar). *The average pressure at sea level is (1013.25 mbar*) Air pressure is measured using a barometer.

A higher pressure occurs when air heavier due to lower temperatures is sinking downwards (descending). A lower pressure occurs when air is warmed up by the sun or high-water temperatures and the warm air rises. The horizontal movement of air from the high pressure to low pressure creates the wind.

Globally the main wind systems are the trade winds that move cool air from the high-pressure religions of the higher latitudes to the low-pressure region near the equator where the more direct sunlight causes the air to warm up and rise. The rotation of the earth causes the wind to be deflected to the west. This deflection (Coriolis force) result in south east trade winds in the southern hemisphere and north east winds in the northern hemisphere.



The strength of the wind is determined by the pressure gradient. A steep gradient caused by a rapid change in pressure over a short distance will result in a stronger wind.

The wind direction is always recorded as the direction that it is coming from. *Therefore, if you are looking into the wind and facing east it will be an east-wind.*

The Wind Direction can be expressed in either cardinal units or in degrees.

For example:

- South Easterly Wind SE or 125 degrees
- Westerly Wind W or 270 degrees

The Wind Speed can be expressed in a number of units:

- beaufort wind scale (see Annex 1) (force number using the Beaufort wind scale 1 – 12)
- knots (nautical miles per hour);
- kilometres per hour (Km/h);
- meters per second (m/s); or
- described in words.

The standard measurement at sea is either *Knots* or *Beaufort Wind Scale* (force number). By observing the sea state an estimation of the wind speed can be determined.

Sea state and swell (height and direction)

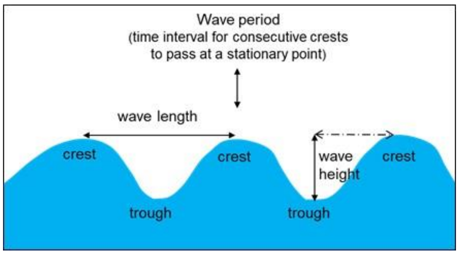
<u>Sea waves</u> are waves generated locally by the prevailing wind and move in the same direction as the surface wind. Larger wind waves often break and have foaming crests.

<u>Swell</u> are waves that have been generated elsewhere and have travelled out of the area where they were generated and have no relation to the prevailing wind direction. A swell never breaks or has a foaming crest.

Waves of both types appear to travel in groups consisting of a number of waves of varying height with the higher wave occurring in the centre of the group. A relatively flat area consisting of a number of distinctly smaller waves separates groups or sets of waves. Wind waves have an irregular form while swell waves will have a more regular form. Note a large swell can often be present with little or no wind blowing and no sea waves present.

<u>Sea direction</u> is expressed as the direction from which the sea is coming. Cardinal points or degrees are also used to record the direction of the sea, similar to wind direction.

<u>Sea height</u> is expressed in meters and is the height from the trough to the crest of the wave. This height can be estimated by looking at an object on the sea surface (for example a bird or white patch from a recently broken wave) and watch it move as a number of waves pass and attempt to estimate the height of its vertical movement.



As the heights vary from wave to wave an average is estimated. With time and experience you will become more accurate with your estimations. The wave height and sea condition also form a cross-reference to estimating wind strength.

<u>Swell direction and height</u>

Swell direction and height are estimated in the same way as determining sea height and direction. However, a swell will never break or have a “white cap” and has no relation to the prevailing wind. In many cases the swell direction will be different from that of the prevailing sea. If two wave forms are observed and their movement is in the direction of the surface wind, the system, which has the longer distance between crests and a more regular form, is considered to be the swell.

Current systems of the Indian Ocean

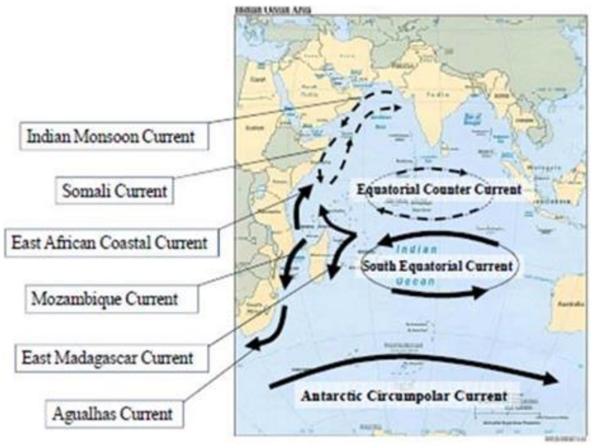
A is a displacement of sea water characterized by its direction, speed and flow. The force of wind on the sea surface causes the surface water to move in the same direction as the wind.

Note: A current direction is recorded in the direction it is flowing towards.

Similar to wind, currents are influenced by the rotation of the earth (Coriolis force), which results in ocean currents turning in an anti-clockwise direction in the southern hemisphere and a clockwise direction in the northern hemisphere. These are called ocean gyres.

Current directions and temperature have a major influence on the tuna fishery in the Indian ocean.

The Indian Ocean is the third largest ocean and covers about 14% of the Earth's surface area. Because much of the Indian Ocean lies within the tropics, this basin has the warmest surface ocean temperatures (20 - 30°C).



However, the extent of the Indian ocean basin north of the equator is limited by the Asian landmass and currents in this region do not follow the same pattern as other ocean basins such as the Atlantic and Pacific.

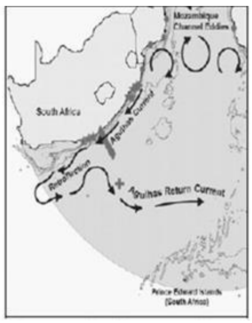
A major characteristic of all ocean currents (gyres) is that water flowing away from the equator (southwards in the southern hemisphere and northwards in the northern hemisphere) are warm currents. Currents flowing towards the equator are cold currents.

The major currents at the equator is the south equatorial currents, flow towards the west parallel to the equator.

The South Equatorial Current splits into a south-flowing arm, becoming the East Madagascar Current and the Mozambique Current. A portion of the south equatorial current also turns north forming the East African Coastal Current. The latter flows as far as the Somali Current, after which its direction depends on the season.

Agulhas Current

The sources of the Agulhas Current are the East Madagascar Current and the Mozambique Current. The flow of the Agulhas Current is directed by the topography and follows the continental shelf from Maputo to the tip of the Agulhas Bank (Cape Agulhas). Here the momentum of the current overcomes the balance holding the current to the topography and the current leaves the shelf and retroflex (turns back on itself), becoming the Agulhas Return Current.



Monsoon Season and affect

Monsoon season and winds are caused by the projection of the Indian landmass into the in the Indian ocean. A monsoon is a seasonal reversal in the prevailing wind direction and weather. A warm air mass with low pressure at the surface forms over the continent as it is warmed by the sun. Air from the relatively cooler and higher-pressure air mass over the ocean then flows toward the low pressure over land. In winter this process is reversed as the air over the land becomes cooler, developing into a high pressure and winds blow off-shore towards the low pressure caused by the relatively warmer ocean. These conditions also influence the strength and direction of coastal currents.

During the South-West monsoon (June to September, northern hemisphere summer) the flow of the East African Coastal Current and is increased by 4 knots and its range extends further north becoming the Somali Current and later joins the Indian Monsoon Current. During the North-East monsoon the northerly flow of the East African Coastal Current is reduced to less than 1 knot in places and its course is a diverted eastward flowing back into the Indian Ocean and becoming the Equatorial Counter Current.

Upwelling occurs along the Somali and Arabian Peninsula where nutrient-rich water provides a source of nourishment for phytoplankton which feeds the zooplankton. The massive concentration of sardine and other small pelagic fish, which feed on the zooplankton form the basis of the seasonal and highly productive fishery in this area. Most of the other parts experience down-welling and the surface water is generally nutrient poor.

Sea surface temperature and colour

Sea surface temperature (SST) in an important parameter measured in the tuna fishery. Vessels target thermal fronts where there is a sudden change in SST. Also associated with water temperature is the water colour. When cold, nutrient-rich, oxygen-rich water is upwelled there is an increase in primary activity (phytoplankton blooms) and an increase in concentrations of “green water” (water with high concentrations of chlorophyll). This is often clearly discernible from the warm clear blue oceanic water.

PART D: VESSEL OPERATIONS

SHIP LAYOUT AND TERMINOLOGY

Key personnel

Captain	The Captain is a certified officer that is in overall command of the vessel and is responsible for operation and safety of the vessel and all its crew. All official documents that involve the vessel, must be signed by the Captain. The Observer also has to prepare a preliminary report at the end of the cruise and this should be given to the Captain who should sign a copy to acknowledge receiving the report.
Fishing Master	On some vessels a Fishing Master is responsible for all fishing operations. The Fishing Master may have no formal certificates and is a company appointee to take charge of fishing operations. Note: the Captain is sometimes called the Master if he carries out both tasks.
Mate	The mate is also a ticketed officer second in command to the Captain and is often in charge of the fishing operations on the deck.
Factory Manager	The factory manager is responsible for the factory and all the handling and processing of the catch.
Bosun	The bosun is below the mate and is often in charge of the fishing gear.
Chief Engineer	The chief engineer is responsible for all mechanical equipment on-board.
Cook	The cook feeds you. Don’t upset him.

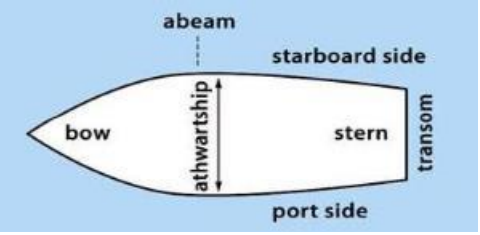
Nautical terms

Galley	The galley is the compartment of a vessel where food is prepared and cooked.
Mess hall	The “mess hall” is a term sometimes used for the dining room on board where the crew eats and can relax.
Accommodation	Accommodation is the area or deck where the crew sleep and ablutions are situated.
Bunks	A bunk is term for a bed on-board a vessel.
Fairleads	Fairleads are guides for ropes or cable passing over the side of the vessel.

Anchor	The anchor is used to “anchor the vessel” in one position and shut down the engines.
Scupper	A scupper is the “gutter” on the side of the deck that allows the water from the deck to run-off directly over the side back into the sea.
Bollards	Strong points onto which ropes can be tied.
Propeller	Propels the vessel through the water.
Rudder	Used to steer the vessel.
Bow thrusters	Propeller situated in the bow that is used to manoeuvre the vessel when it is stopped or moving too slow to be effectively steered by the rudder.

Vessel structure

Hull	The hull is the outer layer of the vessel and determines its size and overall buoyancy. Hull material can be steel, wood or glass-fibre reinforced plastic (GRP)
Main Deck **Upper-decks** **Lower-decks** **Superstructure**	A deck on a vessel is the horizontal partitioning of the vessel. The main deck is the most continuous deck above the water line running from the bows to the stern. All decks below the main deck are termed “lower decks” and all decks above the main deck are called “upper decks” or form part of the “super structure”.
Bridge / Wheelhouse	The Bridge or “wheelhouse” is the position from where the vessel is controlled and is normally situated on the highest point of the superstructure and provides an unobstructed view ahead of the vessel.
Bows/Stern	The front of the vessel is the “bow” also termed “forad” or “foc’sl” and the back is called the “stern”, or “aft”
Port / Starboard	If you stand in the centre of the vessel and face the bows the side on your right hand is the “starboard” side and the side on your left is the “port” side.



Engine room

The engine room is located near the bottom, and at the rear, or aft, end of the vessel. It usually comprises a few compartments that contain the main engine that drives the vessel and auxiliary engines and generators to provide power for the machinery and refrigeration on-board.

Chart Room table

The chart room on the bridge is used for plotting on navigation charts and is often where the skipper will keep and fill in his logbooks.

Hatches & Hatch covers

A "hatch" is an opening between two decks that allows for vertical movement in a vessel. For example, a hatch would be found from the factory deck down to the hold where the fish are stored. Cargo and product is loaded or unloaded through hatches.

A "hatch cover" closes off the hatch. It is important to note that hatches below the main deck or hatches exposed on the main deck will need to be "water tight" in case of flooding.

Bulkhead & Bulkhead doors

Bulkheads are vertical partitions between decks. Bulkheads in a vessel serve several purposes:

- increase the structural rigidity of the vessel;
- divide functional areas into compartments;
- creates watertight compartments that can contain water in the event the hull is breached or any other leak occurs; and
- can contain a fire or gas leak.

Bulkheads and bulkhead doors, especially in lower decks are often watertight. In these instances, the bulkhead doors will have several clips around the doors edge that seal the door into its frame.

Bilges

The bilges are found at the bottom of the vessel. Wastewater from the engine room and the holds normally drains into the bilges. An observer may be required to monitor the discharge of bilge water to see if it contains oil or any other possible pollutants.

Hauling station

On a vessel operating longlines or traps the position from where the line is hauled on-board is called the "hauling station". The hauling station on most vessels is situated forward on the starboard side so that the skipper from the bridge can view the line coming on-board. On large tuna Purse-seiners the net is hauled back on the port side.

Hold / freezer / ice/ Wells [brine freezing]

The "hold" on a vessel is where the fish or product are stored. A hold can be refrigerated to keep fish on ice at 0o C or frozen products at "below" 0^{o} C, (-30^{o} C)

On Purse Seiners fish are stored in "wells". These are tanks that contain brine and the water is cooled to sub-zero temperatures [as low as (-20^{o}C)].

Vessel identification and markings

The "FAO Standard Specifications for the Marking and Identification of Fishing Vessels" provides minimum requirements to which vessels must comply

Vessel name	The vessels name is usually written up on the bows and across the stern.
Port of Registration	The port of registration is normally written across the stern below the vessels name.
Registration number	The registration number is written below the name on the bows.
Call sign	On fishing vessels, the call sign is often required to be shown in large letters alongside or above the bridge.

FISH AGREGATTING DEVICES (FAD)

Fish Aggregating Device (FAD)

Anchored, drifting, floating, swimming or submerged object or group of objects, of any size, that has or has not been deployed, that is living or non-living, including but not limited to buoys, floats, netting, webbing, plastics, bamboo, logs, whales and whale sharks that fish may associate with.

IOTC glossary of scientific terms, acronyms and abbreviations, 2015

While FADs are used in a range of industrial, artisanal and recreational fisheries, this fishing practice is most widespread – and most developed – in industrial purse seine and pole and line fisheries.

FADs can be:

- natural floating objects (logs), or.
- artificial [man made]
    - anchored (aFAD)
    - drifting (dFAD)

Observer's will be required to report on all aspects of FAD fishing

In 2019, the IOTC Commission adopted IOTC Regional Observer Scheme Minimum Reporting Standard Data Fields that request for observers to collect information on the types and configuration of FADs used (e.g. FAD markings, construction materials, design, entanglement incidents). This information is important for scientists to assess the efficiency of different designs in reducing FAD entanglements.

Natural floating objects

Natural floating objects include natural logs of plant (branches, trunk, palm leaf, etc.) and animal origin (carcasses, live whale sharks); and logs resulting from human activity related or not to fishing activities (nets, wreck, ropes, washing machine, oil tank, etc.). These can be equipped or not with a satellite or instrumented buoy.

Artificial fish aggregating device

Artificial FADs can be:

- Anchored fishing aggregating devices
  - Coastal anchored FAD (A);
  - Archipelagic anchored FAD (B)
- Drifting fishing aggregation devices (C)

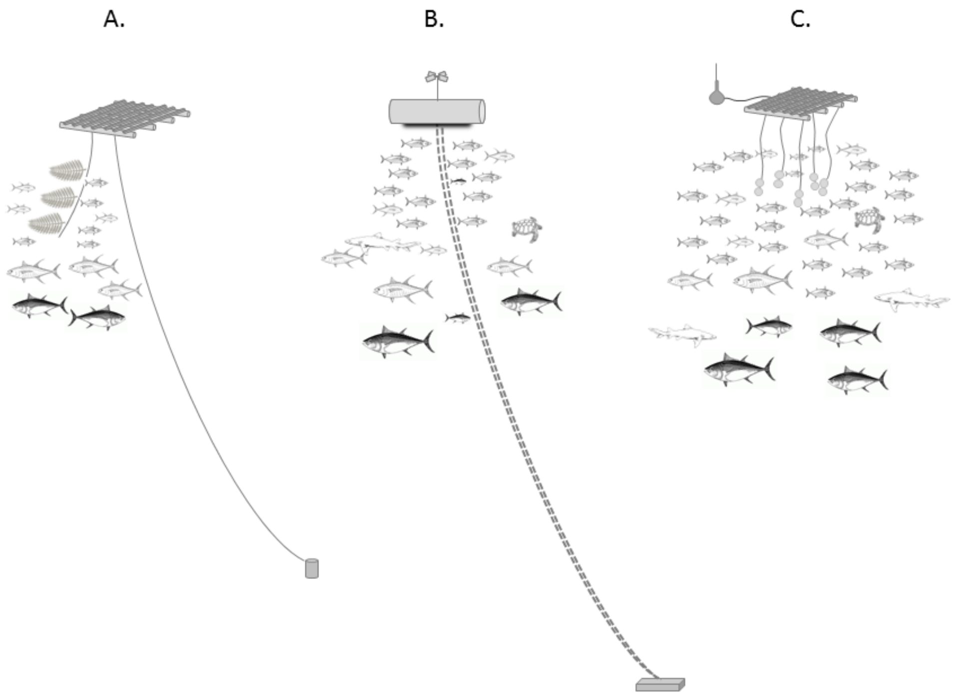


Figure 8 - Schematic drawing of three FADs. (A) Coastal anchored FAD; (B) Archipelagic anchored FAD; (C) Drifting oceanic FAD (© Bush, S. R., & Mol, A. P. (2014). Governing in a placeless environment: Sustainability and fish aggregating devices).

Anchored fish aggregating devices (aFADs)

Anchored FAD

Any 'FAD' which is anchored to the substratum.

IOTC glossary of scientific terms, acronyms and abbreviations, 2015

Anchored FADs are used by a wide range of industrial, artisanal and recreational fisheries, mostly in coastal and archipelagic regions and within a relatively short distance from shore. Note that aFADs are called 'payaos' in in the Philippines and 'rumpons' in Indonesia. Anchored FADs can float at the surface or lie below the surface to avoid detection and hazards such as weather and ship traffic.

Anchored FADs can be split into coastal and off-shore or archipelagic aFADs depending on where they are used.

Coastal aFADs are primarily intended to improve the catch rates of subsistence and small-scale fishers, but may also be utilised by recreational fishers in some areas to enhance their catches. These smaller, less robust aFADs tend to be anchored close to shore, typically within the range of small motor boats and canoes, and attract neritic tunas and other medium-sized pelagic species.

Off-shore aFADs are used most extensively by industrial pole and line fisheries to target skipjack and other tuna species, these aFADs tend to be large robust structures, designed to last at sea for several years, and may be anchored reasonably far offshore at depths of over 2,000 m. However, the use of off-shore and archipelagic aFADs, may overlap with semi-industrial and artisanal operations.

Key features of anchored FADs

- Used by a wide range of industrial pole and line fleets, artisanal fisheries and recreational fishers.
- Anchored inshore (A) or offshore at depths of up to 2,500 m (B)
- Coastal anchored FADs can be constructed with high or low technology materials:
    - the raft can be made from steel, aluminium or fiberglass, and equipped with radar reflectors and solar powered lights; or
    - the raft can be made of bamboo, and large metal buoys or large Styrofoam blocks.
- Off-shore and archipelagic anchored FADs can also be constructed from different materials using different levels of technology. They can consist of:
    - very large buoy, anchored to the bottom of the ocean with a chain attached (such as aFADS installed in Reunion Island); or
    - a raft made of bamboo and large metal buoys or large Styrofoam blocks and sometimes have houses on them for watchmen;
- Industrial and recreational aFADs are usually state-funded and owned, with private use agreements in place in some regions.

Anchored FADs structure

Coastal anchored FAD	Off-shore or Archipelagic anchored FAD
• typically varied lighter, lower cost (<US$300) designs;	• heavy and semi-heavy designs ranging between relatively low (<US$1000) and very high cost (>US$1 million);
• small surface floats built from recovered buoys or cheap materials (e.g. bamboo, cork, vegetation);	• large steel or PVC surface buoy, or multiple smaller buoys;
• anchored using rope usually at depths of less than <1000 m.	• anchored using heavy duty chain or cable wire at depths up to 3000 m;
• deployed permanently or seasonally, but may break up after several months if not maintained.	• deployed permanently or seasonally and usually robust enough to last many years.

Drifting fish aggregating devices (dFADs)

Drifting FAD

Any 'FAD' which is not anchored to the substratum, but left to drift freely in ocean currents.

IOTC glossary of scientific terms, acronyms and abbreviations, 2015

Fish aggregating devices not tethered to the bottom of the ocean (C). Most drifting artificial FADs have three main components: a floating structure (such as a bamboo or metal raft with buoyancy provided by buoys, corks, etc.), a submerged structure (made of old netting, canvass, ropes, etc.) and a satellite buoy. The most sophisticated dFADs include sonar so that the fish population under the FAD can be estimated.

It has been estimated that 81,000-121,000 dFADs were deployed globally in 2013 and that in the Indian Ocean, where dFAD use has increased by 70% since the early 2000s, the number of annual dFAD deployments may now be between 10,500 and 14,500 (MRAG, 2017).

Key features of drifting FADs

- Used almost exclusively by industrial tuna purse seine fleets.
- Deployed in offshore oceanic waters throughout most of the tropical Atlantic, Indian and Pacific Oceans.
- Low-cost construction, made from floating rafts of bamboo or plastic fitted with instrumented buoys containing satellite tracking devices and echosounders' for fish finding.
- Owned by the vessel that deploys them, although in practice a fisher will fish on any dFAD that is encountered.

Drifting FADs structure

Radio and satellite buoys

Today, all tuna purse-seiners operating in the Indian Ocean are equipped with instrumented buoys[23] and a reception system (INMARSAT or IRIDIUM). This receiver system displays the position and drift of the FADs, the temperature of the water under the FADs and buoys batteries condition. Some instrumented buoys are equipped with an echo sounder capable of transmitting data, which allows captains to check the quantities of fish near the FAD.

The use of lights on DFADs is prohibited.

Figure 9 – Instrumented buoy equipped with a sonar (© CPS).

[23] IOTC Res. 17/08 defines an instrumented buoy as a buoy with a clearly marked reference number allowing its identification and equipped with a satellite tracking system to monitor its position.

Raft

(FAD surface structure)

The floating structure is usually made with bamboo canes laced together and/or other floating materials (e.g. cork floats or hermetically sealed PVC pipes). Often called "rafts", floating structures are usually wrapped in a net to hold the components together, as well as to camouflage the FAD. The floating structure is often rectangular (from 4 to 6 square meters) but other forms are also used (e.g. cylindrical). The form of FADs, construction techniques and materials used vary considerably.

Tail

(FAD submerged structure also called underwater extension

Attached to the floating raft, the underwater extension (also called "tail") generally consists of a section of purse-seine net weighted at the base to remain almost vertical while the FAD drifts. The "tail" seems to have two uses: attract fish and slow FAD drift. These sections of net can hang at depths ranging from a few meters below the surface to more than one hundred meters.

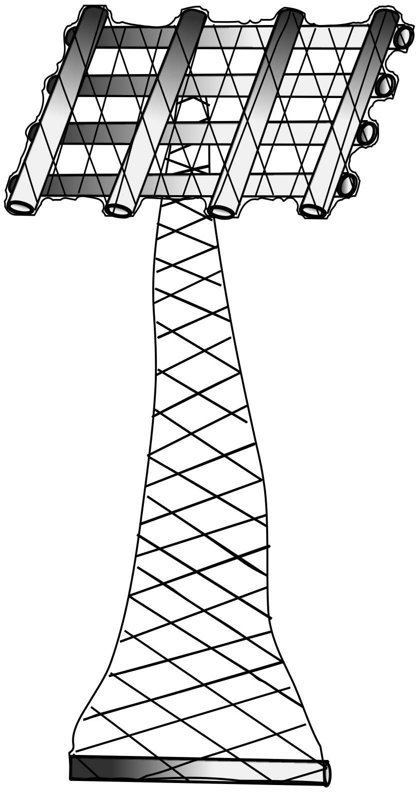


Figure 10 – Drifting FAD structure (©ISSF)

Ecological drifting FAD structures

In 2013, the IOTC adopted resolution 13/08, that contained regulations and recommendations regarding the use of non-entangling FADs by purse seine fleets, superseded by Res. 15/08 in 2015 and in 2017, by Res.17/08: "Procedures on a FADs management plan including limitation on number of fads, more detailed specifications of catch reporting from FAD sets, & development of improved designs to reduce incidence of entanglement of non-target species". Annex III of IOTC Res. 17/08 provides the principles for the design and deployment of ecological man-made drifting FADs. Furthermore, this resolution requires that all artificial FADs deployed or modified by their flagged fishing vessels in the IOTC area of competence to be marked in accordance with a detailed marking scheme, e.g. including FAD marking or beacon ID.

Raft (surface structure)

The surface structure of the FAD should not be covered, or only covered with non-meshed material (burlap, canvas of sisal, thick fabric, tarpaulin, raffia, canvas claustra, horticultural felt, etc.).

Tail (submerged structure)

If used, it should not be made from netting but from non-meshed materials such as ropes or canvas

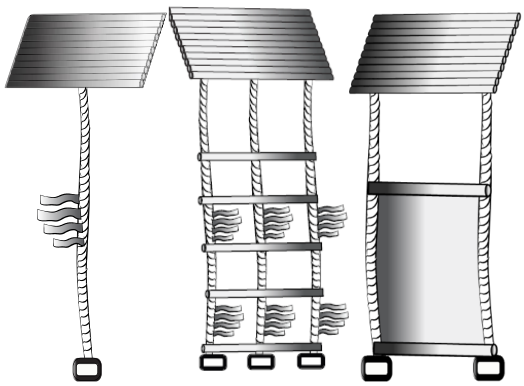


Figure 11 – Ecological (non-entangling) FAD structure (©ISSF)

	sheets.	
Biodegradable materials	To reduce the amount of synthetic marine debris, the use of natural or biodegradable materials (such as hessian canvas, hemp ropes, etc.) for drifting FADs should be promoted.	*Biodegradable non-entangling FADS are constructed exactly like other non-entangling FADS, but using only natural and/or biodegradable materials, further reducing the environmental impact of DFADs on the oceans.*
Markings	All artificial FADs deployed or modified by fishing vessels in the IOTC area of competence are to be marked with a unique identification number, easy to read and applied in such a manner that it will not become unreadable or disassociated with the artificial FAD.	 **Figure 12 – Marked satellite buoy. Manufacturer unique identification code is identified with red ovals. White codes painted on the buoy are the identification codes added by buoy owner (© AZTI Tecnalia).**

IOTC FISHERIES

IOTC fisheries are categorised on the basis of geographical, scientific, technical and economic characteristics. These are defined by using the following criteria:

- Type of fishing craft involved and type of fishing gear/s used: fishing crafts are usually classified according to their shape and size; the type of gear used is related, in most cases, to the type of vessel and its size.
- Gear configuration, fishing mode and target species: fishing gears are usually configured in different ways depending on the type of species targeted.
- Type of operation: these are related to the scale of the fishing operations and can be broadly classified as:
    - Industrial/ semi-industrial (vessel ≥24m overall length or fishing beyond EEZ)
    - Artisanal (vessels <24m fishing within EEZ).

Four main fisheries (defined by gear type), targeting tuna and tuna-like species, are described in the IOTC Regional Observer Scheme Observer Manual (Version 1.2 2015), these are:

- purse seine
- longline
- gillnet; and
- pole and line

Tuna purse-seine fishery

Background and vessels (IOTC, 2015)

Purse seining for tuna is a technique used by industrial and semi-industrial fleets throughout the Atlantic, Pacific and Indian Oceans that enables fishers to catch and freeze large quantities of tuna. Purse seine vessels fish either by spotting free-swimming schools of tuna or by utilizing floating objects that attract fish, either with natural or manmade objects.

Tuna purse-seining is an active fishing technique that targets tuna and tuna-like fishes above the thermocline, in the surface and sub-surface zone down to 300 m depth. The industrial fleets of super seiners which can be up to 110 m long, are highly mobile and can change oceans regions rapidly in response to fishing conditions and market demands. Most of the modern tropical tuna purse seiners fishing in the waters of the Indian Ocean have nets of around 1,500-1,850 m long and with a depth of 250-280 m.

Tuna purse seine vessels commonly target fish at depths of 60–70 m, sometimes reaching up to 300 m depth, although setting below 150 m is rare. As the purse seine catches fish above the thermocline, tuna and tuna-like fish inhabiting the surface and sub-surface zone (mixing area) are the target of this technique, whose fishing grounds range from the high seas to areas near the coast. These vessels can catch large volumes of fish, in average 20 to 30 tonnes per fishing set, that they freeze in refrigerated brine (water and salt solution) and store in fish wells at -20°C. A tuna purse-seiner can catch and freeze up to 800 / 1200 Mt of fish before returning to port to unload or tranship its catch.

Basic layout of a tuna purse-seiner

Layout of large oceanic Tuna Purse-seiners are all very similar. These vessels usually have the bridge and accommodation placed forward of the workspace. At the centre of the deck, a crows nest is placed at the top of the mast. A very heavy boom is fitted at the mast to carry the hydraulic power block. A three-drum purse winch returns the main seine line by the stern after the fish are inside the net and a hydraulic power block to haul back the net on the port side. Fish are also brailed from the net on the port side. The power block is also used to stack the net on the stern of the vessel, with the float line stacked on the starboard side and the chain weights on the port side. Vessels are normally equipped with a skiff located on top of the net or at the stern ramp of the vessel.

Below the upper deck is the well deck that runs down the full length of the vessel. The brine storage wells are situated on either side of the deck. On most vessels a conveyor belt runs down the centre of the deck and leads fish from the chute where the brail is emptied to designated wells for brine freezing (at -20 °C), each with a capacity of 20 to 40 metric tonnes (total 800 to 2000 metric tonnes). Some vessels also possess dry storage that allows to preserve fish at -40°C.

On the upper bridge also called summer bridge (I) we'll find:

- All antennas (radio, radar, satellite, GPS, Gonio),
- The mast supporting the navigation lights (known as the Christmas tree)

At the upper decks (E, F, D) we'll find:

- The bridge (D)
- The kitchen, cabins and crew space (E)
- The cabins and the officers' quarters, as well as the infirmary (F)
- The console for controlling the operation of the winches.

At the main deck (G) we'll find:

- The back deck (A) used to store the seine and the skiff;
- The main mast which ends with a crow's nest (B), a lookout for tuna.
- The power-block (C), fixed on a long horn, used to raise the seine;

At the level of the lower deck (H):

- The engine room and the navigation bar on the back,
- The fish holds and the well to the chains of the mooring anchors, in the centre and on the front.

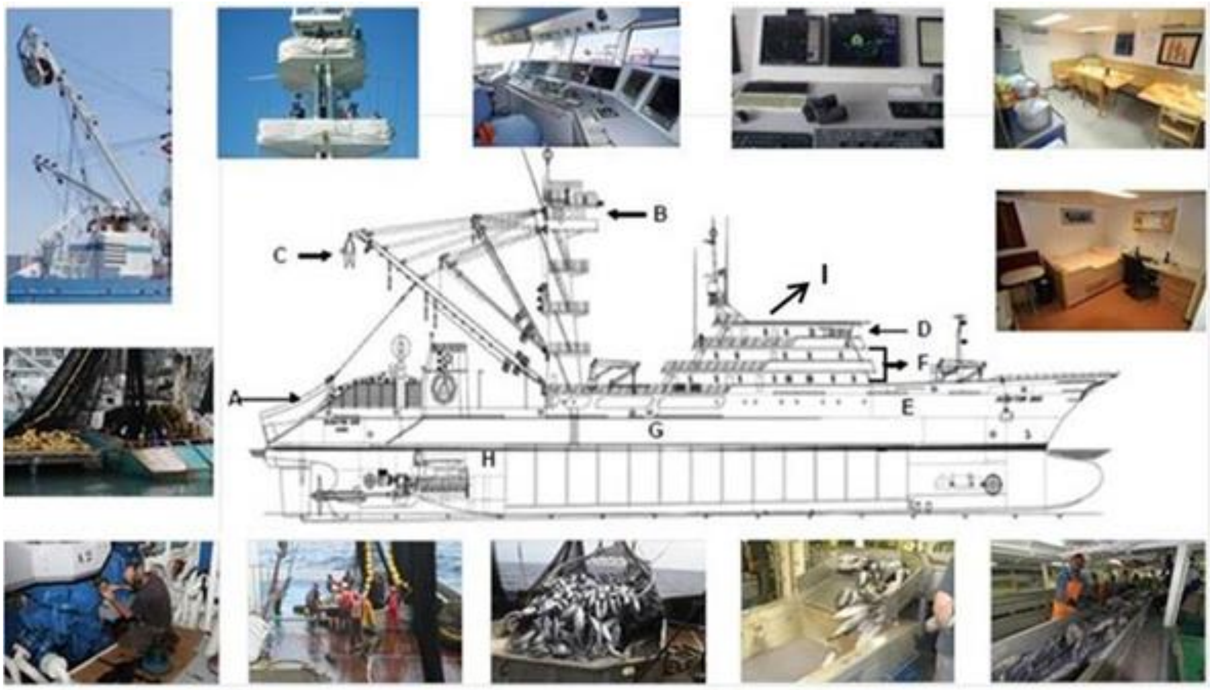


Figure 13- Layout of a Tuna Purse-seiner.

Fishing gear and related equipment, design and specifications[24]

Purse-seine (the net) Purse seine tackle is made up of a trapezoid shaped net consisting of a series of horizontal and vertical panels with different sized mesh nets making up different parts of the gear. The middle area of the net is called the central body or bag. This is flanked by panels of thicker mesh that form the "cutter" to the stern and the pre-chafer and "chafer" [also termed "bunt" of the net] to the fore that will house the fish once the final bag of the purse seine is formed.

[24] P. Pravin - Purse Seine and its operation Central Institute of Fisheries Technology, P.O. Matsyapuri, Cochin-682 029.

At either end, the gear has the necessary struts to steer the net to the stern and to close the net to the fore with the help of “purse line”. The material used to make the panels of netting is usually dyed nylon or other kinds of synthetic fibres (Kevlar) and nets are made both with and without knots [knotless net]. The size of the mesh usually varies between 110-150 mm stretched length (Doc. Int. IEO-COC 2007).

Bunt or Chafer

The region in the purse seine net where the catch is accumulated before brailing is called the bunt because of the excess strain it has to withstand. It is made up of heavier netting. The bunt is placed in the centre or at the end of the wall of the netting depending on the type of operation. The bunt should be at least as long and deep as the length of the boat.

Main body

The main body of the net extends from one end to the other end of the net, except the bunt region. It is the largest part of the net and facilitates surrounding of the fish shoal during operations. It is made by joining together large sections of netting of appropriate mesh sizes to catch the target fish. The material used should have high specific gravity to increase the sinking speed during setting. Twisted knotless netting and “Raschel” braided netting are lighter and are widely used for purse seines. Knotted net is more recently preferred over knotless net, because of the difficulty to repair knotless net when damaged.

Selvedges or guarding

Selvedges are strips of strong netting and are used for strengthening the main netting and to protect it from damage during operations. It is provided in the upper, lower and side edges of the main body of the net. It consists of few rows of large meshes of thicker twine. The upper selvedge is attached to the float line also called the head rope and the lower selvedge to the lead line or chain foot rope as chain reinforcement. It is also attached to the side ropes or gavel lines. Lead line is usually longer than float line by 10 %.

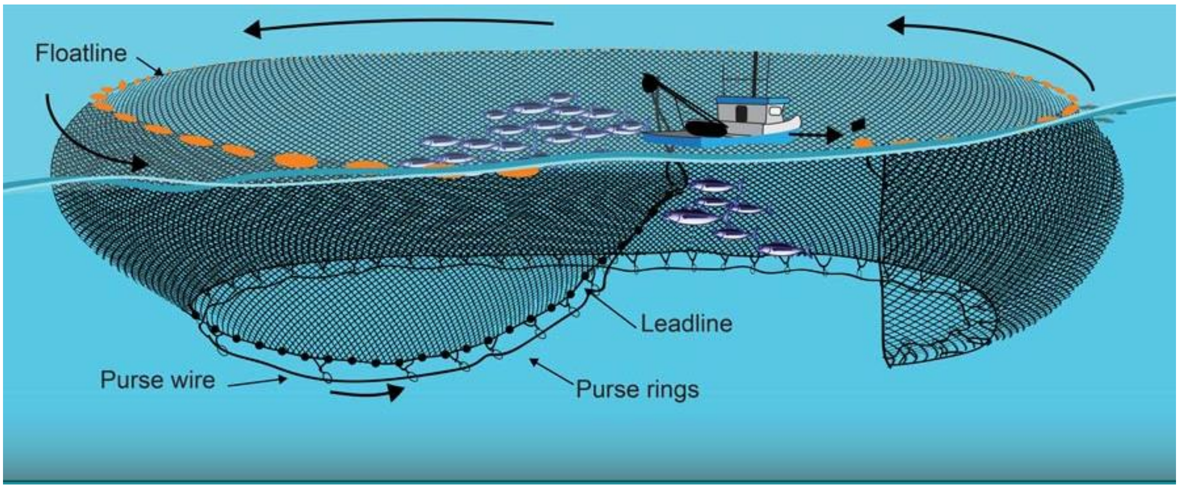


Figure 14- Tuna purse-seine gear components (© Australian Fisheries Management Authority)

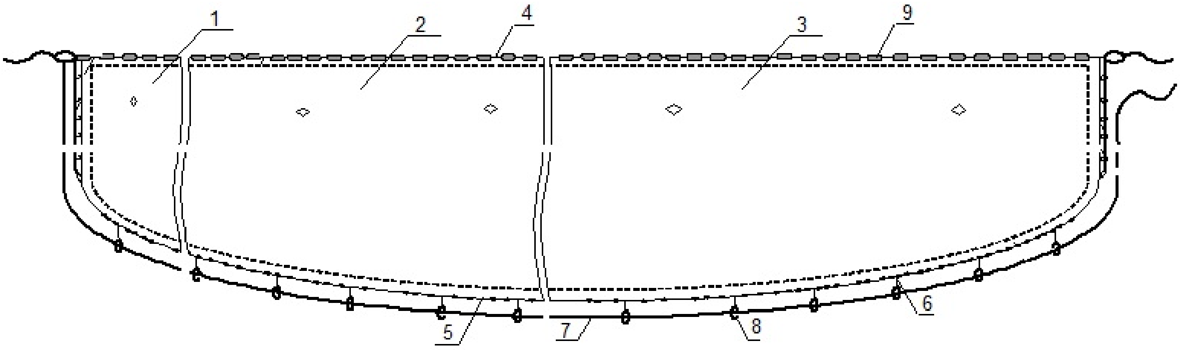


Figure 15- Tuna purse-seine net components (© SPC)

1. Bunt (chafer or sack)	2. Mid-net (main body or shoulder)	3. Wing
4. Float line	5. Lead line (chain foot rope)	6. Gavel lines (bridle)
7. Pursing wire (or purse line)	8. Pursing ring (seine ring)	9. Floaters

Purse Line A purse line is steel wire rope that is housed on the "purse winches" Most seiners have purse lines at least 10 – 20 % longer than the total length of their seines. The purse line is passed through the metal rings [purse rings or ringbolts], which, when drawn on, cinches (purses) the lower portion of the net closed to trap the fish from below. To close the net, at the bottom, there is a series of or ringbolts held by a chain running from strut to strut, through which a steel cable runs, known as the lacing.

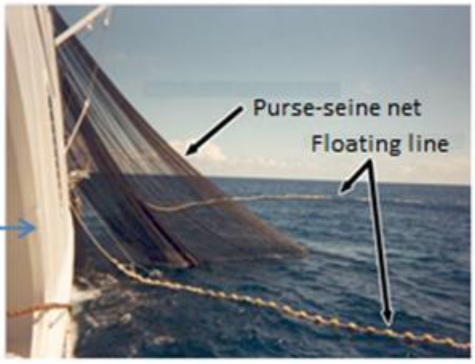
Lead Line A weighted bottom rope [lead line or footrope], is crucial to take the net down as fast as possible to encircle the school of fish. Spindle shaped lead sinkers may be threaded onto the lead line to attain 1-3 kg. per metre for small purse seines and for large tuna purse seines. Lager tuna purse seiners often use a heavy chain up to 8 kg per meter to weigh down the foot rope. The lead line is usually longer than float line by 10 %.

Float line The buoyant head rope or float line is important to keep the head rope on the surface at all times and prevent fish escaping over the top of the net. The float line consists of cylindrical or spindle shaped plastic or high-density plastic foam floats stung onto a rope to form a float line to which the netting is hung directly. Usually, double float lines are used [one rope with right hand twist and the other with a left-hand twist], which prevents it from twisting and distorting the top section of the net. Braided rope is very good for float line because once stretched it does not kink twist (turn around itself) or twist.

The total buoyancy of the float line should be maintained at 1.5 to 3.5 times the total under water weight of the purse seine net and its appurtenances. Higher buoyancy is provided in the bunt or chafer area in order to counteract the sinking force due to weight of heavier netting in this area and the weight of fish while concentrating the catch. Usual extra buoyancy of floats is 2 to 4 times the weight of foot rope with sinkers.

Purse-seine stored under an orange tarpaulin, with the pursing line, the metal rings and chains clearly visible (© SPC)

The purse-seine deployed with the float line and the floaters clearly visible (© SPC)



Power block

A hydraulic power block attached to the end of an extended boom is used to haul the net back and restack it in at the stern of the vessel ready for the next set.

Figure 16 – The Power block hauls the net (© CFTO)

The winch and the seine arrow

The purse seine winch is used to return the main seine line. The cable enters the blocks on the seine arrow which leads them to the winch while pursing and hauling the net.

Figure 17–The seine arrow (left) and the winch (right)© David Itano

Skif

Powerful boat of 8m with an engine of 600CV, used to assist in setting the net around a school of fish.

Figure 18 – The Skif (left ©CFTO ; right SPC)

Brailer

Large scoop-net with a capacity of up to 10 tonnes. The brailer is used to scoop the fish out of the net and empty it into a chute leading down to the lower deck, where the fish is channelled into the brine tanks for freezing.

Figure 19 – A full brailer

Figure 20 – Different types of brailers (© ISSF)

Target Species (IOTC, 2015)

Tuna purse-seiners target species include adult and juvenile Yellowfin and Bigeye tuna, Skipjack tuna and small tuna-like fish such as Frigate tuna and Kawakawa in tropical waters. In temperate waters juvenile and adult Bluefin tuna are targeted while feeding on baitfish or spawning (adults). Purse seine vessels are also occasionally used to harvest albacore in temperate waters, generally at night when they are feeding higher in the water column.

Purse-seine fisheries non-targeted catch or bycatch can include a range of oceanic species such as marlins, pelagic sharks, other pelagic fish and PET species such as turtles, whale sharks and even whales or dolphins (more common in the Atlantic and Pacific Oceans).

Fishing operations

Tuna purse seine operations are divided into two phases:

1. the search and detection of the fish schools, and
2. the fishing event itself.

Search and detection

The search for tuna schools by the industrial tuna purse seiners can be either direct or indirect.

Indirect Search and detection methods

The indirect search for tuna schools involves evaluating a range of environmental parameters and factors that influence the spatial and temporal distribution of tuna and abundance. These include:

- water temperature

- depth of the thermocline
- water oxygen content
- water colour and transparency
- amount of total suspended matter
- presence of chlorophyll and macrophytes and
- currents

The combination of these parameter values is used by skippers to decide on the fishing location in order to maximise the chance of finding schools of tuna.

Direct Search and detection methods

Methods used to directly search for and detect of tuna schools include the use of high-performance binoculars, bird radar, echo sounder, sonars and instrumented buoys attached to artificial and natural FADs.

High performance binoculars

The search phase is an activity that can occupy the crew for more than 12 hours a day, from sunrise to sunset. Spotters equipped with powerful binoculars (20X) are positioned in the crow’s nest near to 15 meters above the sea to search for indicators of fish in the immediate vicinity of the vessel.

Bird radar

Purse seine vessel also are equipped with high frequency and long-range radars that can detect concentrations of feeding seabirds and, in certain conditions, can detect the agitation on the sea surface from feeding fish.

©SPC

Acoustic sonar and depth sounders

The use of acoustic sonar and depth sounders are reserved for fishing. The fine use of these vertical sensing devices allows detecting shoals of fish in the immediate vicinity of the vessel. These are also used to assess the school before setting the net, informing the captain of the composition and distribution of the tuna school.

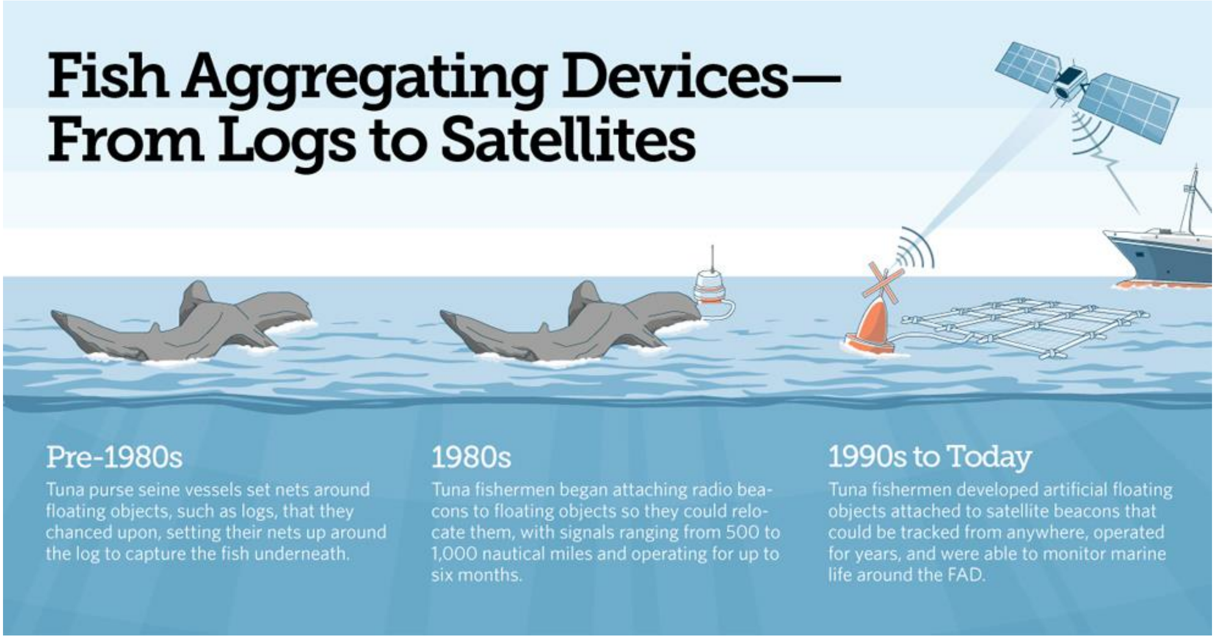
©SPC

Instrumented satellite buoy system

GPS satellite buoy system allows for the position, speed, course and drift of each buoy to be received by the vessel. Other optional features include the reception of meteorological, oceanographic and sounder data (chlorophyll levels, water temperature up to 150 meters, shear flow in the water column up to 150 meters, and surface wind speed).

© Marine instruments

FAD usage in the purse-seine fisheries



Fishers have long known that fish, such as tuna, congregate around naturally occurring floating objects such as logs or a dead whale and that by mimicking this effect fish aggregation could be exploited. This aggregating behaviour is used in industrial tuna fisheries so as to concentrate fish around Fish Aggregating Devices (FADs) a highly effective way to improve catch rates and reduce operating costs, especially when compared to the practice of targeting free swimming tuna schools. As a consequence, since the early 1990's, purse seine drifting FAD fishing for tropical tunas has rapidly expanded and experienced a large number of innovations that have made fishing more effective over time. Today, drifting FADs used in the open ocean play an important role in industrial tuna purse seine fishery, with purse-seiners deploying thousands of dFADs in all tropical oceans to catch tropical tunas.

The association of tunas with dFADs is highly advantageous to industrial tuna purse-seine fishing as:

- allow fishing opportunities to be focused into a smal number of predictable locations;
  - dFADs equipped with instrumented buoys can be tracked, which minimises search time and vessel operating costs;
  - dFADs equipped with most recent generation of buoys equipped with echo-sounders allow to confirm tuna school presence and size. And by considering information from many active buoys allows to select productive areas to visit.
  - supply vessels allied with one or more purse seine vessels, used to deploy and monitor dFADs further optimising searching efficiency.
- aggregate sparsely distributed schools, which makes them easier to spot than schools swimming freely beneath the surface;
- stabilise tuna schools and reduce the speed at which they travel, making them comparatively easy to catch (Dagorn et al., 2012);

Consequently, fishing around floating objects is associated with a higher successful haul, or ‘set’, rate than targeting free swimming schools (Chassot et al., 2015).

Fishing event - deployment and retrieval of the purse seine net [“set” or “event”]

Tuna purse-seining involves surrounding a tuna school with a net, impounding the fish by pursing the net, and drawing up the catch by hauling the net so that the fish are crowded into the bunt of the net and can then be brailed out of the water using a brailer and emptied into a chute on the deck leading down to the well-deck where they are channelled into the brine tanks for freezing.

A “set” or “event” starts when the net is deployed and ends when the net is hauled back onto the deck. This is an intensive activity taking no more than a few hours depending on the amount of fish caught.

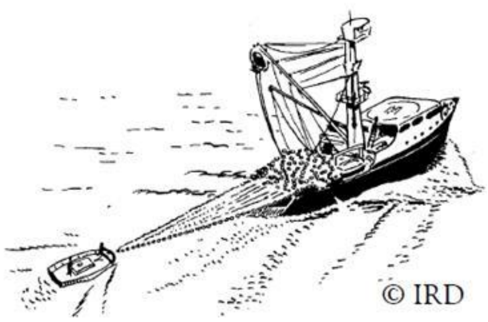
There are a few distinct passes in a single fishing event:

- setting the net
- circling the school of fish
- pursing the net
- haul back or hauling the net and
- brailling out the fish

Shooting

1. Once the presence of a tuna school is confirmed by the sonar, the fishing vessel circles until its port side is facing the school (most of the tuna purse seiners have deck arrangement for operating from the port side).

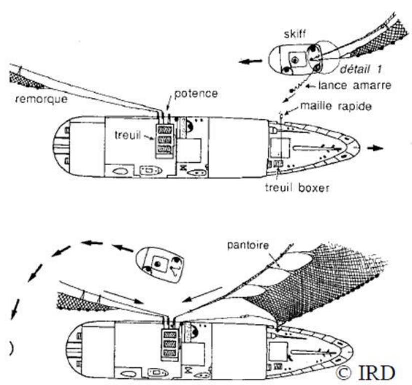
2. At the release signal ordered by the skipper, the skiff is deployed with the end of the seine attached to its rear.



Circling

3. The skiff is used to hold the net during the encircling of the school. He serves as a fixed point while the purse-seiner encircles the school at maximum speed. This action lasts between <u>4 to 8 minutes</u>.

4. Once the fish encircled, the skiff finishes the loop, then passes each of the cables to the purse seiner, which starts to close the net.

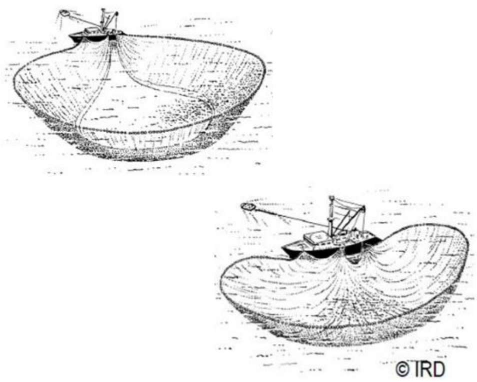


When FAD fishing and during the execution of this operation, it is frequent to place a speed vessel inside the circle formed by the net, next to the FAD to keep the tuna school on an optimum position so that it does not escape before the circling is completed.

When fishing for a free school, the speed vessel keeps the school of fish grouped by circumventing.

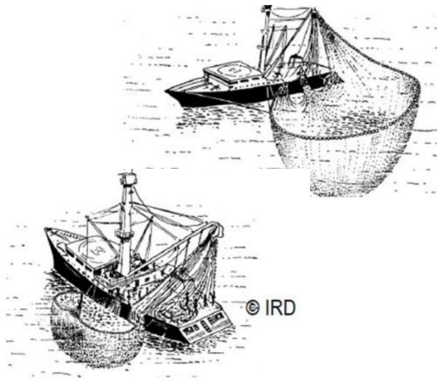
Pursing

5. Once the encirclement is completed, the end of the net attached to the skiff is transferred to the purse seiner and the two ends of the purse line cable are hauled in with the winch as rapidly as possible to close the bottom of the net - this is called "pursing".
Pursing may take up to 15 or 20 minutes for large purse seines.



Hauling

6. The net is then pulled aboard the purse seiner with a hydraulic power block attached to the end of a boom above the deck. Under the power block, the net is stacked on the stern by fishermen in such a way that it will come smoothly off the stern at the beginning of the next set. The net is hauled until the fish are concentrated into the bunt or chaffer of the net.



Barring incidents, the operation should take about an hour.

7. Then comes the delicate moment of "making the pocket". As the pocket is reduced, the captured fish concentrate in an increasingly restricted volume. It is from this moment that a correct estimate of the catch can be made and that the brailing begins.

Brailing

8. When most of the purse seine has been retrieved, and the tuna are concentrated within the bunt on the portside of the vessel. The fish are scooped out of the using a large scoop-net called the "brailer". Up to 10 tonnes of fish can be taken on board with each scoop.

9. The duration of brailing depends on the quantity of fish in the net (1 to 2 hours).

10. The tunas are then emptied into a specialised chute on the main deck and channelled from the upper deck to fish-wells below.

11. The crew conducts a first on-site sorting. Rejections are returned to the sea using

the rejection conveyer belt if the vessel has a discharge opening at the lower deck. Otherwise the rejections are grouped in bins or nets and discharged at the end of sorting.

12. Sorted tuna are preserved on brine (refrigerated sea water) tanks at -2 ° before being frozen at -15 °.

13. There can be 20 to 30 tanks on an industrial purse seiner ranging in size from 20 to 40 metric tons. The total capacity of a purse seiner varies between 700 and 2500 tonnes.

Photos ©CFTO (http://www.cfto.fr/)

Shifting

14. Some ships make "sashimi quality" tuna. This practice requires additional manipulation called "shifting". Shifting corresponds to the passage from a brine tank (-17 ° C) to a dry dock (-40 ° C). Shifting can take place during the day or night, during which a second sorting takes place.

Figure 21 - Shifting large tuna from brine tanks to a deep-freeze tank.

Unloading

15. Tuna-purse seiners land at port. Upon arrival at the port, the fish is landed by flotation, that is to say that the stevedores do not go down in the tanks. By maintaining the level of the brine at the top of the tank, the fish rises to the surface as it’s lighter than the brine, so stevedores just have to transfer it from the tank to the unloading nets, using a conveyer belt.

Figure 22 – Unloading tuna at port using nets.

Preservation of the catch

Once fished, the tuna is loaded on board as soon as possible as the quality of fish caught in tropical waters (23° to 30°C) deteriorates very quickly.

Tuna purse-seiners are equipped to preserve fish in two ways:

Chilled brine

Practical and economic cooling method, in which the fish is immersed whole (non-processed) in tanks containing sea water cooled to a temperature of 0° C. Once the temperature of the tank, falls to 0° C the tank is emptied and the chilled water is replaced by brine (seawater preparation in which the salt content has been increased so that the temperature can be lowered to -18 ° C). The number of tanks varies from 12 to 27 depending on the vessel, and their volume varies according to their location in the hull. The use of this refrigeration method eliminates the need of purchasing ice, prevents bruising and crushing the fish and allows to fish a large quantity of tuna in a short time. Brine tuna is mainly used for canning.

Frozen at -40 ° C

In order to avoid any type of cold burn, tunas are first immersed in an ice-cold brine bath (-15°C). Once frozen, they are sorted and the big ones are shifted (transferred) into deep freezer hold and frozen at -40° C. Frozen whole fish is processed into loins, steaks, steaks, cubes without being thawed adding value to the vessel catch.

Fishery impacts on the ecosystems and interactions

Despite the clear benefits of dFADs to the industrial tuna purse-seine fishing industry, their use is associated with several potential negative impacts, including the catch of small tunas, bycatch of vulnerable non-target species, modification of tuna habitat, potential damage to coastal habitats.

IOTC has recognised the increasing use of FADs in IOTC fisheries, notably for tropical tunas, and Resolution 15/09 has established an ad hoc working group on FADs to assess the impact they may have on the species composition and on the rates of by-catch associated with fishing on FADS. Concern has also been raised about the impact of FADs on the incidental mortality of sea turtles and sharks through entanglement, .and emphasis is now being placed on the use of environmentally friendly materials in FAD construction (MRAG, 2017).

Ecological impacts

1) Impacts on tuna stocks
    a) catching too many fish that prejudices reproduction (recruitment overfishing);
    b) catching too many small fish and reducing the number that reach maturity;
2) The capture/entanglement of non-target species (bycatch);
    a) retained bycatch (byproduct);
    b) incidentally taken in a fishery and returned to the sea (discarded);
    c) incidentally affected by interacting with fishing equipment in the fishery, but not taken (released);
3) Damage to marine and coastal habitats and marine litter, when FAD structures are lost or abandoned, in fragile marine habitats like coral reefs;
4) Ghost fishing, the accidental capture of marine life by fishing gear lost or discarded at sea that continues to entangle animals;

For conservation and management measures put in place by the IOTC to limit the capture of juvenile tunas, to avoid the capture/entanglement of Species of special interest (SSI), to investigate, limit and avoid ecological impacts of FADs and of purse-seine fishing, please consult the most recent version of the Compendium of Active Conservation and Management Measures for the Indian Ocean Tuna Commission (https://www.iotc.org/cmms).

Interactions

SPECIES	IMPACT	MITIGATION
Marine turtles	• entanglement in FADs; • encircled by the purse-seine net.	• use of ecological FADs; • turtle should be encouraged to swim out of the net; or • a brail or a large dip-net can be used to pick up the turtle from the net; • usage of the proper techniques to handle and release bycatch species such as turtles.
Cetaceans (various species)	• encircled by the purse-seine net.	• small speed-boats can be used to chase the cetacean(s) out of the net before it is fully closed. • a side of the net can be lowered to allow the cetacean(s) to escape • small explosive devices can be used to chase the animals out of the net before it's fully closed.
Sharks, rays, marlins and other large fish	• entanglement in FAD; • encircled by the purse-seine net;	• use of ecological FADs; • a brail can be used to pick large individuals from the net and to attempt to release them directly, by tipping one edge of the brailer, into the ocean; • usage of the proper techniques to handle and release bycatch species, such as Sharks, rays, marlins and other large fish
Whale sharks and whales	• encircled by the purse-seine net;	• interdiction of setting a purse seine net around the animal if sighted prior to the commencement of the set (IOTC Res. 13/04 & 13/05); • usage of the proper techniques to handle and release bycatch species, such as Whale sharks and whales.

Pelagic Longline Fishery

Background and vessels (IOTC, 2015)

Longlining is a passive fishing technique using baited hooks to attract and catch fish. Pelagic longlines (surface or drifting longline) are not anchored and typically drifts with the ocean currents while fishing. It consists of a mainline, kept near the surface by buoys or float and branch lines with baited hooks suspended from the main line at regular intervals along its length.

The method is typical of high seas fisheries, and is also widely used in the national waters within coastal states exclusive economic zones, EEZ. Large Scale Tuna Longline Vessels (LSTLV) or "industrial tuna long-liners" range in size from 30m to over 70m length, with up to 25 crew (and smaller vessels less than 15m sometimes having only four to six crew.

Pelagic longlines target fish at or near the surface and can target fish much deeper than surface fishing method, (purse seine and pole and line). The depth that hooks are set at will often influence the catch.

Some of the larger industrial LSLTVs can set their hooks down to 300 m depth, to target larger yellowfin, bigeye and southern bluefin tuna (also termed deep-water or mid-water longlining).

The primary characteristics of these vessels are:

- capacity (fuel, water, accommodation, crew, etc.) to reach distant fishing grounds and operate on high seas in extreme conditions, for months at a time without return to port; and
- facility to freeze and store high quality fish at low temperatures for the entire time that they are at sea.

Basic layout of a pelagic Longliner

Longline fishing entails two main operations setting of the line and hauling the line back, which predominantly influence the layout of the vessel. A wide-open hatch generally present across the stern from which the line is set. The working deck is generally closed on the port side and open on the starboard side from where the line is hauled, and the fish are landed. The line is hauled back by a line hauler positioned forward on the working deck on the starboard side and landing door is present on the same side just aft of the line hauler. A blast freezer is situated either aft or forward of the work deck and the fish are stored in the main hold below the workspace. Most longline vessels have the bridge set aft of the workspace so that the fishing master can view the line being hauled and the fish being landed.

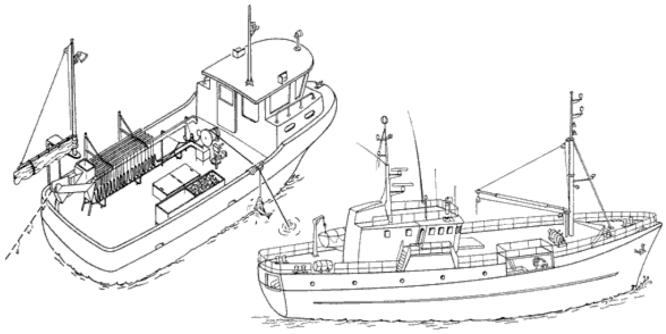


Figure 23 Basic layout of a longline vessel

Figure 24 - Large Scale Tuna Longliner

Figure 25 - Tuna Longliner less than 20m

LONGLINE CONFIGURATION AND GEAR (IOTC, 2015)

A pelagic longline (drifting longline) consists of a mainline that is held near the surface or at a certain depth by regularly spaced buoys or float (Figure 26). Branch lines (also known as droppers, snoods or ganglions) with baited hooks are suspended from the main line at regular intervals along its length. The entire line can extend from 20 to over 120km.

The attachments of branch lines, hooks and buoys onto the main line and measurements required for data collection are shown in the figure below.

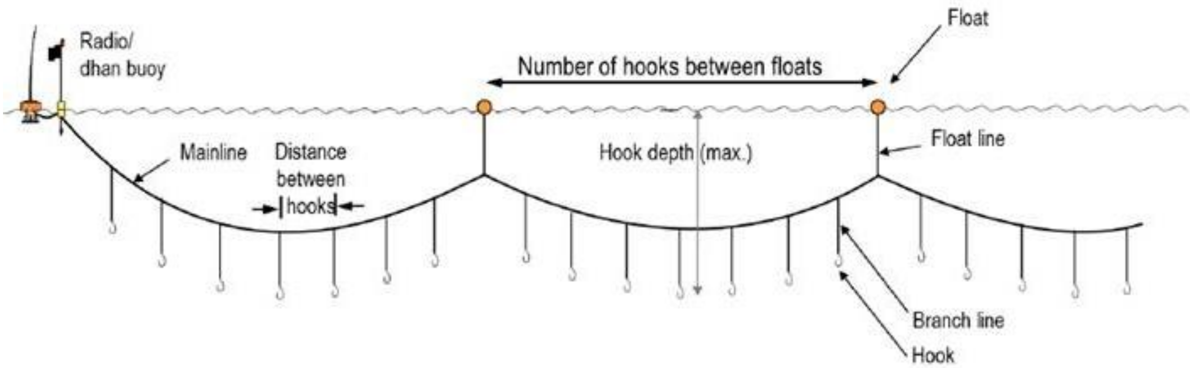


Figure 26 Longline gear configuration (*IOTC ROS Observer Manual, 2015*)

The longline is set from the stern where the branch lines and buoylines are attached during the setting

Figure 27 - Setting of a longline and casing out branch lines

The line is then hauled back on the starboard side from the hauling deck (Figure 12), where fish are landed and processed. Throughout the hauling process the gear is made up and stored ready for the next set.

operations (Figure 11).

Figure 28 - Line hauling deck on a LSTLV

Longline Gear Description (IOTC, 2015)

Mainline

The main line forms the backbone of the longline from which the branch lines are suspended and the buoylines are attached to keep the line close to the sea surface. The mainline materials can vary from country to country and on vessels of difference size, construction and layout. However, three main categories of can be distinguished:

1. tarred 4-strand twisted cord (6 to 8 mm diameter);
2. nylon monofilament (6 mm); and
3. braided nylon mono-filament (8mm)

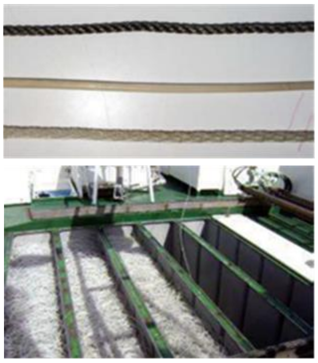


Figure 29 - Braded mainline storage on a LSTLV

Longline systems can also be distinguished into two categories, separated by the specifications and storage method of the mainline:

- The first system uses multi-strand or braided nylon monofilament that is stored in large coils or is layered down in a large bin or storage well).

- The second system (sometimes termed “Mono” system) uses a monofilament nylon mainline approximately 6mm in diameter that is stored on a large drum or reel (Figure 30).

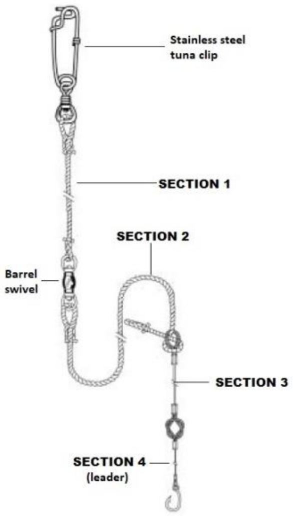
Figure 30 – Drum or reel on deck

Branch lines

The branch lines are clipped onto the main line when setting and the hooks are baited at the same time.

A typical branch line can vary between 30 m to 50 m in length and are attached to the mainline with a stainless-steel tuna clip. A large range of branch line configurations exist, varying from vessel to vessel and country to country. Observers are required to record the length and material that make up the different sections of the branch lines used on the vessels they observer.

Simple branch lines can made out of one type of line material (normally mono-filament nylon), between the tuna clip and the hook. Vessels using a single monofilament mainline generally use these type of branch lines. The branch lines are layered into large rectangular “tubs or bin” for storage, one on top of the other with the hooks and clips arranged around the edge of the bin. On vessels using shorter longlines the branch lines and buoy lines may be wound up into large baskets (Figure 20), or on to reels one on top of the other.



Larger longline vessels (LSTLV’s) mostly use more complex branch lines (Figure 41) with multiple types of line and swivels attached. Multiple materials usually include an initial section of nylon / polyester braid combinations which is then attached to a length of monofilament leading to a hook. Barrel swivels are used to connect sections, some of which may be weighed with lead.

The construction of the branch line often determines the species being targeted and the depth to which the bait is set. On LSTLV’s branch lines are generally prepared into separate coils and packed into baskets (Figure 41).

Bullet-buoy / Hard-floats / Radio-buoy / light-buoy

Buoy lines are used to keep the main line close to the surface. Two main buoy types exist:

Hard floats: made from a rigid plastic that can withstand a high pressure should a large fish pull them under and *Bullet-buoys* are made of a soft polyurethane foam material.

The buoys and floats are attached to the mainline with buoylines of various length. The spacing of the buoys are dependent on the number branch lines attached between them and the buoyance required to keep the line close to the surface.

Marker-buoys*, GPS beacons, radio buoys, light buoys and radar reflectors (highflyers)* are attached to the longline at intervals dividing the longline up into sections. A predetermined number of buoys are attached to the line between marker or radio buoys. Their prime function is to determine the location of the fishing gear and assist in locating the ends of the line if it is accidentally broken.

Buoys are generally stored on top of the superstructure near the stern where they can be easily accessed when setting the line. Radio buoys are stored in fixed holders on the main deck to prevent them getting damaged and to recharge or replace the batteries between sets.

Other gear and equipment associated with longlining

Hook types

Different shapes and sizes of hooks are used depending on target species. Hooks can be made out of stainless steel or hardened steel that is galvanised. The observer will be required to record hook type during their observations.

Modified from Beverly 2009

Line setter

A line setter / shooter is situated on the stern and is used to pull mainline from the storage drum or its storage bin. It deploys the mainline at a consistent speed during setting, recorded in meters per second (m/s). By varying the line setter speed to the vessels setting speed the depth of the hooks can be controlled.

Bait Casting Machine (BCM)

The bait casting machine is used to cast the bait away from the vessel outside of wake zone. It is generally situated on the stern rail on the port side of the line setter.

Line Hauler

Mainline hauler – uses hydraulic motor to assist with retrieving the main line. The line hauler is used predominantly on vessels that use a multi-strand rope or braided monofilament nylon mainline, which is stored in layers in a large bin or storage well. The line hauler is generally positioned on the starboard side.

Vessels that use a monofilament nylon mainline use the storage drum to retrieve the line.

Branch line hauler/coiler

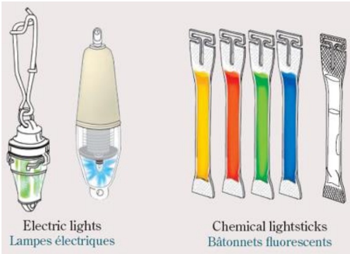
A branch line hauler/coiler – winds branch lines into tight, consistent coils and assist in quickly recovering and packing branch lines for the next set.

Electric Shocking

An electric cable attched to a steel ring is used the slide down the branch line to shock and subdue large fish and sharks to facilite hauling them in.

Light Sticks Two types of light sticks can be used, chemical (disposable) light sticks and battrey operated lightsticks that are reusable.

Lightsticks are used mostly to selectivly target swoardfish or sharks.



Target Species (IOTC, 2015)

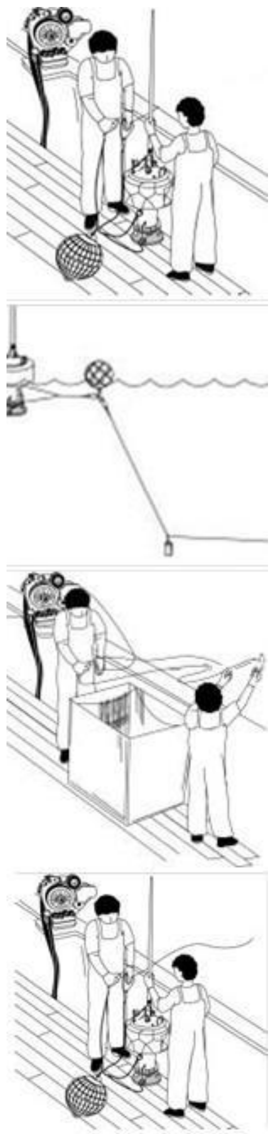
Longline fisheries target fish in relatively deep water compared with surface fishing methods such as purse seine and pole and line operations.

Primary target species in the IOTC Convention area are:

- bigeye and yellowfin Tuna; and
- swordfish.

Oilfish and some shark species as well as a range of other oceanic species that are retained can be classified as commercial by-catch.

The depth at which hooks are set influences the species and size composition of the catch. Some of the larger industrial longliners can set their hooks down to 300 m depth to target larger, mature individuals of Yellowfin, Bigeye and southern Bluefin tuna (termed deep-water or mid-water longlining).



Shark mortality, through bycatch or direct targeting, often for fins, can be a contentious issue in this fishery.

Fishing operations (IOTC, 2015)

Fishing Strategy

Various methods are available to Fishing Masters to determine the position of thermoclines and “fronts” between warm and cool water, where lines should be set. Fisheries information systems can provide vessels with satellite information on sea-surface temperature (SST), phytoplankton densities or sea height. In addition, on-board echo sounders and temperature recorders are used to detect fish and determine the positions to set lines. Longliners from some companies may also work together and share information to follow schools of fish.

Setting

A longline is typically deployed from the stern of the vessel and the operation is termed” setting or shooting”. At least five crew members are required for the operation. The line is paid out from the aft storage wells on the upper deck through a series of PVC pipes and a hydraulic line feeder, situated on the lower deck amidships, at a rate of about 6 to 8 meters per second, (approximately 450 m per minute, 27 km per hour). On larger industrial longliners a typical set will consist of 200 or more units or "baskets" 4 to 15 branch-lines in a basket, setting a total of about 3 000 hooks on a line. The vessel steams at between 9.5 knots and 11.5 knots and the whole operation can take about five to six hours.

Branch lines are stored separately in baskets or tubs and attached to the main line while setting the line. A buoy is then attached at intervals between baskets or following a fixed number of branch lines. The make-up of the branch lines in each basket can vary with respect to their position from the buoy.

A radio buoy is attached after every (approximately) 20 baskets, dividing the line up into sections that correspond to the number of radio buoys set. The rate at which branch lines and buoy lines are attached to the mainline, and therefore the space, is controlled from the wheelhouse by a synchronous time series of "beeps" that is measured in seconds.

The depth where the hooks are set in the water column is a crucial element, and this can be regulated mainly by modifying the length of the main line set between buoys, through varying the vessel speed and line setter speed as well as by adjusting the length of float-line and to a lesser extent, by modifying the length of the branch-lines.

Each hook is baited just before being set. Common bait species used are horse mackerel, milkfish or squid. The baited hooks are cast out either by hand or using a bait casting machine.

After the last radio buoy is set the line is left to "soak" for a predetermine time of 3 to 4 hours "soak time" before the start of the hauling operation.

Hauling

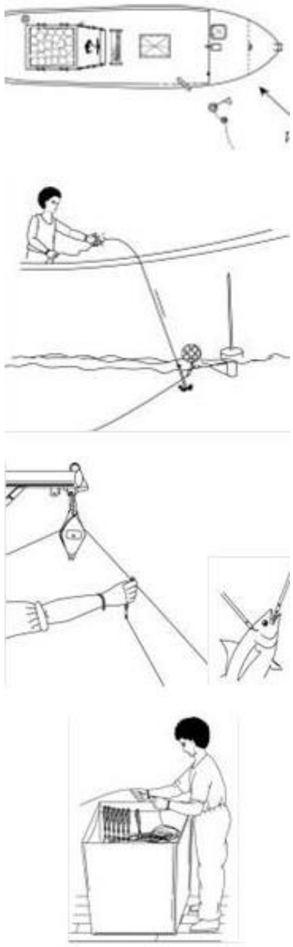
Hauling longlines usually takes at least a full day (11 hours and more) depending on the number of hooks set and the catch rate. The last radio buoy set is usually the first to be hauled on board.

The radio buoy is located with the help of the radio direction finder or by radar, and is hauled on board and detached from the mainline.

On vessels where the mainline is stored in a bin on the upper deck, the mainline is threaded over roller guides and through the hydraulic mainline hauler. A crew member controls the speed of recovery. Line-hauling is conducted at a slower speed than setting, being influenced by the sea state and the rate of fish capture. The vessel steams along the mainline at an average speed of about 6 knots, with the line retrieved over the starboard side, at a rate of between 150 and 250 m per minute. The mainline coils under its own tension from the hauler onto a conveyor belt which carries it across the deck from starboard to port side. Tangles in the mainline are removed as it moves along on the conveyor belt.

On vessels using the monoline system the main line hauled and wound up on the dram at the same time.

Branch lines are unclipped off the mainline as they come over the side of the vessel or after they go through the line hauler. The snoods are coiled, either by hand or with an automatic coiler, and are tied off around the hook with a loop of the line near the clip, then packed back into baskets ready for setting.



© SPC

These bundles or baskets and the buoys are placed at intervals onto a conveyor belt on the port side of the vessel. This takes them to the crew member who is packing the mainline into the aft wells and they are then stacked at the stern ready for the next set.

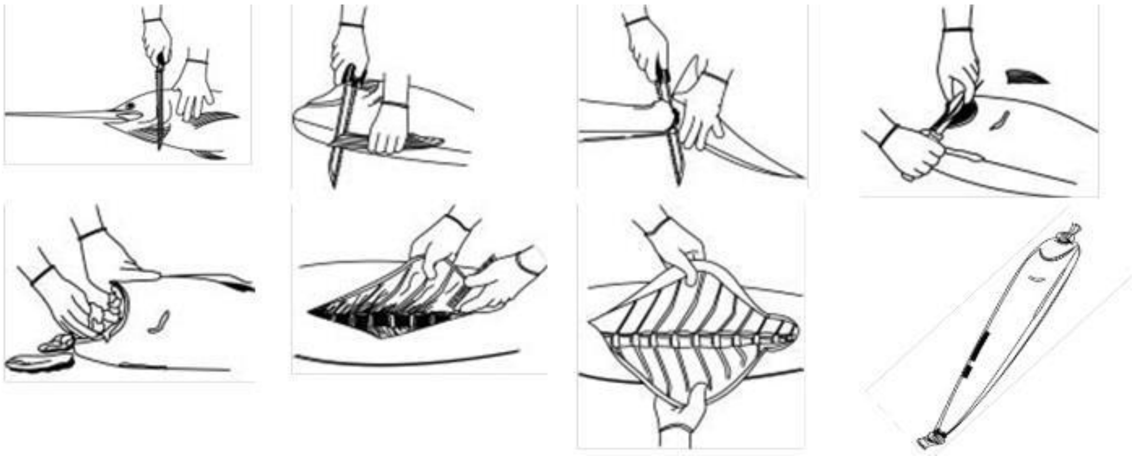
Hooked fish are brought alongside, gaffed and hauled aboard by the crew (**Error! Reference source not found.**). All large tuna, billfish and sharks are landed using gaffs and harpoons attached to bamboo poles, targeting the mouth or head of the fish to minimise damage to the trunk.

Gaffing a Yellow-fin tuna

Processing

Target species are handled with great care, processed and preserved accordingly to their final market destination. Fish can be *eviscerated and gilled*, *headed and gilled*, *headed, gilled and finne*d. Fish can also be cut into pieces or cut into filets or loins, with or without bones, with or without the skin. Fish destined to the high-quality Japanese are meticulously cleaned to remove any traces of blood or viscera and then weighed prior to freezing.

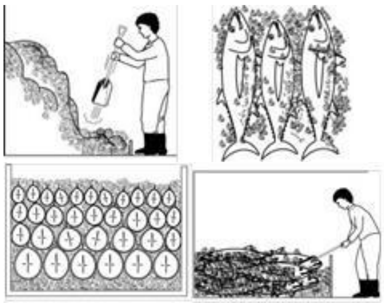
Hold capacity is determined by vessel size. An average sized industrial LSTLV has an average storage capacity of 200 MT of catch. Longliners will unload their catch in port or at sea to refrigerated carrier vessels.



© SPC, 2003

Preservation of the catch

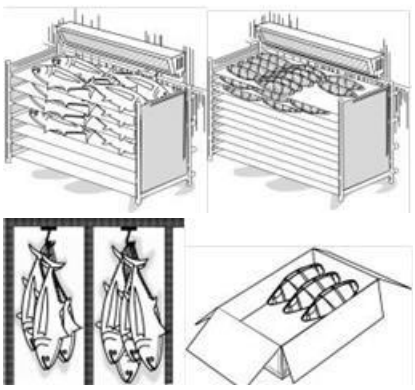
Fresh fish storage



Longliners targeting and landing fresh fish keep the product either on ice. The fish are often first chilled by putting them into an ice slurry before packing them in the hold with ice. All freshly chilled fish must be stored at temperatures below 4.4 °C, but must not be frozen. The ideal temperature for refrigerated fish is 0 °C. Fish can be kept fresh on ice for several weeks before landing ashore. Fresh fish production is mostly done on smaller longliners 15 to 30 meters.

Freezing

Frozen whole fish or loins must be stored on board at minus 18°C, or at a lower temperature. Freezing at -18°C is mostly done on board smaller longline vessels (15 to 30 meters).



© SPC, 2003

Deep freezing

To preserve the quality of the fish, deep frozen tunas are rapidly frozen in blast freezers (-55°C to -65°C) immediately after processing. After blast freezing, they are transferred to the hold storage at (-40o C to -50°C). Deep-freezing mainly occurs on larger industrial LSTLVs fishing on the high seas (vessels over 40-meter).

Ecological impacts

1) The capture/entanglement of non-target species (bycatch)
   a) retained bycatch (byproduct)
   b) incidentally taken in a fishery and returned to the sea (discarded)
   c) incidentally affected by interacting with fishing equipment in the fishery, but not taken (released)
      i) seabirds
      ii) turtles and
      iii) endangered sharks and marlins

For conservation and management measures put in place by the IOTC to avoid the capture/entanglement of Species of special interest (SSI), , please consult the most recent version of the Compendium of Active Conservation and Management Measures for the Indian Ocean Tuna Commission (https://www.iotc.org/cmms).

Interactions

SPECIES	IMPACT	MITIGATION
Marine turtles	• entanglement in the line; • hooked.	• use circle- instead of J or the Japanese hooks; • use fish baits; • set gear below turtle-abundant depths; • reduce gear soak time; retrieve in daytime; • avoid hot-spots near breeding colonies; and • use efficient handling & release methods to increase survival rates.
Sea birds	• hooked.	• night setting with minimal bridge lighting; • bird scaring devices ("tori lines"); and • weighted traces. • have onboard line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled. • use efficient handling & release methods to increase survival rates.
Marine mammals	• predation; and as a result • hooked; • entangled in the line.	• have onboard line cutters and de-hookers in order to facilitate the prompt release of marine mammals caught or entangled.
Sharks, rays	• entangled;	• have onboard line cutters and de-

and marlins	• hooked.	hookers in order to facilitate the prompt release of sharks' species that are prohibited from retaining on board (white-tip sharks, thresher sharks); • have onboard line cutters and de-hookers in order to facilitate the prompt release of striped marlin, black marlin and blue marlin; • use efficient handling & release methods to increase survival rates.

Pole-and-line fishery

Background and vessels

Pole-and-line is an active fishing method where tunas are caught one-by-one using a hook attached to a line and pole (IPNLF). This fishery requires live baitfish (i.e., small pelagic, coastal and coral reef varieties), which are cast into the sea to attract tuna schools. Pole-and-line vessels fish either by spotting free-swimming schools of tuna, tuna schools associated to natural floating objects or by utilising man-made floating objects that attract fish (drifting FADs or anchored FADs). Pole-and-line fishing grounds range from near the coast (bait and tuna fishing) to the high seas (tuna fishing).

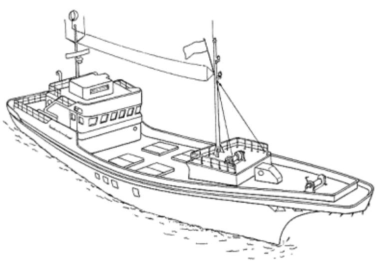
Basic layout of a pole and line vessel

Pole-and-line vessels range from 20 to 40 m in length and may be artisanal, semi-industrial, or industrial. Vessel layout varies with vessel type: in some vessels (as the Maldives vessels), the bridge and accommodation are located in the front third of the vessel, while in other (as the Indonesian vessels), are located in the back third of the vessel.

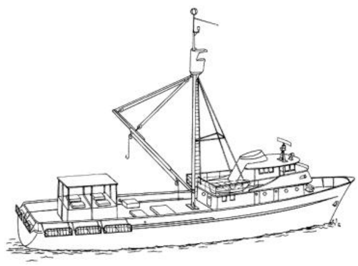
According to vessel layout, fishing will be conducted from the rail fore of the vessel (as in Indonesian vessels) or from the side abaft amidships and around the stern of the vessel (as in Maldivian vessels), either directly from deck or from steel racks mounted on the vessel just above the surface of the water.

The fish holds are located under the deck where the catch is stored using various refrigeration methods. The storage method often determines or is dependent on the range of the vessel.

Live bait is stored in tanks filled with seawater. Powerful pumps are used to circulate the water, and each tank has a light (above or underwater.



Japanese pole-and-line vessel (©FAO)



American pole-and-line vessel (© FAO)

Spanish pole-and-line vessel (© Moreno G.)

Maldives pole-and-line vessel (©J. Lowe)

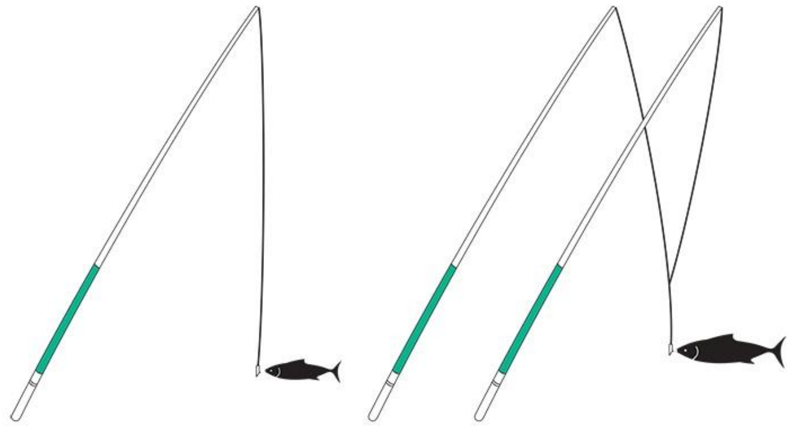
Indonesia pole-and-line vessel

Portuguese pole-and-line vessel

Fishing gear and related equipment, design and specifications

Pole-and-line fishing gear

A pole-and-line consists of a line attached to a pole at the extremity of which may hang a feathered jig mounted on a barbless hook. Poles can be made of wood (including bamboo), of fiberglass and increasingly of carbon fibre.



© FRDC

© Moreno G.

Manual poles

Manual poles are usually held and operated by one fisher. In order to bring on board large to very large fishes, a unique line can be attached to 2 poles held by 2 fishermen (exceptionally 3) or, even, the extremity of the pole can be attached to a rope hauled by another fisherman when additional strength is needed.

Automatic poles

In the last decade, new pole-and-line systems that improve the mechanisation of the fishing operation have been developed. Automatic poles are held by an articulated support that is fixed onto the gunwale. The pole is connected to a pulley that is in turn connected to a spool run by a motor that reels and unreels the line, which is controlled via a program-logic controller.

The ship's captain can control the entire automatic system from a screen installed in the bridge. The system is complemented by a button panel that the fisher can use to reproduce pre-set variables including: pole size, fishing and reeling position, reeling and unreeling speed and position correction (AZTI, 2019).

Articulated support and button panel (© AZTI)

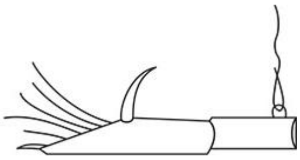
Pole-and-line fishing with automatic poles (© AZTI)

Hooks and jigs

A wide variety of hooks and jigs are used in the pole-and-line fisheries as both hook size and type of jig depend on the species being targeted. The only thing that is common across all pole-and-line fisheries is the use of barbless hooks for quick catch and release.

Fisheries targeting skipjack tend to make their one hooks and jiggers (as in Indonesia, in Maldives and possibly in India). Hooks used to target larger tuna species (as albacore and yellowfin) are commercially produced, but the large majority of the associated jiggers are made by the fishers on-board the vessels.

Observers will be expected to collect information on hook type and size as well as on jiggers used.



Scheme of a barbless lure (© FRDC).

Artisanal barbless jigs Indonesia (© Moreno)

Artisanal barbless jig South Africa(© CapMarine)

Artisanal barbless hooks Indonesia (©Moreno)

Bait fishing gear[25]

A wide variety of net types are used to collect tuna baitfish, both by the tuna fishing vessels themselves and by other fisheries that supply live baitfish to pole-and-line operations. The most common baitfish nets used by pole-and-line vessels include beach seines, boat-operated seines (lampara nets, purse seines, ring nets), drive-in type nets, and many styles of lift net. The most critical factor relates to mesh size, which must be small enough to avoid gilling a large proportion of the haul while remaining efficient for pursing and hauling.

The type of net used and whether it is hauled in the day or at night depends on several factors:

- depth of the fishing ground
- bottom type (smooth or rough)
- behaviour of targeted baitfish species

Drive-in type nets

Fish can be caught by driving them into a fishing gear of any type. Most of them are caught also without driving, but in small quantities. There are some stationary gears which catch only when the fish are driven into them by swimming or diving fishers or by frightening lines, among other methods. This gear is used to capture the fish, usually in shallow waters, by driving them into the netting by noise and other means. These gears can be used from the shore or from a boat.

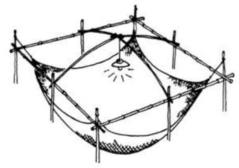
Lift nets

[25] International Seafood Sustainability Foundation and International Pole & Line Foundation, 2019. Skippers' guidebook to pole-and-line fishing best practices. Version 1.0 – April 2019. ISSF & IPNLF.
FAO fishing gear types (http://www.fao.org/fishery/geartype).

Lift nets consist of a horizontal netting panel framed by wood or metal bars or a bag shaped like a parallelepiped, pyramid or cone with the opening facing upwards. Often, depending on target species the catching process is supported by lights (in cases, a series of powerful ones) or simply some bait.

Stationary Lift Nets

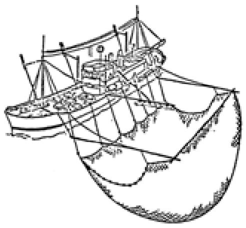
These lift nets, which can be relatively large, are usually operated from stationary installations situated along the shore. After being submerged at the required depth, the nets are lifted or hauled out of the water by hand or mechanically sometimes with the use of lights.



© FAO

Boat-operated Lift Nets

These lift nets are hauled out by hand or mechanically from one or more boats. To operate a large lift net and maintain it open, several long poles on one or the of two sides of the boat are, in general, necessary. A number of pulleys and/or small winches are used to dip and haul the lift net.



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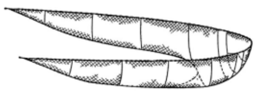
Boat-operated seines (lampara nets, purse seines, ring nets)

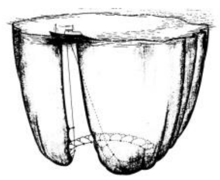
Lampara nets



© FAO

The lampara net is a surrounding net (without purse lines), shaped like a dustpan or a spoon (the lead line is much shorter than the float line) with two lateral wings and a central bunt with small mesh to retain the catch. The net is mostly used like a boat seine and operated by a single vessel. Once the shoal of fish has been surrounded, the two wings are hauled up at the same time, in general, by hand by several crew members.

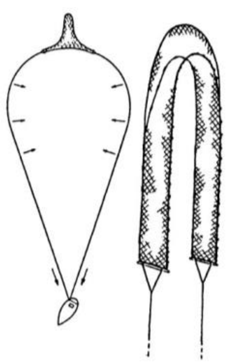
Ring nets



© FAO

A ring-net is a purse seine net made of a long wall of netting framed with float line and lead line (usually, of equal or longer length than the former) and having purse rings hanging from the lower edge of the gear, through which runs a purse line made from steel wire or rope which allow the pursing of the net. The ring net can be operated by one or two boats and it is set around a detected school of baitfish. After that, the net is closed underneath the school by hauling the purse line running through the rings (pursing).

Purse seines



A seine net is a very long net, with or without a bag in the centre, which set either from the shore or from a boat for surrounding a certain area and is operated with two (long) ropes fixed to its ends (for hauling and herding the fish). Two types of gear can be distinguished in this category: beach seines and boat seines. While, no specific gear handling equipment is required for beach seine operations, the problem for manoeuvring seine nets in general consists, first, in hauling the long ropes attached to the ends of the net: this is done either by hand (Beach seines) or with a winch (Boat seines). When seine nets are used from boats, rope drums can be used for storing the long ropes, a power block can also help for bringing the net on board. Seines are usually set from a boat to surround a certain area and are hauled either from the shore (beach seines) or from the boat itself (boat seines).

TARGET SPECIES

Tuna fishing

Pole-and-line fisheries operating in the Indian Ocean, typically target skipjack and small yellowfin tuna, as well as tuna-like species occupying the upper surface waters, while small bigeye tuna are also targeted at dawn and dusk. In temperate waters small albacore tuna is also targeted. Nonetheless, poling vessels also have the ability to catch larger tuna >40kg.

Pole-and-line fishing for tuna is a very selective technique, with very low levels of bycatch compared to other major tuna fishing methods (Miller et al. 2017b). Yet, as bait-fishing is an integral part of pole-and-line fishing, ecosystem impacts of bait-fishing must be considered, including the bycatch of non-target species and ETPs, mainly turtles species (ISSF/IPNLF, 2019).

Bait fishing (IPNLF/ISSF, 2019)

The composition of baitfish species that pole-and- line fisheries use depends on the target tuna species and the location of the fishery:

- Higher latitude pole-and-line fisheries that target the temperate tuna species (albacore and bluefin tunas) generally harvest a small number of hardy baitfish species.
- Temperate water fisheries often rely on one or two dominant species.
- Tropical fisheries targeting skipjack and yellowfin tuna rely on a large assortment of nearshore and reef-associated species that are often delicate and difficult to maintain in captivity.

  Tropical bait fisheries may encounter over 15 useable species per haul, although the catch is normally dominated by fewer than five species.

FISHING OPERATIONS

Pole-and-line fishing operations include:

1. Tuna fishing operations; and
2. Bait fishing operations.

Tuna fishing operations

Pole-and-line tuna fishing operations are divided into two phases:

1. the search and detection of the fish schools;
   a. free-swimming schools;
   b. associated schools.
      i. Logs;
      ii. anchored FADs; and
      iii. drifting FADs

2. the fishing event itself, including:
   a. the chumming of baitfish/water spraying; and
   b. the poling of the fish.

Search and detection

Direct Search and detection methods

Methods by pole-and-line vessels to search for and detect of tuna schools may include:

1. the use of high-performance binoculars to search for:
   a. free swimming tuna schools or changes in sea-surface that indicate their presence;
   b. seabirds, schools of dolphins or other marine mammals associated with tuna;
   c. natural floating objects (LOGs); and occasionally
   d. drifting FADs;
2. the use of long-range radars that can detect concentrations of feeding seabirds;
3. the use of acoustic sonar and depth sounders to detect shoals of fish in the immediate vicinity of the vessel;
4. visiting anchored FADs.

High performance binoculars

The search phase is an activity that can occupy the crew for more than 12 hours a day, from sunrise to sunset. Spotters equipped with binoculars (of various range), search for indicators of fish in the vicinity of the vessel.

Acoustic sonar and depth sounders

The use of acoustic sonar and depth sounders are reserved for fishing. The fine use of these vertical sensing devices allows detecting shoals of fish in the immediate vicinity of the vessel. These are also used to assess the school before start chumming, informing the captain of the composition and distribution of the tuna school.

© SPC

Bird radar

Pole-and-line vessel can be equipped with high frequency and long-range radars that can detect concentrations of feeding seabirds and, in certain conditions, can detect the agitation on the sea surface from feeding fish.

©SPC

Anchored FAD Anchored FADs are used most extensively by semi-industrial and industrial pole and line fisheries to target skipjack and other tuna species (e.g. Indonesia and the Maldives). Fishing can become crowded and contentious when vessels compete for the best area close to an anchored FAD (ISSF/IPNLF, 2019)

FAD use by the pole-and-line fisheries

Tuna are naturally attracted to any floating object in the open ocean - whether natural (such as a log or dead floating whale), from human origin (like a wooden palette or a pile of discarded rope) or man-made (artificial dFADs and aFADs).

Some pole-and-line vessels utilize floating objects to achieve more productive fishing and some fisheries depend almost entirely on anchored FADs (aFADs). With large numbers of drifting FADs (dFADs) set by purse seine fleets in most tropical regions, they can drift into EEZs and thus provide fishing opportunities to coastal pole-and-line fishers.

The association of tunas with aFADs is highly advantageous to industrial pole and line fisheries as it:

1. allows fishing opportunities to be focused into a small number of predictable locations;
   - The known position of anchored FADs reduces the time required for searching;
   - the construction of an array of anchored FADs, aids the identification of promising fishing areas;
2. aggregates sparsely distributed schools, which makes them easier to spot than schools swimming freely beneath the surface;
3. stabilises tuna schools and reduce the speed at which they travel, making them comparatively easy to catch (Dagorn et al., 2012);
4. reduces the risk of another vessel 'hijacking' a tuna school when multiple vessels are fishing competitively in close proximity;

Consequently, fishing around floating objects is associated with a higher successful haul, or 'set', rate than targeting free swimming schools (Chassot et al., 2015).

Figure 31 – Anchored FADs used by the Pole-and-line fisheries

Fishing event

The "set" or "event" starts when the first line enters the water and ends when the last line comes out of the water. If the vessel stops fishing for a period of at least 10 minutes then it should be considered that the fishing event ended, even if fishing is to restart shortly afterwards on the same school. Although pole-and-line fisheries in the world can present different vessel configurations and fishing techniques, there are some common features pole-and-line fishing, these include:

Chumming

The scattering of live baitfish onto the surface of the water (chumming), to create a feeding frenzy, when a school of tuna is located.

Spraying[26]

The fishing area is sprayed with water to obscure the fishing line and the hook and further excite tuna, creating the illusion and sound of a large school of small fish near the surface;

Poling

The action of catching fish with poles (that can be of different materials, dimensions, operated manually or mechanically by one or more fishers).

Fishing strategy when fishing on a free-swimming[27] *school*

1. When a free-swimming school is sighted, the vessel will attempt to intercept the lead portion of the school at full speed;
2. The sonar indicates whether tunas are present as well as the size of the fish and the density of the school, while the echo sounder indicates the depth of the school. Both devices are monitored closely throughout the operation.
3. As soon as the vessel is positioned above the school, the sprayers are turned on and chumming commences (or vice-versa). The combination of the spray agitating the surface and chum are used to get the fish into a feeding frenzy.
4. Fishing commences when the tunas are observed near or on the surface, starting with live bait. Feathered jigs can sometimes replace live bait when a feeding frenzy is induced.
5. Hooked fish are pulled from the water rapidly and landed on the vessel.

[26] Modern pole-and-line vessels are equipped with high-pressure seawater lines that lead to spray nozzles mounted along the gunwale or hull.
[27] Schools of tuna found in the open ocean and not associated with any structure or floating object are called "free" or "un-associated" schools.

Fishing strategies when fishing on an associated[28] school

A. Fishing on an anchored FAD is very different from fishing on a free-swimming school. In this type of fishing, consideration also needs to be given to other vessels due to limited manoeuvring and fishing area around the floating object (IPNLF/ISSF, 2019).

   1. At the arrival to the aFAD, the sonar or echo sounder is/are used to assist with school location and chumming strategy. Additionally, the activity of birds, visual cues, or trial and error can help locate the fish;
   2. As a general rule, vessels approaching a FAD give way to a vessel already fishing the object, and thereafter take turns making drifts or approaches. Fishing can become crowded and contentious when vessels compete for the best area close to a FAD;
   3. As soon as the vessel is positioned above the school, the sprayers are turned on and chumming commences (or vice-versa).
   4. Fishing commences when the tunas are observed near or on the surface.
   5. When fishing on a FAD, the initial catch normally consists of rainbow runner and dorado. These fish occupy the top layer and have to be landed before the yellowfin and skipjack are caught.
   6. At times fishing may be halted before the school is exhausted.

B. Fishing on logs (floating objects of natural or man-made origin)

   1. At the arrival to the log, the sonar or echo sounder is/are used to assist with school location;
   2. Live bait is casted ahead or to the side of the log as it tends to produce a strong biting response from associated tuna schools and the sprayers are turned on (or vice-versa);
   3. Fishing commences when the tunas are observed near or on the surface.
   4. When fishing on a log, the initial catch normally consists of rainbow runner and dorado.
   5. At times fishing may be halted before the school is exhausted.
   6. The boat will then drift with the school while various methods might be used to encourage more tuna to aggregate under the boat until fishing recommences. Aggregation methods can include:
      - Fishing for short intensive periods.
      - Turning on water sprayers and chumming between fishing sessions.
      - Drifting day and night.
      - Turning on powerful deck lights at night.

[28] Schools of tuna associated to a floating object (FAD), being this floating object of natural origin (log), of human origin, an artificial anchored FAD or an artificial drifting FAD.

Preservation of the catch (IPNLF/ISSF, 2019)

Vessels that operate single day trips may simply rinse their catch prior to landing to fresh fish markets. If the fish are for international markets, they will generally be kept on ice until offloading. For multiple day trips, an array of storage techniques can be implemented to maintain high quality fish until unloading at port:

Ice

Storage in ice reduces the core temperature of tuna quickly to maintain a high-quality product.

Ice brine

A mixture of seawater and crushed ice (slurry) cools tuna far quicker than ice alone and also acts as a cushion to crushing and abrasion. Ice brine is commonly stored in emptied bait holds or purpose-built insulated holds. The ice brine system can keep tuna in decent condition for about four days, after which quality reduces rapidly.

Refrigerated coils (refrigerated seawater)

<u>Refrigeration</u>

Fish holds can be lined with metal coils cooled with a compressed refrigerant such as ammonia or Freon. Vessels equipped with this type of system can refrigerate and freeze fish. The coils can maintain seawater in refrigerated seawater (RSW) systems for fresh sashimi markets, as well as for canned products.

<u>Freezing</u>

Freezer coils can also chill a hyper-saline solution of seawater and salt that remains in a liquid state but is cold enough to freeze the whole tuna solid. Whole tuna are transferred to the brine freezing wells that circulate the high-density brine at −18°C to −20°C. When the brine hold is filled with frozen tuna, the brine is pumped out and the fish kept in a dry, frozen state usually at a lower temperature — either in the same hold or sorted and transferred to other refrigerated holds.

Spray brine systems

Fish can be also frozen in storage wells using a simple spray brine system: refrigerated brine solution is recirculated from the bottom of the well and sprayed over the top of the fish. The catch is loaded whole from the capture deck, and chilled brine runs by gravity over the fish, which freeze solid at the temperature of the brine (−18°C to −20°C). This system is adequate for canning-grade tuna.

Air blast dry freezers

Large Japanese pole-and-line vessels use dry-blast freezing technology to preserve high-quality frozen tuna at an ultra-low temperature (ULT) of −45°C to −60°C. ULT frozen tuna can be held for extended periods while maintaining suitable quality for sashimi, seared tuna and high-grade markets.

Use of Nano-Multi-Ice (NMI)

New technology that is currently being trialled in the Maldivian pole-and-line fishery. NMI is a very fine silky ice solution that is proving to be effective in bringing core temperatures of pole-and-line caught tuna down quite rapidly. It has several refrigerating benefits with substantial time savings (up to 20x faster cooling of fish), much improved fish quality, small size, light weight, extremely low refrigerant charge and relatively low power consumption.

Bait fishing operations

Pole-and-line fishing requires live baitfish (i.e., small pelagic, coastal and coral reef varieties), which are cast into the sea to attract tuna schools. Pole and line vessels spend a significant amount of time catching live bait. The high-seas tuna fishing grounds are often far from the sheltered bait fishing ground, presenting some unique challenges to this fishing technique.

Pole-and-line vessels either capture their own baitfish, purchase baitfish from other fisheries, use cultured baitfish, or get a baitfish supply through a combination of these activities.

For example:

- Maldivian tuna boats capture their own wild baitfish similarly to how the pole-and-line boats of the Azores, Canary Islands, Lakshadweep, Brazil, Indonesia in some areas, and others.
- In Japan, baitfish are purchased from separate bait fishing operations, which can be a component of larger fisheries harvesting the baitfish species for various purposes, including human consumption.
- Some pole-and-line fisheries, including the Indonesia pole-and-line fishery, may obtain bait through a combination of the two methods.

Baiting operations can be generally divided into:

- daytime methods, which are the most common. Beach seine or surround nets and drive-in nets are usually operated during daylight hours.
- Night-time activities, where the use of artificial bait-attraction lights is needed. Liftnets are an example of nets often used at night.

The type of net and whether it is hauled in the day or at night depends on several factors, such as:

- depth of the fishing ground
- bottom type (smooth or rough)
- behaviour of targeted baitfish species

Once caught, the fish are carefully handled to reduce mortality. Some species, particularly those harvested in cool waters at higher latitudes with strongly adherent scales, can be “dry scooped” with dipnets and quickly transferred to the bait wells. Yet, delicate species, such as the ones harvested in tropical waters, need to be loaded within buckets of seawater, taking care not to overcrowd each bucket. Survival and condition of night caught baitfish that are allowed to settle, or calm down in the net, and are loaded during daylight hours are higher than for night-loaded bait.

Using cultured fish for pole-and-line chum may be an option as an environmentally responsible alternative to harvesting wild coastal species or when wild baitfish are not seasonally available. Projects and studies on the effectiveness of cultured chum peaked in the 1970s but were discontinued when pole-and-line fisheries declined as purse seining became the predominant surface tuna fishing method worldwide. There is renewed interest in culturing baitfish species in some regions to support pole-and-line fisheries as an environmentally responsible alternative to wild baitfish harvest. This can relieve pressure on wild stocks and nearshore resources.

Tuna fishing

Ecological impacts

Despite the clear benefits of FADs to the pole-and-line fisheries, their use is associated with several potential negative impacts, including the catch of small tunas, bycatch of vulnerable non-target species, modification of tuna habitat, potential damage to coastal habitats and interference with other maritime activities.

IOTC has recognised the increasing use of FADs in IOTC fisheries, notably for tropical tunas, and Resolution 15/09 has established an *ad hoc* working group on FADs to assess the impact they may have on the species composition and on the rates of by-catch associated with fishing on FADS. Concern has also been raised about the impact of FADs on the incidental mortality of sea turtles and sharks through entanglement, .and emphasis is now being placed on the use of environmentally friendly materials in FAD construction (MRAG, 2017).

1) Impacts on tuna stocks
    a) catching too many fish that prejudices reproduction (recruitment overfishing);
    b) catching too many small fish and reducing the number that reach maturity (growth overfishing);
2) The capture/entanglement of non-target species (bycatch);
    a) retained bycatch (by-product);
    b) incidentally taken in a fishery and returned to the sea (discarded);
    c) incidentally affected by interacting with fishing equipment in the fishery, but not taken (released);
3) Damage to marine and coastal habitats and marine litter, when FAD structures are lost or abandoned in fragile marine habitats like coral reefs;
4) Ghost fishing, the accidental capture of marine life by fishing gear lost or discarded at sea that continues to entangle animals;

For conservation and management measures put in place by the IOTC to limit the capture of juvenile tunas, to avoid the capture/entanglement of Species of Special Interest (SSI), to investigate, limit and avoid ecological impacts of FADs and of purse-seine fishing, please consult the most recent version of the Compendium of Active Conservation and Management Measures for the Indian Ocean Tuna Commission (https://www.iotc.org/cmms).

Interactions

SPECIES	IMPACT	MITIGATION
Marine turtles, Sharks, Birds	• entanglement in FADs;	• use of ecological FADs. • usage of the proper techniques to handle and release bycatch species such as turtles, sharks, and birds.

Bait fishing

Ecological impacts

Many baitfish species used by pole-and-line fisheries display relatively high productivity and resilience to fishing due to their high fecundity, high turnover due to rapid growth, and relatively short life spans. However, bait fishing can still have significant environmental impacts (IPNLF 2012; Gillett 2012), such as:

1) Reduction in the amount of forage available for larger fish
2) overexploitation of some baitfish species, and
3) bycatch of non-target species
    a) retained bycatch (byproduct);
    b) incidentally taken in a fishery and returned to the sea (discarded);
    c) incidentally affected by interacting with fishing equipment in the fishery, but not taken (released).

Management of bait fisheries as well as the ongoing collection of data on bait fishing activities (species composition, total catch, catch-per-unit-effort) are key components for ensuring this aspect of pole-and-line fisheries is sustainably managed.

Interactions

SPECIES	IMPACT	MITIGATION
Marine turtles	• encircled/ caught on bait fishing nets.	• turtle should be encouraged to swim out of the net; or • a large dip-net can be used to pick up the turtle from the net; • usage of the proper techniques to handle and release bycatch species such as turtles.
Cetaceans (various species)	• encircled/ caught on bait fishing nets.	• a side of the net can be lowered to allow the cetacean(s) to escape
Sharks, rays, marlins and other large fish	• encircled / caught on bait fishing nets.	• usage of the proper techniques to handle and release bycatch species such as sharks and others.

IOTCGillnet fishery

Background and vessels

Gillnets or driftnets consist of a series of net panels that are suspended in the water column. It is a passive method of fishing that does not use bait to actively trap fish. The fish swim into the net and become entangled. Gillnets can be broadly classified into several categories: set nets (anchored); and drift nets (un-anchored).

A trammel net is a combination of gillnets of different mesh sizes consisting of three layers of net. A slack, small mesh, inner panel of netting sandwiched between two outer layers of netting, which are taught and have a larger mesh size. The inner panel may be made of multifilament or monofilament nylon, whilst the outer panels are generally made of multi filament material.

Gillnets and trammel nets are widely used all over the world, both in inland and in the marine environment, especially with artisanal fisheries. Driftnets were used extensively on the high seas by a number of countries in the 1980's to target tuna. However, they were also associated with high numbers of incidental capture of marine mammals and turtles.

The use of drift nets longer than 2.5 kilometres on the high seas was banned by the United Nations in 1991. In 1993, the United Nations banned gillnets in international waters, but their use is still permitted at the discretion of the coastal states within their exclusive economic zone.

On the current (2019) IOTC list of vessels 1306 gillnet vessels are registered"

- 1295 from Iran;
- 10 from Pakistan; and
- 1 from France

However, taking the artisanal component of gillnet vessels, 21 countries are reportedly carrying out gillnet fishing in the IOTC area[29].

The length over all (LOA) of vessels and area of operation are main factors depicting the classification between artisanal and industrial gillnet and compliance with IOTC resolutions:

- vessels with LOA greater than 24m are classified as industrial both within their EEZ and on the high seas.
- vessels with LOA greater than 15m that operating on the high seas outside their counties EEZ are classified as industrial vessels;
- vessels less than 15m operating within their countries EEZ are classified as artisanal.

The main IOTC Resolution governing gillnets is Resolution 12/12 to prohibit the use of large-scale driftnets on the high seas in the IOTC Convention area based on the UNGA's resolution 46/215 which calls for a global moratorium on large scale driftnet fishing on the high seas.

Gillnet fishing is also subject to IOTC Resolutions governing statistical reporting and marine turtle conservation, (IOTC Resolution 12/04)

[29] IOTC report; (IOTC-2017-WPEB13-18)

Fishing operations involving gillnets contribute around 35% to the IOTC nominal catches[30]. These catches amount 630 thousand tons of fish. It arises as the most important single fishing gear in terms of volume of catches.

Figure 32: Gillnet vessels operating in the Indian Ocean.

Basic layout of a gillnet vessel

Gillnet vessels layout can vary depending on the size and construction of the vessel. Larger purpose-built gillnet vessels (15m plus) have hydraulic powered drums positioned on the bow from where the nets are hauled and the net is then stored either on the deck forward or in forward holds. The fish are processed on the deck aft of the net haulers. The bridge and accommodation are positioned aft of the vessel.

Figure 33: Hydraulic drums on a gillnet vessel in the Indian ocean and nets stored in hold below deck.

Alternative layouts can be found on multipurpose vessels that may operate either longlines or gillnets. On these vessels the nets are often set and hauled from the starboard side. A long roller is mounted on the starboard rail to facilitate setting and hauling the net.

Larger industrial size vessels (often converted from previous industrial longline vessels), set the net from the stern. The net is then hauled from the starboard side, forward of the bridge, using an elongated drum mounted on a winch and open on one side. A roller is extended over the side to assist in guiding the net to the hauling drum. A shute or channel is used to guide the net from the hauling point back to the stern where it is ready to set again.

30 IOTC report; (IOTC-2017-WPEB13-18)

Figure 34: Drum or net roller used to haul in the gillnet

Figure 35: Guide to haul a gillnet over the side inboard.

Figure 36: Gillnet being set showing top rope and weighted bottom rope.

Fishing gear and related equipment, design and specifications

Gillnets are generally made up out of a series of panels with a weighted "footrope" attached along the bottom, and a "headline", to which floats are attached. The net material can consist of either monofilament nylon or multifilament twine materials.

The size of the mesh is determined by stretching the mesh and measuring the distance from knot to knot in either centimetres or millimetres. The spacing between two points where the net is attached to the headline is called the hung length or bridge length. The hanging ratio determines the depth and mesh tension on a panel of net. The hanging ratio (HR) is effectively the relation between the length of the net attached to the headline or footrope divided by the maximum length of the net. This can be calculated by dividing the bridge length (BL) of a single mesh by its stretched length (SL), (measured from knot to knot).

HR = HS / SML

When nets are constructed with a hanging ratio of 0.5 or slightly higher, they have more tension on the net panel and tend to be more selective in the size of fish caught. However, if the ratio is less than 0.5 then the nets is “slack” with less tension on the net panel and have a reduced selectivity and greater tendency to catch smaller fish or easily entangle larger fish.

The size and spacing of floats on the headline and weight of on the footrope will also vary depending on where the net is to be positioned in the water column. Buoys used on the headline, (float line) are usually solid foam, oval or cylindrical buoys. The footrope is weighed using lead weights attached to the rope or integrated lead core rope.

<u>Observers should be familiar with both these aspects and be able to measure and record these specifications if requested.</u>

Panels of net are commercially available in “skeins” or net panels and a vessel can easily store a large number these on on-board to make up nets while at sea to replace lost or damaged nets.

A number of gillnet panels can be made up into a single net and several nets can be connected into a continuous net. Driftnets used on the high seas can extend up to 60 km.

Figure 37: Gillnet footrope, integrated lead core rope

Figure 38: Gillnet net, footrope, and float line with solid foam floats

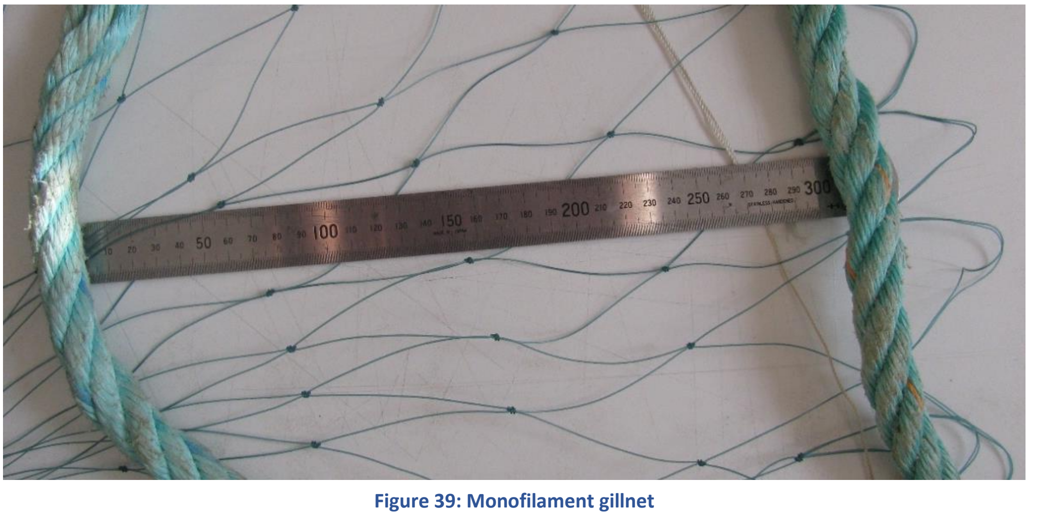


Figure 39: Monofilament gillnet

Alternative terms when describing gillnets

Bottom-Set Nets, Gillnets, Entangling Nets, Trammel Nets;

Net panel (skein) of net:	variable length, depths, mesh sizes and materials obtainable from net manufacturers;
Fleet:	number of net panels connected together. single working unit that is set and hauled.
Float line (top rope):	attached to the top row of meshes and connects net panels into a continuous net (fleet).
Weight line (groundline):	weighted rope attached to the bottom row of meshes connecting fixed number of net panels of a fleet in conjunction with the float line.

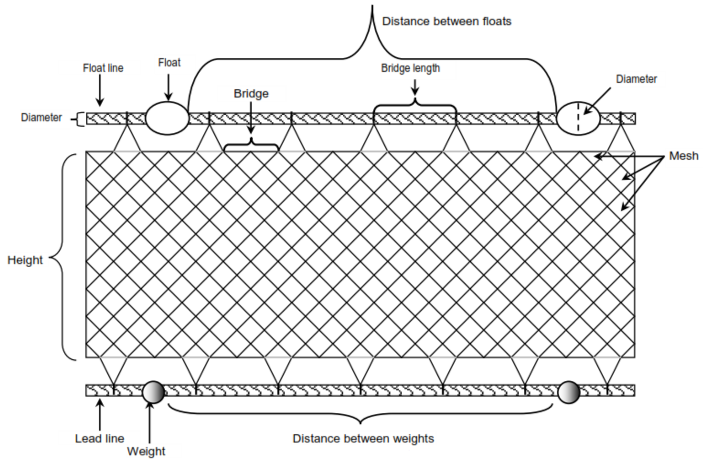
Terminal anchor and buoys: weights and anchor and marker buoys attached to the end of each fleet, (similar or the same as those used to mark the ends of a longline).

Target Species

The main target species of commercial gillnet vessels is yellowfin tuna and skipjack tuna. However large numbers of bigeye tuna are caught as well as larger billfish species. The indiscriminate nature of gillnet fishing can result in a large range of other neritic species that inhabit the near surface area being caught. These are often the main target species of artisanal fishermen, including smaller tuna like species such as: Kawakawa, Frigate tuna and Longtail tuna.

Fishing operations

Both trammel and gill nets entangle fish in three different ways. The fish may become wedged, held by the mesh around the body; gilled, caught by the gills; and tangled, held by teeth, spines or other protrusions without necessarily penetrating the mesh.



The mesh size of gillnets can be highly effective at selecting or regulating the size of fish caught. Fish that are smaller than the mesh of the net are able to pass through the net unhindered, while those, which are too large to push their heads through the meshes as far as their gills, are also less likely to be caught.

Trammel nets also entangle fish in bags or pockets of netting. This occurs when fishes swim through one of the outer panels, hit the inner panel, and are carried through to the other outer panel, which creates a bag or pocket, thereby trapping the fish. Trammel nets are therefore less selective in the size of fish caught.

On small boats, gillnets are handled by hand while hydraulic net haulers and/or net drums are used on larger vessels to handle and store nets.

Search and detection

Similar to longline fishing, the fishermen look for temperature fronts to set their nets. These may be also be areas of local upwelling where there are concentrations of fish. Larger motorised vessel operation on the high seas also have modern-day satellite equipment to assist in detecting areas to set nets.

Artisanal fishermen target area traditional fished on shelf edges.

Fishing event

In shallow water, gillnets and trammel nets are anchored to the seabed and the anchor lines determine the vertical orientation, artisanal fishermen using nets up to 20m deep can fish the whole water column in this way. In deeper waters drifting nets are set and reported length of up to 12km of net can be set in a single event. (*Note this is contrary to the IOTC Resolution 12/04*). These drifting nets can be set on or just below the surface and are not anchored and are allowed to drift with the currents.

Nets are generally set from the starboard side of the vessel, a raise section like and inverted “V”can assist in keeping the weighted and floating lines apart. The vessels forward speed determines the rate at which the net is set. Danbuoys with lights attached are used to buoy off the ends of the net. On longer sets the additional marker buoys can be attached.

Once the net is set it is left for a predetermined soak time. Soak times are likely to vary depending on likely hood of fish being caught. As the fish quickly die in the net that can quickly deteriorate and longer soak times can affect the fish quality. There is also the risk of secondary predation is soak times are too long.

An alternative fishing strategy is to ride along the net so that it is hauled and reset at the same time and fish are removed as the net is hauled. This has the advantage of keeping the net in the water and removing catch before they deteriorate.

Preservation of the catch

Factors that influence the processing and preservation of the fish are the size of the vessel and its range. Processing takes time and needs space, and this can be limiting on smaller vessels. Larger powered vessels have ability for refrigeration for keeping either fresh or frozen fish for several weeks or month if freezing. Whereas artisanal vessels may undertake trips of only a 1 to 5 day and fish can be kept on ice.

On larger vessels with refrigeration the fish may be processed according to the species, gill and gutted or head off. Smaller tuna species are often frozen in the round similar to that on purse seine vessels. Smaller vessels are more likely to land fresh fish, unprocessed.

Fishery impacts on the marine ecosystems and interactions

Ecological impacts

Entanglements with gillnets set close to the surface is not discriminant and poses a high risk to a number Endangered, Threatened and Protected (ETP) species, especially:

- turtles
- small and large cetaceans; and
- sharks.

The high risk of cetacean mortality was one of the main reasons for international communities adopting the moratorium on large scale driftnets. Small cetaceans attempting to feed on fish in the net are at high risk of also getting caught.

Mitigation Measures

No mitigation measures are specifically covered in the IOTC Resolutions. Possible measures that could be employed would be seasonal and area restrictions to setting nets when high populations of turtles are likely to be present. In addition, a restriction in soak time could make it possible to release some of the PET species before they drown or die in the nets.

Interactions

Amongst the species of cetaceans which may interact with gillnet fisheries in the Indian Ocean are Indo-pacific bottlenose dolphin (*Tursiops aduncus*), common bottlenose dolphin (*Tursiops truncates*), risso dolphin (*G. griseus*), spinner dolphin (*S. longirostris*), and diverse whales such as Bryde's whale, and Eden's whale[31].

Figure 40: Entangled turtle recorded by an observer in Indian Ocean.

Olive Ridley turtle (*L. olivacea*) seems to be most abundant, whereas green turtle (*C. mydas*) is the second more frequent turtle tuna gillnets. On a few occasions' hawksbill turtle (*E. imbricata*), loggerhead (*C. caretta*) and leatherback (*D. coriacea*) have also been observed to be entangled[32].

Sharks by-catch is also a commercial by-catch for gillnet fishermen and are likely to be marketed with the target species when the vessel lands.

[31] IOTC report; (IOTC-2017-WPEB13-18)
[32] IOTC-2017-WPEB13-18

PART E: SAMPLING PROCEDURES

SAMPLING PROGRAMS EMPLOYED IN REGIONAL INDIAN OCEAN TUNA FISHERIES

IOTC Regional Observer Scheme

The IOTC Regional Observer Scheme (ROS) has as its core objective: to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area. In addition, the observers will be required to carry out scientific work as requested by the IOTC Scientific Committee.

A. Specific sampling requirements referenced in the IOTC Resolution 11/04 require observers to:

1. for all fishing gears, observe and estimate catches as far as possible with a view to identifying catch composition, monitoring discards, by-catches and size frequency;
2. observers on purse seiners to monitor the catches at unloading to identify the composition of bigeye tuna catches.
3. record catch and effort data that include;
    a. fishing gear specifications;
    b. use of electronic aids to fishing;
    c. total catch determination by species;
    d. fishing strategies;
    e. time start fishing and end fishing; and
    f. search times.
4. biometric sampling of the catch;
    a. taking and recording specific biological samples of the catch that includes;
        i. measuring fish length and weight according to species type and anatomical features
        ii. length and weight ratios;
        iii. sex and maturity
        iv. collect, preserve, store and label samples for DNA analysis.
5. record interactions of the fishing activities with the environment;
    a. assess negative interactions; and
    b. monitor the effectiveness of mitigation measures.
6. be familiar with protocols for the photographing and preservation of an individual species for accurate identification; and
7. how to the use, maintenance and calibration of sampling equipment.

B. Data collection protocols can be separated into several categories and these can be adapted to the vessel and specific fishery being monitored that include:

- generic data;
- specific fisheries vessel & gear;
- biological data collection; and
- environmental monitoring.

C. Generic data encompasses all vessel types and fisheries. These data are generally trip specific and headings in this category will include:

- observer and deployment details;
- vessel owners and compliment;
- vessel details;
- vessel electronics;
- trip information; and
- catch information.

D. Fisheries specific data will cover vessel and gear parameters pertaining to the fishery and include catch and effort information that is collected continuously during the trip specific to each fishing event. Data headings in this category will include:

- operational vessel and gear details;
- catch per unit fishing effort;
- catch processing and storage;
- by-catch and environmental mitigation measures; and
- tagging and tag returns.

Other sampling programs

Scientific Observers are to be informed of other sampling programs that might be in place nationally or regionally in the Indian Ocean Tuna fisheries and of the roles of the observers in relation to these sampling programs.

SAMPLING METHODOLOGIES

Trip selection

Resolution 11/04 states that at least 5% of the number of operations/sets for each gear type and fleet must be sampled. When selecting which fishing trips to place observers on, these should be stratified wherever possible based on vessel size/type, spatial location of fishing operations, temporal variation in fishing operations and any other distinguishing factors between fishing trips of a fleet so that the sample is representative of the fleet.

Sample Selection Strategies

Sampling strategies and methods, of selecting samples on-board a vessel, are determined by the operational nature of the fishery and specific data collection requirements. These will differ between surface fisheries (purse-seine and poling) where large quantities of fish are caught and processed in a relatively short time, [within a few hours] and gillnet and longline fishery where catches from a single set can be spread out over a day.

To achieve these objectives, the observers require the knowledge and training on how to undertake various strategies to obtain the samples they can analyse. Most sampling strategies have a statistical component that is important to ensuring that samples are representative of the total catch. However, it is more important for the observer to fully understand the practical procedure used to collect samples.

Sampling can be conducted for:

- total catch estimation;
- catch composition;
- size and weight composition; and
- biological sub-sample (sex, maturity stage and collection of samples).

Sampling include, but is not restrained to, the following methods:

Exhaustive sampling

Exhaustive sampling is a method of sampling that involves the sampling of the totality of the population (catch, species).

Example:

1. The totality of the hooks or net panels hauled during a longline or gillnet set are observed;
2. The observer weighs/counts every individual caught during purse-seine set (only feasible if the catch is small);
3. The observer counts all fish that land on the vessels during the pole-and-line fishing event; and
4. All individuals caught for a particular species are subsampled (exhaustive sub-sampling).

Proportional sampling

Proportional sampling is a method of sampling that involves the sampling of a proportion (%) of the population and the raising to the totality of the population.

Example:

1. A proportion (%) of the longline is observed /sampled by selecting batches of 10 hooks at every 100 hooks along the line;

2. A proportion (%) of the gillnet is observed by sampling all panels hauled for a period of 1 hour every two hours; and
3. The observer selects two pole fishers and counts fish caught for a period of 5 min every 15 min.

Random sampling

Random sampling is a method of sampling that involves the sampling of a part of the population via the collection of multiple samples randomly selected, i.e. selected haphazardly and raised to the totality of the population.

Example:

1. Hooks are sampled randomly by selecting at random batches of 10 hooks along the longline being hauled;
2. Gillnet panels are sampled randomly by sampling all panels hauled during 1-hour periods selected at random during the hauling time;
3. The observer selects two pole fishers and counts fish caught for 5 min periods selected at random during the fishing event time; and
4. The observer samples all individuals of a particular species present on a purse-seine brail randomly selected.

Stratified sampling

Stratified sampling is a method of sampling that involves the division of a population into smaller sub-groups known as strata, that are mutually exclusive. In stratified sampling or stratification, the strata are formed based on members' shared attributes or characteristics such as size.

Stratified random sampling is also called proportional random sampling or quota random sampling.

[Important: Stratified sampling is used to highlight differences between groups in a population, as opposed to simple random sampling, which treats all members of a population as equal, with an equal likelihood of being sampled.]

Example:

1. The observer tips the fish from a brail/pile/receptacle/conveyer belt into a bin to avoid hand selection of individual fish, divides fish into homogeneous subgroups before subsampling e.g. 50 yellowfin tuna.
2. The observer pulls by hand a selected number of fish from a brail/pile/receptacle/ conveyer belt and divides fish into homogeneous subgroups before subsampling e.g. 50 fish of more than 15 kg.

Systematic sampling

Systematic sampling is a sub-sampling method that involves the organised, regular sampling of a sub-sample of the population. This sub-sample can be collected randomly or proportionally.

Example:

1. Of the random sample taken, the fish are identified to species level. Once the main species have been determined, a pre-determined number of fish of each species is sub-sampled.
2. Of the random sample taken, a small random subsample is taken and biological information extracted.
3. A proportion (%) of the catch or of the individuals caught and brought on-board for a certain species is subsampled in a systematic way (e.g. every 10th fish caught is sub-sampled for length frequency).

Which type of within-set sampling takes place must be well documented!

Sampling for total catch estimation

To be successful as an observer, the estimation of sizeable quantities of fish is an important skill to learn. There are three ways to estimate a set / fishing event total catch:

1) Weigh/count the entire catch (feasible if the catch is small)
2) Use the vessel estimate
3) Record the catch weight /number of samples and raise these, or take numbers and length measurement for conversion.

The first option is generally unavailable, and the second option introduces the possibility of bias, given the source of the data. The third option is independent, but is an approximation and requires careful observation to achieve better accuracy which will increase with the experience of the observer. Potential methods to calculate total catch include exhaustive, random and proportional sampling, yet, these will differ between fisheries. Whatever type of within-set sampling takes place must be well documented.

Sampling for catch species composition

Sampling for catch composition is where the observer collects information on the species composition of the catch. This will include target species and bycatch species. Bycatch can comprise species with commercial value (retained), species with NO commercial value (discarded) and incidentally affected species such as sea birds, marine mammals and turtles, and some sharks' species (released). Observer is expected to provide an estimation on the weigh or number of each of the species that compose the catch per fate (i.e. if they were, retained, discarded or released).

Potential methods to calculate total catch include exhaustive, random and proportional sampling, yet, these will differ between fisheries.

Sampling for size composition

Sampling for species and size composition is where the observer collects information on individual species size composition -length frequency (and sometimes weight frequency, on a smaller proportion of the catch (sub-sample).

Potential methods to use for this might be exhaustive sampling; systematic proportional sampling; stratified sampling; systematic random sampling of a fixed number of species or of a mixed species sample; or other sampling methods that are specifically required from the observer by its managing authority and that are to be detailed in a sampling protocol to be provided to the IOT Secretariat together with the set of data for the observed trip.

Biological sub-sampling

Biological sub-sampling is where the observer collects detailed biological information on a smaller proportion of the catch, such as sex, maturity stage, takes otolith and/or genetic samples. Potential methods to use for this might be systematic random sampling, such as selecting every nth fish from the original sample taken.

Fixed number of each species
Of the random sample taken, the fish are identified to species level. Once the main species have been determined, a fixed number of fish of each species are measured to obtain a size frequency distribution for each species. An advantage of using this method is that all species should be evenly sampled, however, the main species may be under-sampled so priority species, such as bycatch may be selected prior to the trip.

Mixed species sampling
Of the random sample, a small random subsample is taken and biological information extracted. The advantage with this strategy is that the main species will be well sampled while a disadvantage is that the minor species component of the catch may be under sampled.

Priority species
Particular species may be selected by the observer scheme managers prior to the trip taking place based on specific research projects, or species targeted for stock assessment or review at a regional level. These may be selected purposefully from the random sample. This may also include certain bycatch species.

Sampling strategies as a function of the fisheries

Sampling on industrial tuna purse-seiners

Surface fisheries like purse-seiners tend to target and catch schooling fish in greater numbers in a short time period and within a fixed location at a time. The catch is often more uniform in size and in species composition.

Practically, in these situations, only smaller sub-samples of the catch can be measured and a stratified sampling protocol is followed. On the contrary, the catches associated to FADs present a great variability in size and species composition. In this situation, the choice of the sampling protocol to follow will be done in function of sampling objectives.

Sampling on industrial tuna purse-seiners needs to be repeated several times during a same set as fish have the tendency to assemble per size and species inside the net, therefore catch species and size composition can vary during brailing.

PURSE-SEINE

1) Free school (catch uniform in size and in species composition)
   - Stratified sampling
2) Associated school (catch with high variability in size and species composition)

   Catch species composition
   - Proportional sampling

   Size frequency
   - Stratified sampling
   - Proportional sampling
3) Pre-sorted catch
   - Stratified sampling

SAMPLING ON INDUSTRIAL TUNA LONGLINERS

The gear and nature of the longline fishing operations results in *individual* fish being targeted. The gear is spread out over a large area (up to 200 km). Larger adult fish from small shoals are targeted and catches can show a greater variance in size and possible species composition. However, the catch rate in time is generally low as a line can be hauled over a whole day, which makes it possible to sample a high percentage of the catch.

Therefore, observers on longliners can record most of the species and measure the length of each as they are landed. In addition, the observer can generally sample each line set.

When the catch rate is higher, the species composition is usually more uniform so a smaller proportion of the fish can be measured following systematic sampling approach such as every measuring every *"n^{th}"* fish. Also, the observer needs to spend a proportion of their time on deck monitoring the line being hauled for interactions with PET species. At this time, they may not be able to take biometrics, but can still accurately record catch composition. On average an observer should be able to monitor at least 80% of a line being hauls and collect biometrics from more than 50% of the species caught.

LONGLINE

1) Low catch rate
   - Exhaustive sampling
2) High catch rate
   - Proportional sampling

   Species composition
   - At least 80%

   Size frequency
   - At least 50%

SAMPLING ON GILLNET VESSELS

The gear and nature of the gillnet fishing operations results in fish being individually remove from the net. The gear is spread out over a large area (up to 10 nm). Catches can show a greater variance in size and species composition. However, the catch rate in time is generally low as a gillnet can be hauled over a whole day, which makes it possible to sample a high percentage of the catch.

Therefore, observers on gillnet vessels can record most of the species as they are landed. When the catch rate is low, the observer can also measure the length of each specimen.

When the catch rate is higher, a smaller proportion of the fish can be measured following systematic sampling approach such as every measuring every *"nth"* fish. Also, the observer needs to spend a proportion of their time monitoring the net being hauled for interactions with PET species. At this time, they may not be able to take biometrics, but can still accurately record catch composition. On average an observer should be able to monitor at least 80% of the gillnet being hauls and collect biometrics from more than 50% of the species caught.

GILLNET

1) Low catch rate
    - Exhaustive sampling
2) High catch rate
    - Proportional sampling

Species composition
- At least 80%

Size frequency
- At least 50%

SAMPLING ON POLE AND LINE VESSELS

Surface fisheries like pole-and-line tend to catch large number of fish in a short time period, within a fixed location at a time, even if it catches one-by-one.

When fishing in free-schools the catch is often more uniform in size and in species composition. On the contrary, the catches associated to FADs present a great variability in size and species composition.

Observers on pole-and-line vessels will record catch size composition while fishing is occurring following a systematic proportional sampling approach such as every measuring every *"nth"* fish.

Total catch and catch species composition are to be recorded at the end of the fishing event when the fishers bring them to the cold-storage hold. For small catches are to be exhaustively sampled for species composition and total catch (in numbers). For large catches the observer is to follow a proportional sampling protocol by counting the total number of baskets taken to the cold-storage and sampling one or more of these baskets, for species composition and weight.

POLE AND LINE

1) Size frequency
    - Systematic proportional sampling
2) Total catch and catch species compositions

    Small catch
    - Exhaustive sampling

    Large catch
    - Proportional sampling

IOTC ROS sampling requirements

Target species

According to IOTC Res. 15/02[33] para. 5: Size data:
"Size data shall be provided for all gears and for all species (...). *Size sampling shall be run under strict and well described random sampling schemes which are necessary to provide unbiased figures of the sizes taken*. ***Sampling coverage shall be set to at least one fish measured by ton caught, by species and type of fishery, with samples being representative of all the periods and areas fished.*** (...)."

Non-target species

As providing information on bycatch is a key requirement of observers, information on bycatch species, should be recorded as far as possible, whether retained or discarded and of non-target species state at capture and at release.

Species of Special Interest

As providing information on the bycatch of species of special interest is a key requirement of observers, these species are to selected for biological sub-sampling, as far as possible, whether retained or discarded and their state at capture and at release recorded.

Tagged fish

Catches are also monitored for the recapture of tagged fish and so these fish may be selected for biological sub-sampling.

For sampling strategies to be followed when sampling on-board industrial tuna purse-seiners, pelagic longliners, gillnetters and pole-and-line vessels, operating in the IOTC convention area please report to IOTC ROS Scientific Observer Workbooks.

BIOMETRICAL SAMPLING

[33] Resolution 15/02: Mandatory statistical reporting requirements for IOTC contracting parties and cooperating non-contracting parties (CPCS).

Measures

LENGTH MEASURING INSTRUMENTS

Length measuring instruments include:

- callipers
- measuring board
- flexible tape
- electronic measuring boards

Callipers

Callipers provide the most accurate measurements and are good for measuring small and medium size tuna and by-catch species. Their main advantage is their accuracy and they can accurately record straight measurements on tuna that have a solid round trunk that cannot be flattened out. However, their maximum measurement is limited to approximately 1.5m.

Callipers are generally made out of hard wood, brass, aluminium or plastic. A constraint is they can take up space when transporting and are delicate instruments that can get easily damaged in the working environment onboard a vessel.

Usage

1. Place one of its ends at the point of origin of the measurement to be taken.
2. Slide the other tip of the calliper to the end point of the measurement.
3. Read the length indicated by the calliper.

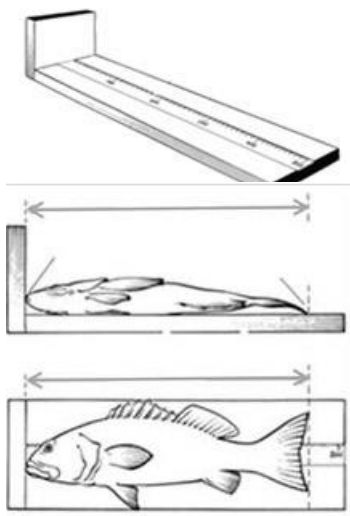
Figure 41 - Measuring a tuna using a calliper (© RTTP-IO)

Note: If the fish is too long for the calliper, then measure it in two times.

Measuring Board

A measuring board consists of a ridged board with a ruler graduated in mm, cm or ½ cm. One end has a stop so that fishes head can easily be positioned at the zero mark.

Electronic measuring boards use mechanical electronic touch sensors to record measurements on a digital display and directly onto electronic data systems.



A measuring board is ideal for taking flat measurements and can be used to rapid measure smaller fish, less than 1.2 meters and recording only a single parameter, (e.g. total length or fork length).

Usage

1. Place the fish on the ruler, the anterior end (mouth or nose) in contact with the stop.

2. Place your eye just above the tail of the fish to read the measurement correctly (if the observer moves the head to one side or the other, the angle of observation will cause a measurement error).

3. Take the most appropriate measure according to the species measured

Flexible tape

A flexible tape is a versatile means of measuring large tuna and the larger billfish. It is easily carried around in your pocket. However, it must be used correctly to record straight measurements. If the curve of the fish is recorded this must be clearly noted.

Usage

1. Flat (placed on the floor) to make flat measurements (same use as the scale rule). This method being less precise than the two previous methods.

2. To take curved measurements, only in the case of turtle shells and some measurements of billfish.

> The use of the tape measure is recommended to perform curve measurements on turtles.

Measurements to be taken

Observers must be clear on exactly what measurements they are recording. The following points must be noted:

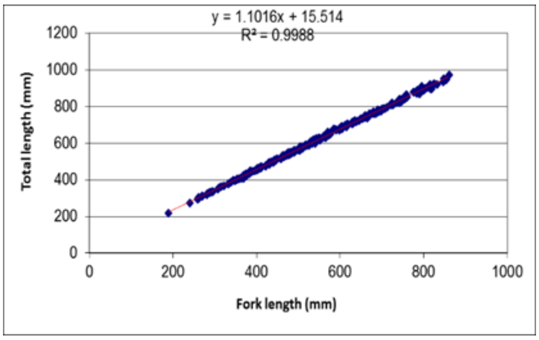
- all measurements must be made in the lower cm.
  - If the length of the fish is 43.1 cm, note 43 cm.
  - If the length of the fish is 43.8 cm, note also 43 cm.
- all measurements must be associated with a measurement type and a measurement tool and recorded using IOTC ROS approved codes:
  - FT - Curved fork length taken with a tape measure;
  - FB - Board fork length taken with a board;
  - FL - Fork length taken with a calliper, etc.
- always reference the length measured (as per IOTC ROS approved standard lengths)

- always measure a fish on a flat surface
- never measure a crushed, broken, deformed or curved fish.

Reference measurements

There are standard measurements taken for different species group these are referred to as the reference length. In some cases (*if the fish is already trimmed or in case of depredation*) the reference length cannot be measured. For these cases, there are other lengths that can be measured. In general, apart from the case of turtles and billfishes, all measurements presented below should be taken as flat lengths.

It is important to record exactly the means and type of measurements taken. The observers sampling instruction may require them to take several measurements from a single fish. These measurements can later be used to draw up regression tables to calculate alternative measurements when these could not be measured for any reason, (*i.e. the fish were all processed head off and scientists require the total lengths for statistical purposes*).



Tuna length measurements

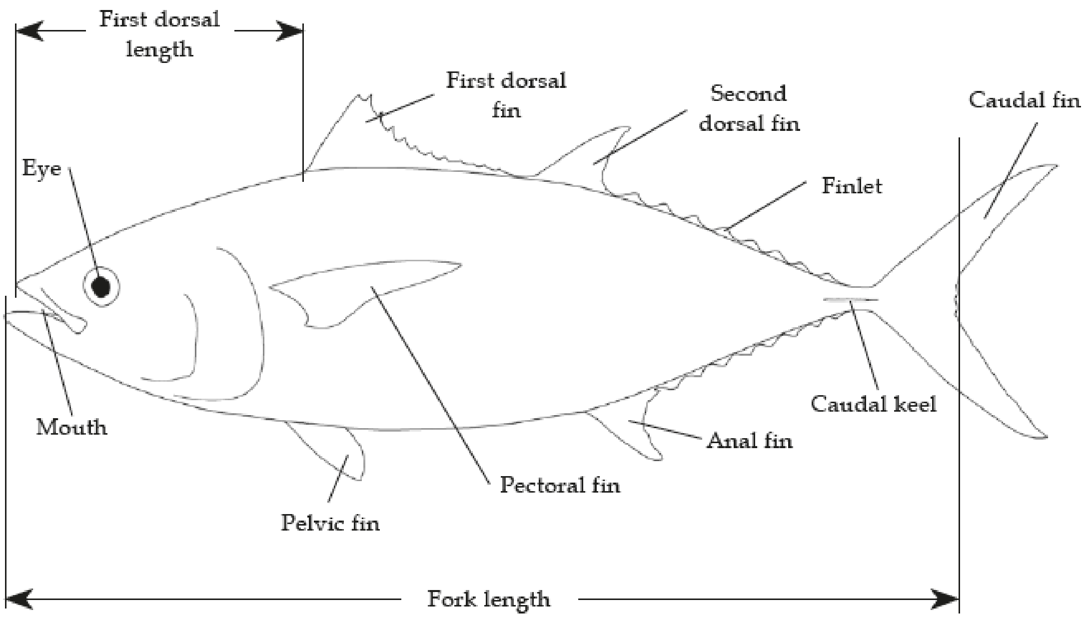


Figure 42 - Tuna Length Measurements (Illustration © R. Swainston/ anima.net.au)

The primary reference measurements for tuna are "fork length" (FL), measured as a straight-line from the tip of the snout to the fork of the tail and **"upper jaw fork length" (UJFL)**, measured as a straight-line from the tip of the upper or top jaw to the fork of the tail. If these measurements are taken in a curved-line using a measuring tape, they are to be referred to as "curved fork length" (FT) and "curved upper jaw fork length" (UJFT).

In situations where the fish are too large for the available equipment or the heads or the tails have been cut off for production purposes then the following alternative measurements can be taken:

First dorsal length (FD1) Also called pre-dorsal length, measured as a straight-line from the tip of the upper jaw to the insertion of the first dorsal spine (or the "curved first dorsal length (FD1T) if taking a curved-measurement).

Pectoral fork length (PL) Measured as a straight-line from the anterior insertion of the pectoral fin to the fork of the tail (or the "curved pectoral fork length" (PT) if taking a curved-measurement).

Billfish length measurements

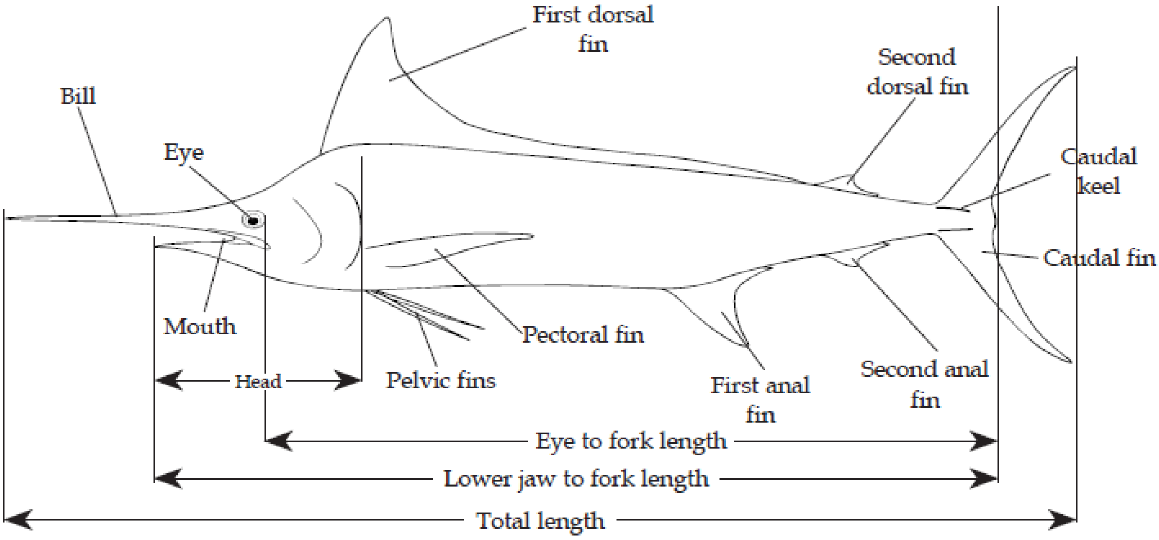


Figure 43 - Billfish Length Measurements (Illustration © R. Swainston/ anima.net.au)

Billfish are preferably measured for "lower jaw fork length" (LJFL) and "eye to fork length" (EF). Both measurements are to be taken as a straight-line with the "LJFL" being measured from the tip of the lower jaw to the fork of the tail and "EF" being measured from the posterior edge of the eye socket to the fork of the tail.

The length of most billfish makes it impractical to use callipers or a measuring board and the preferred measurements can also be taken with a flexible tape pulled over the contours of the body. In such cases these measurements, taken in a curved-line, are to be referred to as "curved lower jaw fork length" (LJFT) and "curved eye to fork length" (ET)).

On some commercial vessels it may not be possible to take the LJFL length as the fish are first dressed by the crew, alternative measurements that can be taken in these situations are:

Eye-fork length (EF) Measurement is taken on a straight-line from the posterior edge of the eye socket to the fork of the tail (or the "curved eye-fork length" (ET) if taking a curved-measurement).

Pectoral-fork length (PF) The length is taken on a straight-line from the most anterior insertion of the pectoral fin to the fork of the tail (or the "curved pectoral-fork length" (PT) if taking a curved-measurement).

Pectoral-dorsal length (PDL) The length is taken on a straight-line from the most anterior insertion of the pectoral fin to the most anterior insertion of the second dorsal fin (or the "curved pectoral-dorsal length" (PDT) if taking a curved-measurement).

Pectoral-anal length (PAL) The length is taken on a straight-line from the anterior insertion of the pectoral fin to the posterior rim of the anal sphincter (or the "curved pectoral-ANAL length" (PDT) if taking a curved-measurement).

Sharks length measurements

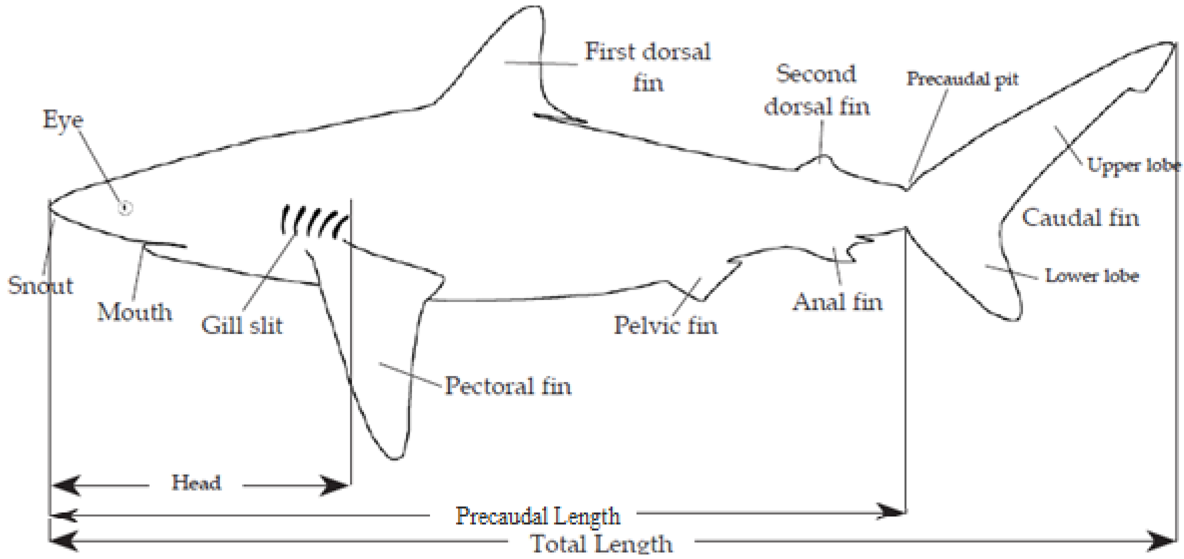


Figure 44 – Sharks Length Measurements (Illustration © R. Swainston/ anima.net.au)

Sharks are preferably measured for total length (TL), from the tip of snout to extreme end of tail in a straight line. Error! Reference source not found.. Alternative measurements are:

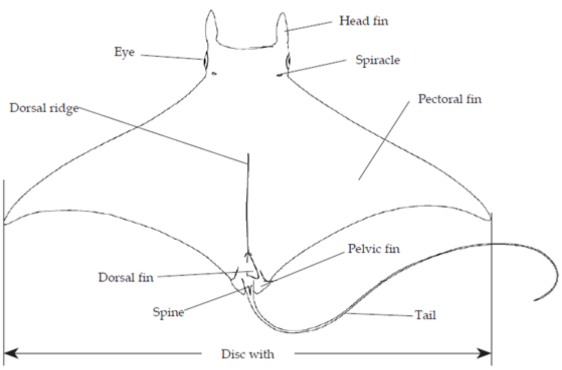
Fork Length (FL) The length is taken on a straight line from the tip of the snout to the fork in the tail (or the "curved fork length" (FT) if taking a curved-measurement).

Pre-caudal Length (PCL) The length is taken on a straight line from the tip of the snout to the pre-caudal notch (or the "curved pre-caudal length" (PCT) if taking a curved-measurement).

Rays length measurements

Pelagic stingrays are normally only measured for total disc-width (TW).

Total disc with (TW) The length is taken in a straight line from the tip of one wing to the tip of



the other (or the “curved total disk with” (TT) if taking a curved-measurement).

Figure 45 - Rays Length Measurement (Illustration © R. Swainston/ anima.net.au)

Marine turtles’ length measurements

Overall size for marine turtles is usually given as **carapace length**, either **straight (CL),** measured using callipers, or **curved (CT),** measured with a length of tape.

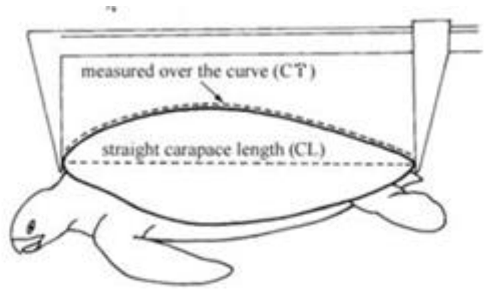


Figure 46 - Common length measurements used for turtles (Illustration © FAO)

Because the precentral scute may be concave and because there is a distinct notch between the postcentral scutes in the Cheloniidae, measurements may be taken from the furthest point on the front margin of the carapace to the furthest part on the hind margin (tip to tip), or from the nearest point on the front margin to the notch in the rear margin (notch to notch) (**Error! Reference source not found.**). A curvilinear notch length should preferably be taken and the type of measurement taken should be recorded using the relevant code category

Bird length measurements

Length measurements for birds are generally made by laying the bird on its back and flattening out the head and neck gently and measuring its total length (TL) in a straight line between the tip of the bill and the tip of the tail. Another length measurement that can be collected is bird wing length (WL) measured from the bend of the wing to the tip of the longest primary feathers) (**Error! Reference source not found.**)[34].

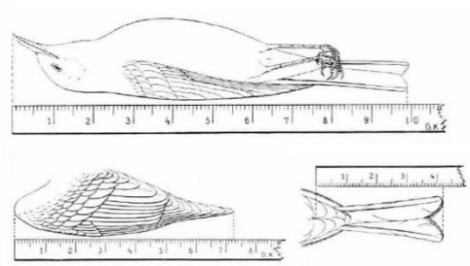


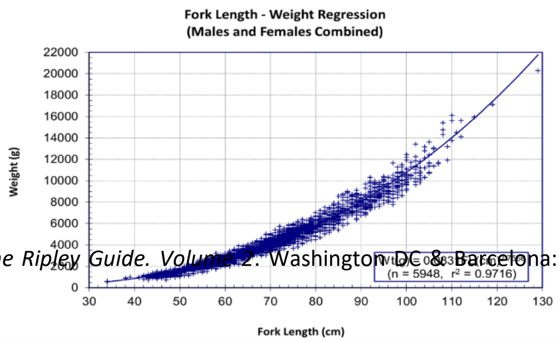
Figure 47 - Common length measurements used for birds (total and wing lengths)

Weights

Normally fish are weighed “in the round” i.e. whole or total weight. These weights are used in fisheries management growth equations to express growth in terms of mass, and in yield-per recruit and spawning biomass per recruit assessments. However, on longline vessels the crew often only weigh the fish after it is processed, before freezing. Due to the size of some species collecting weight data from unprocessed fish may be difficult. *Length/weight relationships* are used to estimate total weights in fisheries where only processed lengths are measured.

When weights are collected the main units are likely to be in kilograms.

When observers are required to collect specific sample weights (*i.e. gonad or stomach weights*)



[34] Rasmussen PC and Anderton JC (2005). *Birds of South Asia. The Ripley Guide. Volume 2*. Washington DC & Barcelona: Smithsonian Institution & Lynx Editions. pp. 18–19.

these are generally recorded in grams. It is important to ensure you record the data using the correct metric specified in the field title (e.g, fish weighs are in “kg” and gonad weight are in “g”).

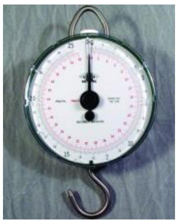
Weighing mechanisms

Fish must be weighed correctly on an as accurate scale as possible or practical. Even so, weighing of fish at sea on small vessels may be difficult due to the movement of the vessel. When weighing at sea the dial on a spring scale or readings on an electronic scale may constantly change up and down with the vessel movement. By watching these changes for a while an average between the maximum and minimum readings should be recorded.

Whilst it is not a specified requirement, the Scientific Committee strongly recommends the use of electronic motion compensating scales for all measurements. However, the high cost of these and conditions where they can be used is a limiting factor.

There are sections in the logbooks and in the cruise report for you to indicate the weighing equipment used during your deployment.

Mechanical scales



The most multipurpose scale used at sea are hanging spring (dial) scale. They can be used when there is no access to electronic scales or when the surrounding conditions are unfavourable (i.e. excessive motion because of rough seas; wet measuring area).

Spring scales come in a large range of weigh capacities (*500g to 500kg*), that can be used different levels of precision (*from 5g, 250g to kg plus*).

To get the most accurate results the weight of the object being weighed should not be less than 20% of the scale capacity and not exceed 80% of the capacity. For example, if using a 50kg scale then it would not be ideal to weigh fish less than 10kg or more than 40kg.

A scale should be regularly calibrated before use and always check it is “*zeroed*” before weighing a fish.

Electronic and motion compensated scales

Electronic and motion compensated scales are Used in good working conditions, such as a dry lab. These are not usually used on the average fishing vessel.

Beam scales

Beam scales often used by tuna longline vessels to record the weight of dressed carcasses before weighing.

ADDITIONAL BIOLOGICAL SAMPLING PROCEDURES (IOTC, 2015)

Sex and Maturity

Tuna and Billfish

When specified in the sampling program the sex or gender of the fish may also be required. On the large purse-seiners the tuna caught are often juveniles and the fish are frozen whole and it is unlikely that sexing of the tuna will be required. However, on tuna longliners where adult fish are mostly caught, these can be determined by first taking the length measurements and then checking the gonads for sex when the crew is dressing the fish. The gonads for both tuna and billfish are found in the ventral part of the body cavity.

Billfish are normally measured for both length and sex. It is well known that male and female billfish have significantly different growth rates with the larger fish mostly being female. Male billfish on average do not weigh much over 100kg. The gonads for billfish may not easy to distinguish, however there is a clear difference in the shape between male and female gonads (Figure 48). The male gonads are relatively irregular in shape and some have many nodules present on the external surface. Cross sections have a characteristic rectangular shape and when sexually active milt can be seen. The lumen will be visible at the base or to one-side of the gonad. The female gonads have a smooth external appearance and the cross section has a characteristic oval shape with a lumen visible in the middle.

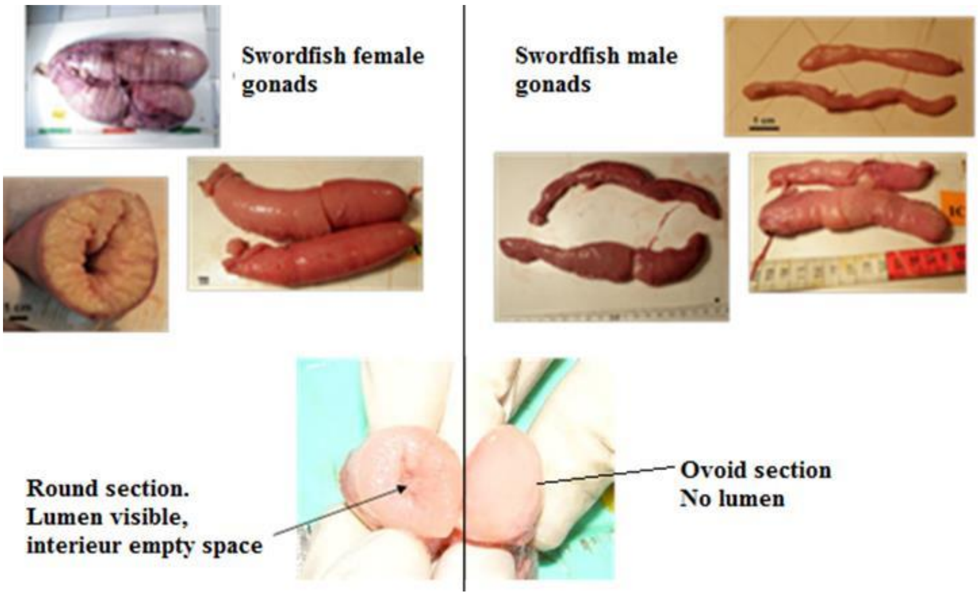


Figure 48 - Difference between female and male swordfish gonads (© IFREMER)

Maturity Stage of Tuna

Maturity can be assessed through visual examination of the gonads and assigned a maturity stage form 1 to 5 (Table 2), however, the visual assessment of ovaries to determine maturity stage is felt to be an imprecise indicator of reproductive condition (West, 1990) so the use of histological and/or chemical methods is recommended. Whichever method is used should be fully documented.

Table 2 Maturity stages used for visual examination of large pelagic gonads

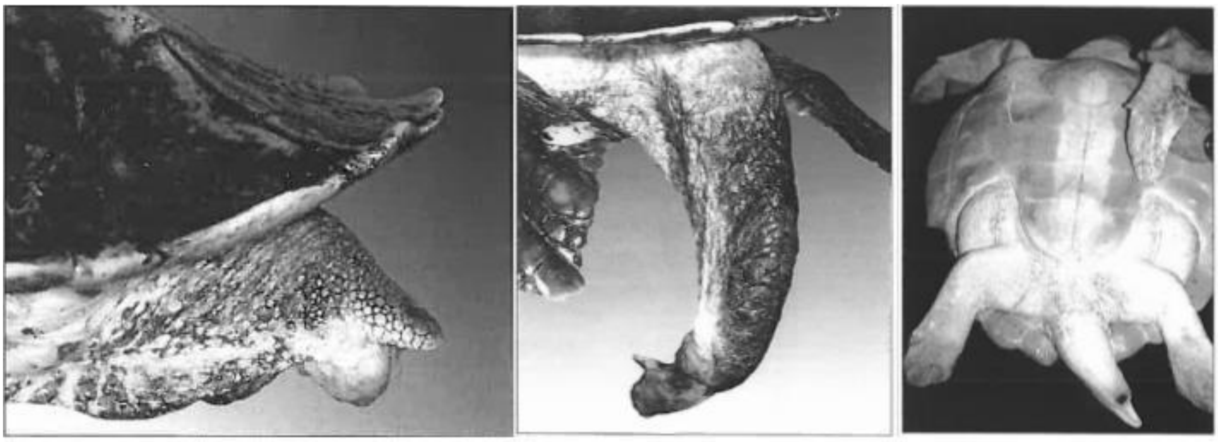
Stage	Criteria	
	Males	**Females**
I	Gonads small ribbon-like, not possible to determine sex by gross examination	Gonads small ribbon-like, not possible to determine sex by gross examination
1	**Immature**; testes extremely thin, flattened and ribbon-like, but sex determinable by gross examination	**Immature**; gonads elongated, slender, but sex determinable by gross examination
2	Enlarged testes, triangular in cross section, no milt in central canal	**Early maturing**; gonads enlarged but individual ova not visible to the naked eye
3	**Maturing**; milt flows freely if testes pinched or pressed	**Late maturing**; gonads enlarged, individual ova visible to the naked eye
4	**Ripe**; testes large, milt flows freely from testes	**Ripe**; ovary greatly enlarged, ova translucent, easily dislodged from follicles or loose in lumen of ovary
5	**Spent**; testes flabby, bloodshot, surface dull red, little or no milt in central canal	**Spawned**; includes recently spawned and post-spawning fish, mature ova remnants in various stages of resorption, and mature ova remnants about 1.0mm in diameter

Sharks and Rays

The sex of sharks and rays can be determined externally by the presence or absence of a pair of claspers on the pelvic fins. Claspers are very prominent in mature males, more subtle in juvenile males and completely absent in females.

Turtles

Turtle gender is not apparent, and it is according to their secondary sexual characteristics that we can determine it. The most obvious is the size of the tail, much larger in males. The size of the claws in the *Chelonidae* (e.g., green turtle) is another.



Female with a small tail **Adult male with a long tail**

Figure 49 - Distinguishing characteristics between male and female turtles

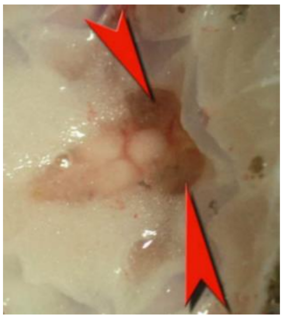
Age and growth

Observers may be expected to collect otoliths for age and growth studies.

Otoliths are hard milky white structures composed of calcium carbonate that form part of the inner ear of fish and are used in maintaining balance.

They grow throughout the life of fish by and form layers each year or season. The layers are used by scientists to estimate fish age (same principle as that of the cross section of a tree trunk that reveals its age).

EXTRACTING OTOLITHS



Open the skull of the fish (use knife or saw) to access cavities containing otoliths. This can be done in several ways:

- Dorsal cross-section - most commonly used, on all types of fish (any species, individual size or cranial morphology).
- Transversal cross-section - performed by separating the body of the fish's head, may be more practical on certain species (i.e. swordfish, tuna).
- Ventral cross-section - through the gills; does not damage the appearance of a fish.

After cutting, remove the brain and tissue to access the semi-circular canals and extract the otoliths using tweezers. Clean the otoliths and store in clearly labelled paper envelopes.

FEEDING BIOLOGY

Fish may be generalists (feed on a wide range of prey items) or specialists (feed on specific types of organisms). Where requested, the stomach (or other parts of the digestive tract) maybe collected and frozen in well-labelled plastic bags. Specific instructions on sampling method and storage to be given by the scientist requesting the samples.

GENETICS

Genetic samples to be collected on request. Detailed instructions on which part of the body to sample (fin clip, muscle, or walking leg in lobster), how many samples required per site, and storage methods (90% alcohol or frozen) to be given by the scientist requesting the samples.

The general procedure for collecting genetic samples are:

- photo sampled fish
- record biometrics of fish [length / weight / sex & maturity]
- use scalpel or scissors [disinfected] with alcohol]
- take small tissue or fin sample of approx. 1 cubic cm
- place tissue in a vial containing 90 ° alcohol completely covering tissue with alcohol and
- clearly label sample

TAGGED ANIMALS (IOTC, 2015)

If a tagged or banded animal is encountered, every effort should be made to recover the tag (if the individual is dead), or to record the information on it (e.g. for a turtle or seabird that will be released).

The tag number, length, weight, sex, time and place of capture should all be recorded in the relevant data field sections of the observer forms where possible. In many cases, instructions on where to report recaptures appear on the tag and with these types of tags, there is often a reward associated with the returning the tag to the researchers who deployed it.

There are a variety of tag types in use, from simple numbered plastic tags to complex electronic tags:

- Plastic spaghetti or dart tags are attached on the back of the fish.
- Rototags are a two-piece, plastic cattle ear tag, which is inserted through the first dorsal fin.
- Sonic tags are miniature radio transmitting devices that are surgically implanted inside the tuna (since these are not visible externally, a conventional tag of a certain colour will be visible on the outside).
- Internal archival tags are implanted in the body cavity and record internal body temperature and the environment's temperature, pressure, and light.
- Smart Position or Temperature Transmitting (SPOT) tags are attached to the dorsal fin and send a signal to a satellite every time the animal surfaces.
- Pop-up Satellite Archival Tags (PSAT) are inserted with an anchor and a tether into the dorsal musculature, recording temperature, pressure, and light, and they detach from the animal on a pre-programmed date.

SPECIES IDENTIFICATION

Resources available to assist with species identification

It is the observer's responsibility to record all species that interact with the fishing gear, whether they are target species or bycatch, retained or discarded.

Identifying fresh species is relatively easy compared to distinguishing frozen or iced fish. Even at small sizes, freshly caught species have distinct coloration, body markings and body morphologies that provide rapid visual keys to positive identification. Frozen species are far more difficult to distinguish due to fin damage, discoloration, skin abrasion and distortion or crushing during the storage process. Even though tuna species are easiest to distinguish in fresh condition, misidentifications and lumping of yellowfin, bigeye and longfin commonly occurs in surface fisheries.

There are a number of recommended resources available to assist with species identification.

For all species groups

1) *IOTC species identification guides*. E-copies are available at: www.iotc.org/science/species-identification-cards or hard copies can be obtained on request from the IOTC Secretariat[35].

[35] secretariat@iotc.org

For tuna

2) McAuliffe J.A., Itano D. G., Arceneaux S. *Photographic identification guide for billfish, sharks, rays, tuna-like and non-tuna finfish taken in WCPO pelagic longline fisheries (v1)*. E-copies are available at: ftp://ftp.soest.hawaii.edu/PFRP/itano or can be obtained on request to David Itano dgi@hawaii.edu
3) Fukofuka S., Itano D. G. *Photographic identification guide for non-target fish species taken in WCPO purse seine fisheries.* E-copies are available at: ftp://ftp.soest.hawaii.edu/PFRP/itano or can be obtained on request to David Itano dgi@hawaii.edu
4) Chapman L. and all. *Marine species identification manual for horizontal longline fishermen.* SPC, 2006[36]

Sharks and rays

5) On-board guide for the identification of pelagic sharks and rays of the western Indian Ocean (Smart Fish, FAO, COI)
   - www.iotc.org/sites/default/files/documents/2014/11/FAO_Onboard_Identification_Pelagic_Guide_Part_1.pdf
   - www.iotc.org/sites/default/files/documents/2014/11/FAO_Onboard_Identification_Pelagic_Guide_Part_2.pdf
   - www.iotc.org/sites/default/files/documents/2014/11/FAO_Onboard_Identification_Pelagic_Guide_Part_3.pdf
   - www.iotc.org/sites/default/files/documents/2014/11/FAO_Onboard_Identification_Pelagic_Guide_Part_4.pdf
   - www.iotc.org/sites/default/files/documents/2014/11/FAO_Onboard_Identification_Pelagic_Guide_Part_5.pdf

Marine Turtles

6) NOAA Identification, Handling, and Release of Protected Species. -copies are available at: http://www.fpir.noaa.gov/SFD/pdfs/PSW_Placards_English_2014.pdf

Seabirds

7) http://bmis.wcpfc.int/docs/links/AFMA_2013_Seabird-ID-Guide-2013.pdf
8) www.acap.aq/en/resources/acap-species2
9) Video on bird scaring line deployment http://youtu.be/9WG6drHNcrk

Marine mammals

10) www.fao.org/docrep/009/t0725e/t0725e00.htm

Electronic species identification methods

Other sources of information on species ID include:

11) iSpot, the online community of species identification experts to assist with identification based on uploaded photos www.ispotnature.org/communities/global

[36] http://www.spc.int/coastfish/en/publications/341-marine-species-identification-manual-for-horizontal-longline-fishermen.html

12) The FAO iSharkFin electronic species identification guide based on photos of shark fins www.fao.org/fishery/ipoa-sharks/iSharkFin/en

BEST PRACTICE GUIDELINES FOR THE SAFE RELEASE AND HANDLING OF CETACEANS, RAYS, SHARKS, SEABIRDS AND SEA-TURTLES

Resources available

It is the observer's responsibility to follow best practice guidelines for the safe release and handling of birds, cetaceans, rays, sharks and turtles and to record if fishing vessels crew follow best practices guidelines as requested in IOTC CMMs. This information is to be recorded in Observer final trip report and presented to the Observer Coordinator for transmission to the IOTC. There are a number of recommended resources available to assist with the following of best practices guidelines in the safe release and handling of cetaceans, rays, sharks, seabirds and sea-turtles.

1) Poisson F., Vernet A. L., Séret B., Dagorn L. Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners. EU FP7 project #210496 MADE, Deliverable 7.2., 30p. file:///D:/Training%20materials/SSI/Sharks%20and%20rays/IOTC-2012-WPEB08-INF07.pdf
2) SPC, 2012. Methods for longline fishers to safely handle and release unwanted sharks and rays. https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/SCXKM5I8%20-%20Anon.%20-%202012%20-%20Methods%20for%20longline%20fishers%20to%20safely%20handle%20and%20.pdf
3) King M. Protected marine species and the tuna longline fishery in the Pacific Islands / Secretariat of the Pacific Community. Coastal Fisheries Programme. SPC. 2004. https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/ZKX6QR7E%20-%20581a42dfea1ad696f2f58622db308ef9.pdf
4) *IOTC sea-turtle species identification guides*. https://www.iotc.org/sites/default/files/documents/2018/11/IOTC_turtles_for_web.pdf
5) Agreement on the Conservation of Albatrosses and Petrels. https://www.acap.aq/en/bycatch-mitigation/hook-removal-from-seabirds-guide.

PART F: OBSERVER REPORT FORMATS

The observer will be required to submit a series of reports to the controlling organisation at predetermined times throughout each trip (Appendix III). These include:

- Deployment Report (within 24-hours of the vessel sailing)
- Five-day status report
- Preliminary trip summary report and full set of data forms
- Final electronic trip report

DEPLOYMENT REPORT

Within 24 hours of the vessel sailing the observer must send a deployment report to their controlling organisation. The content will include confirmation of the contact details of the vessel and serves to set up and confirm the line of communication between the observer and their controlling organisation. This report includes the outcome of the pre-sea inspection as details of flights and logistics prior to boarding.

If a report is not received within 24 hours of the due date, the observer coordinator will contact the vessel operator to send a message to the vessel to remind the observer of his/her obligation in this respect. If a report is not received within a further 24 hours it will be assumed that there is no means of formal communication with the vessel and the vessel operators will be contacted to make arrangements either to establish these or request the immediate return of the observer. Taking into consideration that a breakdown in communication may also indicate an emergency situation with the vessel, emergency search and rescue operations may be initiated.

FIVE-DAY STATUS REPORTS

Throughout deployment observers will be required to send status reports to their controlling agency on specific dates. The monthly schedule for these will be the 1st, 6th, 11th, 16th, 21st and 26th days of the month to report on the preceding five days. The report will provide a summary of fishing operations, catch and sampling undertaken during the period covered. Following a similar procedure to the deployment report, should a report not be received by the time the next report is due the observer coordinator will start the process to establish contact via the vessels operators. In situations where reports have previously been regularly received it may be deemed that there is a problem with the observer's well-being and appropriate action may be necessary.

PRELIMINARY TRIP SUMMARY REPORT

At the conclusion of the trip, prior to disembarking, the observer must prepare a brief summary report of the trip. The report should include details of sampling, summaries of catches and processing, interactions with protected and threatened species and any notable incidences with respect to the vessel operations or weather. The observer will be expected to give a copy to the vessel Captain or Fishing Master and they will be advised to forward any comments they might have directly to the observer's controlling agency within a specific time period (to be defined by the controlling agency). This summary report will also form the basis for the observer debriefing.

OBSERVER TRIP DATA SUBMISSION

The post-trip reporting requirements are outlined in Resolution 11/04:

Para.11 *The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days the report, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State.*

Para.12 *The confidentiality rules set out in the resolution 98/02 [superseded by resolution 12/02] Data confidentiality policy and procedures for fine-scale data shall apply.*

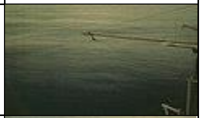
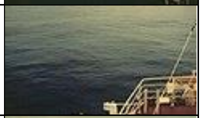
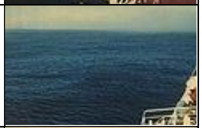
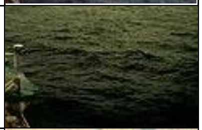
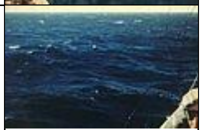
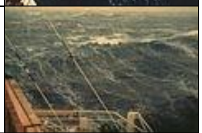
In 2013 the IOTC Scientific Commission requested the Trip Report was changed to an electronic format/excel to facilitate data submission.

In 2019 the IOTC Secretariat developed an e-reporting tool to be used for the submission of observer data.

In 2019, the IOTC Commission approved IOTC ROS standard minimum data collection fields, these are to be submitted to the IOTC Secretariat using agreed data reporting formats, or the IOTC ROS e-reporting tool.

ANNEXES

ANNEX 1 – BEAUFORT WIND SCALE

Beaufort number	Description	Wind speed	Wave height	Sea conditions	Sea state photo
0	Calm	< 1 km/h < 1 mph < 1 knot < 0.3 m/s	0 m 0 ft	Sea like a mirror	
1	Light air	1–5 km/h 1–3 mph 1–3 knots 0.3–1.5 m/s	0–0.2 m 0–1 ft	Ripples with appearance of scales are formed, without foam crests	
2	Light breeze	6–11 km/h 4–7 mph 4–6 knots 1.6–3.3 m/s	0.2–0.5 m 1–2 ft	Small wavelets still short but more pronounced; crests have a glassy appearance but do not break	
3	Gentle breeze	12–19 km/h 8–12 mph 7–10 knots 3.4–5.5 m/s	0.5–1 m 2–3.5 ft	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses	
4	Moderate breeze	20–28 km/h 13–18 mph 11–16 knots 5.5–7.9 m/s	1–2 m 3.5–6 ft	Small waves becoming longer; fairly frequent white horses	
5	Fresh breeze	29–38 km/h 19–24 mph 17–21 knots 8–10.7 m/s	2–3 m 6–9 ft	Moderate waves taking a more pronounced long form; many white horses are formed; chance of some spray	
6	Strong breeze	39–49 km/h 25–31 mph 22–27 knots 10.8–13.8 m/s	3–4 m 9–13 ft	Large waves begin to form; the white foam crests are more extensive everywhere; probably some spray	
7	High wind, moderate gale, near gale	50–61 km/h 32–38 mph 28–33 knots 13.9–17.1 m/s	4–5.5 m 13–19 ft	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind; spindrift begins to be seen	
8	Gale, fresh gale	62–74 km/h 39–46 mph 34–40 knots 17.2–20.7 m/s	5.5–7.5 m 18–25 ft	Moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks along the direction of the wind	
9	Strong / severe gale	75–88 km/h 47–54 mph 41–47 knots 20.8–24.4 m/s	7–10 m 23–32 ft	High waves; dense streaks of foam along the direction of the wind; sea begins to roll; spray affects visibility	
10	Storm,[7] whole gale	89–102 km/h 55–63 mph 48–55 knots 24.5–28.4 m/s	9–12.5 m 29–41 ft	Very high waves with long overhanging crests; resulting foam in great patches is blown in dense white streaks along the direction of the wind; the surface of the sea takes on a white appearance; rolling of the sea becomes heavy; visibility affected	
11	Violent storm	103–117 km/h 64–72 mph 56–63 knots 28.5–32.6 m/s	11.5–16 m 37–52 ft	Exceptionally high waves; small- and medium-sized ships might be for a long time lost to view behind the waves; sea is covered with long white patches of foam; everywhere the edges of the wave crests are blown into foam; visibility affected	
12	Hurricane force [7]	≥ 118 km/h	≥ 14 m	The air is filled with foam and spray; sea is completely white with driving spray; visibility very seriously affected