Data collection protocol for small-scale handline tuna fisheries of Indonesia

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Yayasan Masyarakat dan Perikanan Indonesia

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Chapter 1 – Introduction

1.1 Motivation for a data collection system for Indonesia

In recent years, the concept of 'sustainability' has become an important focus of fisheries management, but is hard to explicitly define, as interpretation of the concept continues to evolve (Rice 2014). It is generally accepted that a fishery must fulfill three sustainability dimensions to be considered sustainable: ecological, economic and social (Garcia & Staples 2000). The three dimensions may be defined as follows:

- ecological dimension: the stock biomass should be greater than a minimum reference level
- economic dimension: the individual vessel profit should be greater than a minimum reference level
- social dimension: there must be a minimum level of employment and activity (Martinet et al. 2007).

Additional requirements relating to bycatch of non-target species and environmental impacts can be included when necessary (Jacquet et al. 2009). Continuous data collection systems are required to evaluate the status and progress of the three dimensions of sustainability. This protocol aims to contribute towards data collection activities for handline fisheries of Indonesia, so that progress towards achieving sustainability can be monitored and improved.

The global demand for sustainably-sourced seafood is increasing as certification schemes and consumer recommendation lists influence consumers' preferences (Belson 2012). The European Commission has regulations stipulating a traceability system as a requirement for food producers and a catch certification scheme to combat the import of IUU fish (EC 2009; EC 2008). In the US, the 2011 Food Safety Modernization Act (Anon 2011) allows the Food and Drug Administration to order the establishment of food product tracing systems as will the newly (2014) formed Presidential Task Force on Combating IUU Fishing and Seafood Fraud. To maintain Indonesia's position as a competitive player in the global seafood market it is advised that Indonesian seafood products begin a conversion process towards sustainability and eventual certification of sustainability. Such a certification process can only be conducted when a high level of knowledge exists regarding annual catch estimates, separated by gear and species, operational catch and effort data, size distribution of the stock and general health of the stock and the ecosystem. This data is usually limited within Indonesian tuna fisheries and it is important that data collection processes are improved.

Despite referencing a 'sustainable approach' to fisheries resource management in its Development Plan, Indonesia has a poor record of implementation and enforcement and has been supporting expansion rather than following the precautionary approach to fisheries, the ecosystem approach to fisheries or improving stock sustainability. Important regulations covering Indonesian fisheries include the decentralisation act of 2010 (MMAF 2010b) and the regulation relating to fishing effort in Indonesia's Fisheries Management Areas (MMAF 2012). National regulations are established and to monitor the success/progress of these regulations, robust data collection is required. Regulations relevant to this protocol include:

- Ministerial Regulation No.56/2014: Temporary suspension of fishing licenses to vessels constructed abroad (MMAF 2014a)
- Ministerial Regulation No.57/2014: Transshipment ban unless offloading to designated Indonesian port (MMAF 2014b)
- Ministerial Regulation No.59/2014: Prohibits export, but not necessarily capture, of oceanic whitetip shark and hammerhead sharks from Indonesia (MMAF 2014c)
- Ministerial Regulation No.2/2015: Prohibition of trawls and seines in all of Indonesia's fishery management areas (MMAF 2015a)
- Ministerial Regulation No.4/ 2015: Fishing banned in breeding and spawning ground of the Banda Sea (MMAF 2015b)
- Indonesian Law No.7/2016: small-scale vessels defined as those <10GT (MMAF 2016)

Monitoring the progress and success of these regulations requires robust data collection activities. Fisheries management in Indonesia has developed into a decentralised system (as mentioned above (MMAF 2010b)), whereby individual regions can introduce region-specific regulations. To coordinate management of the stocks at a national level, the government must have information from the different regions. Each region should have a number of data collection sites, providing sufficient sampling coverage to contribute to national management plans. Efforts should be made to coordinate and consolidate the data from each region. Taken together, the international obligations, the national regulations, the regional decentralisation and the market demand for sustainably-sourced seafood motivate the need for improved data collection systems in Indonesia. This need exists in both the commercial and artisanal fisheries as also in the various gear differentiated fisheries. This protocol focuses on data collection for tuna species from the small-scale hand line tuna fishery.

1.2 Objectives of this data collection protocol

This document is a guide for the data collection process at handline tuna landing sites within Indonesian archipelagic and EEZ waters. It includes: a chapter with seven Standard Operating Procedures, covering various aspects of the data collection process, and a chapter describing the Data Collection Process, both for daily port sampling forms and monthly unloading forms.

This protocol has the following objectives:

- Ensure a set of standards are in place for the data collection process for handline tuna fisheries in Indonesia; that this data is collected in a uniform way, that transferability of this data is ensured and that it is done in a cost efficient method
- Allow fishery managers, government agencies, regional fishery management councils and private industry to have access to high quality data on tuna catches in Indonesia and to use this information to improve Indonesian tuna management
- Ensure Indonesia fulfills its data reporting obligations and its compliance to regional and international institutional frameworks for fishery governance, such as those described by FAO, UN, IOTC and WCPFC

In achieving the above objectives it is anticipated that the following sub-objectives may also be achieved and/or supported through the presence of MDPI staff in the field and the contribution of MDPI to national and provincial level initiatives. These objectives address scientific, management and market-related issues for tuna in Indonesian waters:

- Improve existing knowledge within Indonesia and the wider scientific community on a small but important sector of the Indonesian tuna fishery.
- Use the improved knowledge to better understand stock dynamics, changes occurring due to environmental factors, such as climate change, and to adapt to these changing circumstances with appropriate management measures
- Catalogue the encounters this fishery has with endangered, threatened and protected species and develop strategies to minimize the impact of fishing activity on these species
- Ensure ecosystem and habitat functioning and resilience within the homing range of the tuna by increased knowledge and adaptive decision making
- Acquire additional information on the associated bycatch and make decisions to minimize the indirect effects on these species/stocks

- Ensure that sustainable management practices are implemented to profile the stock correctly, ensuring catch advice adheres to sustainable and precautionary guidelines, progressing towards a sustainable tuna fishery in Indonesian waters
- Ensure that the management of tuna species, which are highly migratory, is appropriately matched to their stock structure, migratory routes and spawning areas
- Ensure that good relations exist between neighboring countries and states with regards to tuna management
- Increase local government involvement in the data collection process by capacity building and creating data collection networks
- Ensure that the management process takes financial as well as food security matters into consideration when making decisions on catch allowances, especially relevant to the handline fishery as it is categorized as an artisanal fishery
- Transfer knowledge and background of the data collection process to various stakeholders involved in the handline and pole and line tuna supply chain, with the aim of developing ownership and eventual acceptance within the community
- Support Indonesian handline tuna achieve management and sustainability levels required for eco-certification, enhancing its competitiveness in the global market
- Maximize/maintain profits from tuna fisheries while considering ecological limits

This protocol is designed to complement existing data collection efforts within Indonesia and provides instructions for data collection staff to help with data recording and entry, species identification, etc. This protocol is subject to change to incorporate recommendations from field staff when necessary. The activities outlined in this protocol are similar to scientific observer schemes, which are implemented globally. Such schemes provide independent baseline information on fisheries, which can be used for stock assessments and for countries to collaboratively manage highly migratory species.

1.3 Background to small-scale handline fisheries in Indonesia

After China, Indonesia is the world's second largest producer of marine capture products, with skipjack and yellowfin tuna being the third and eight most caught species globally, respectively (FAO 2014). Indonesian tuna fisheries are of great economic importance as well as bringing food security value to the country. The main species are yellowfin (*Thunnus albacores*), skipjack (*Katsuwonis pelamis*), bigeye (*Thunnus obesus*), albacore (*Thunnus* *alalunga*) and tongkol (multiple species). The main gears are purse seines, troll line, longline, pole and line and handline. It is estimated that up to 90% of vessels targeting tuna species are <5GT (Sunoko & Huang 2014) but ~60% of the catch volume is caught by larger purse seines and ~20% of the volume caught by longline fishing, the remainder caught with a mixture of small to medium sized purse seiners (Davies et al. 2014).

In Indonesia, vessels >10GT are legally required to register to obtain a license (increased from 5 to 10 GT in recent regulation (MMAF 2016). Smaller vessels are termed 'artisanal' and are encouraged to register but are not required to do so. There are two types of vessel for artisanal handline tuna: 1) small vessels, ~1-16GT, unloading directly and 2) small vessels which transfer fish to a collection vessel. Trips to sea vary between less than one day up to 20 days, with Fish Aggregating Devices (FADs), dolphins and sea birds used to locate tuna. FADs or 'rumpons' in the handline fishery, are predominantly anchored floating platforms, working on the basis that tuna and other species aggregate around such floating objects. FADs are foci for the fishery, with benefits such as less operating costs spent on fuel searching for catch. Various species aggregate at the rumpon at different depths. Skipjack are thought to associate at 0-30 m, juvenile yellowfin and bigeye tuna at 30-80m, large mature yellowfin at 100-120m and bigeye tuna at 150-200m. This species-dependent depth variation has the advantage that theoretically the fishery can be conducted selectively, with hooks dropped to specific depths depending on the target species. The main target of the handline fishery is mature yellowfin and bigeye tuna, with skipjack becoming increasingly important. Sometimes skipjack and juvenile yellowfin and bigeye are caught to maximize use of space, time and efficiency of the trip, especially during low season of the large adults. The Indonesian Ministry for Maritime Affairs and Fisheries, MMAF, developed a Strategic Plan, 2010-2014, aiming to increase marine capture fisheries production by 0.5% per year (MMAF 2010a). This proposed annual increase is despite mounting concern for the status of some stocks, a situation exacerbated by sparse data collection, (under) estimated annual catches and poor management (Bailey et al. 2012).Tuna are a 'highly migratory species', requiring cooperation between multiple countries for efficient management of stocks. Indonesia is subject to the United Nations Law of the Sea, 1982 (UNCLOS), revised and specified in the UN Fish Stock Agreement, 1995, FAO Code of Conduct on responsible fisheries, and is a member of three Regional Fisheries Management Organisations, RFMOs, the Commission for the Conservation of Southern Bluefin Tuna, CCSBT, the Western and Central Pacific Fisheries Committee, WCPFC, and the Indian Ocean Tuna Committee, IOTC, with the latter two being relevant to the important handline relevant species. The RFMOs were established to help manage transboundary stocks. Although

Indonesia is required to submit catch data to both RMFOs, in reality it has a poor submission record and, along with the Philippines, represents one the 'single largest source of uncertainty in current regional stock assessments' (WCPFC 2009). Improving Indonesian input is essential to progress towards sustainability of tuna fisheries and to maintain the role of tuna in the food security of the state.

The most recent review of the status of yellowfin, bigeye and skipjack in the Western and Central Pacific Ocean, WCPO show that:

- For yellowfin tuna latest catch marginally exceed the Maximum Sustainable Yield, MSY, recent levels of spawning potential are likely above the level that will support the MSY and recent levels of fishing mortality are most likely below the level that will support the MSY (Davies et al. 2014)
- For skipjack, latest catches slightly exceed the MSY, fishing mortality is estimated to have increase continuously but fishing mortality remains below the level that would result in MSY and estimates of spawning potential are above the level that will support the MSY (Rice et al. 2014)
- For bigeye, current catches exceed the MSY level, recent estimates of spawning potential are likely at or below the level that will support MSY and recent estimates of fishing mortality lively exceed the level that will support MSY (Harley et al. 2014). Incomplete data for recent years makes it difficult to determine whether the advised 32% reduction between 2006-2009 has successfully reduced fishing mortality

For the IOTC, yellowfin is classified as overfished and bigeye and skipjack classified as fully exploited. These stock assessments are based on catch data submitted by members, of which Indonesia is one, and cooperating non-members. The coverage of this data is not complete, as reporting obligations may not be entirely fulfilled by members and these figures are sensitive to Indonesian catch estimates. Currently, data is collected by government agencies in the port/landing site, either DKP District, DKP Provincial or Central KKP. Some Indonesian ports have Tuna Monitoring Stations that collect data from village sampling and from companies. Despite these collection efforts, the catch is often estimated, recorded either as total catch of mixed species or total catch per species, with little consistency in species identification. This data forms the basis for Indonesian stocks assessments yet contains a large amount of uncertainty: unrecorded catches, low coverage, flawed estimation method, non-differentiation of gear types and non-differentiation of species. Recommendations and analyses based on this information will be unreliable. Appropriate exploitation rates, reference points and harvest strategies need to be developed so that initiatives to reduce fishing pressure can be implemented when the stock is at a low biomass. These initiatives should include input and output controls and may be in the form of closed seasons, limits on vessel numbers or capacity entering the fishery and implementation of total allowable catches, TACs. However these decisions are dependent on complete (as possible) data provision, which comes from data collection initiatives, as is proposed and described by this document.

Two methods for data collection are described in this protocol. The first is a daily port sampling form and the second is a monthly unloading form. The associated staff training protocol (available from the I-Fish website) should be consulted for detailed information on the duties of field staff.

1.4 I-Fish database system and Data Management Committees

Given the volume of data that can be collected to inform fisheries management, a database system has been developed to store the collected data and make it easily available to different types of stakeholders. This system, termed I-Fish (Indonesian Fisheries Information System), aims to inform fisheries management planning at district, provincial and national levels, and address the urgent need for an effective and flexible data management platform in Indonesia (Figure 1), aiming to do this by including industry in the collection and provision of data. I-Fish aims to align with national fisheries data standards, as well as with Marine Stewardship Council (MSC) requirements. In this way, I-Fish provides a transparent tool for data entry, storage and processing, fulfilling an essential need for fisheries under consideration for MSC certification. I-Fish is a comprehensive system for enabling the private sector to collect valid and verifiable data required by the government in order to manage fisheries sustainably. Involvement of the private sector— including fishers, traders, fishing companies, and exporters—provides near real-time data about the fishery, and assists governments to target resources where they are needed most.

To ensure I-Fish data transparency and promote collaboration amongst stakeholders, Data Management Committees, DMCs are established as co-management initiatives. DMCs focus on data from artisanal fisheries, such as handline fisheries for large tuna and skipjack tuna. The committee aims to achieve a complete representation of stakeholders to the fishery in the target area, and if necessary to support a rotational system of membership. The committees are an efficient way to coordinate data management between government officials, representatives of the fishing industry, and researchers. Through the DMCs it is expected that these stakeholders gain an informed and shared understanding about the status of fish stocks in a local region and may make localized management decisions based on this knowledge.

The mission of the DMCs is to support and contribute to the collection and analysis of data relating to catch composition, fishing grounds and effort so as to identify specific patterns within the fishery. A summary of this data shall be published and disseminated to DMC members and stakeholders. Fishery targets can be suggested based on the shared use of the data, stakeholders can be informed of the implications of the data analysis and the information can be integrated into local management decisions. The tools and capacity to contribute to management of the fishery are then developed in the DMC members, who can help sustainably develop and manage the fishery.

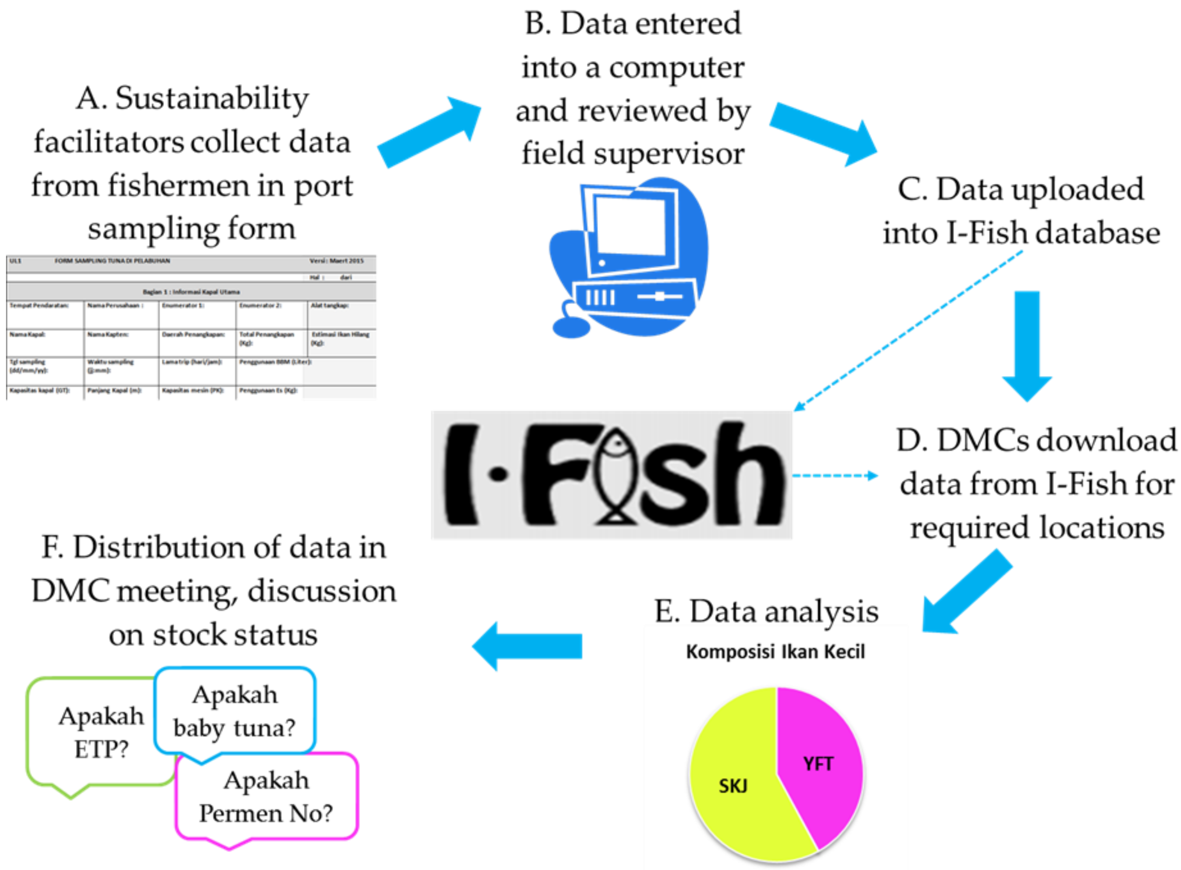

Figure 1. The data flow for the I-Fish approach. A. Sustainability facilitators collect the data from fishermen and suppliers, in both the port sampling form and the monthly unloading form. B. The data is entered in into a computer and verified by the field supervisor. C. Once the data has been verified it is uploaded into the I-Fish database where it can be accessed by stakeholders. D. Representatives of the Data Management Committees, DMCs, can access and download the data from I-Fish. E. Representatives of the DMCs can conduct data analysis and evaluation. F. The analyses data is presented and discussed at the DMC meetings by various stakeholders.

Chapter 2 – Standard Operating Procedures

This chapter covers seven Standard Operating Procedures, SOPs, which can support field staff in their data collection activities. These SOPs should be referred to in the first instance should there be any problem with data collection in the field. If the problem cannot be resolved using the relevant SOP, the site supervisor/manager should be contacted. The solution to the problem should then be incorporated into the relevant SOP.

2.1. Standard Operating Procedure, SOP, I, – Fishing grounds

Indonesia has 11 Fisheries Management Areas, FMAs, also known as Wilayah Pengelolaan Perikanan, WPPs. These are management areas for fishing, mariculture, conservation, research and fisheries development, covering internal waters, archipelagic waters, territorial seas and the Indonesian Exclusive Economic Zone (MMAF 2009). Indonesian waters are part of FAO Fishing Area 57 (Eastern Indian Ocean) and FAO Fishing Area 71 (Western Central Pacific), with the 11 FMAs indexed as follows (Figure 2):

1. FMA 571 – Malaka Strait waters and Andaman Sea
2. FMA 572 – West Sumatera and Sunda Strait of Indian Ocean waters
3. FMA 573 – Indian Ocean Waters, Southern Java to Southern Nusa Tenggara, Savu Seas, and Western Timor Seas
4. FMA 711 – Karimata Strait waters, Natuna Sea, and south China Sea
5. FMA 712 – Java Sea waters
6. FMA 713 – Makassar Strait, Bone Bay, Flores Sea, and Bali Sea
7. FMA 714 – Tolo Bay and Banda Sea
8. FMA 715 – Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea and Berau Bay
9. FMA 716 – Sulawesi Sea and northern Halmahera Sea
10. FMA 717 – Cendera Wasih Bay waters and Pacific Ocean
11. FMA 718 – Arafuru Sea and eastern Timor Sea

Two maps are available to help Sustainability Facilitators collect fishing ground data at the landing site. Figure 2 will help Sustainability Facilitators identify in which FMA fishing activity occurs. The second map (Figure 3) will help describe the approximate locations of the fishing grounds. The maps display Indonesian waters, gridded in 1° latitude and longitude squares. Each square is named by a letter on the vertical axis and by a number on the horizontal axis. The fisherman identifies the square where he conducted fishing activity and the

Sustainability Facilitator records the coordinates of the area in the map, for example, W24 for south Lombok. If fishing was conducted in multiple squares, all of these squares must be recorded. Only squares where fishing activity occurred should be recorded, not squares through which the vessel travelled to get to the fishing ground.

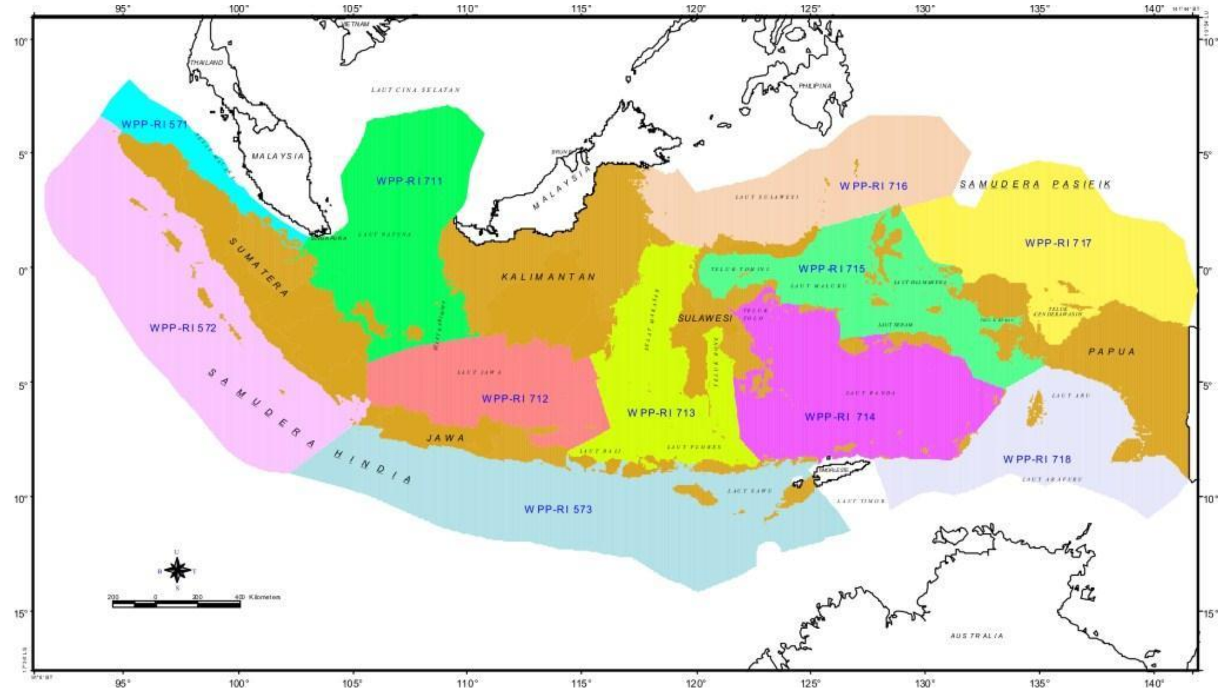

Figure 2. Fisheries Management Areas

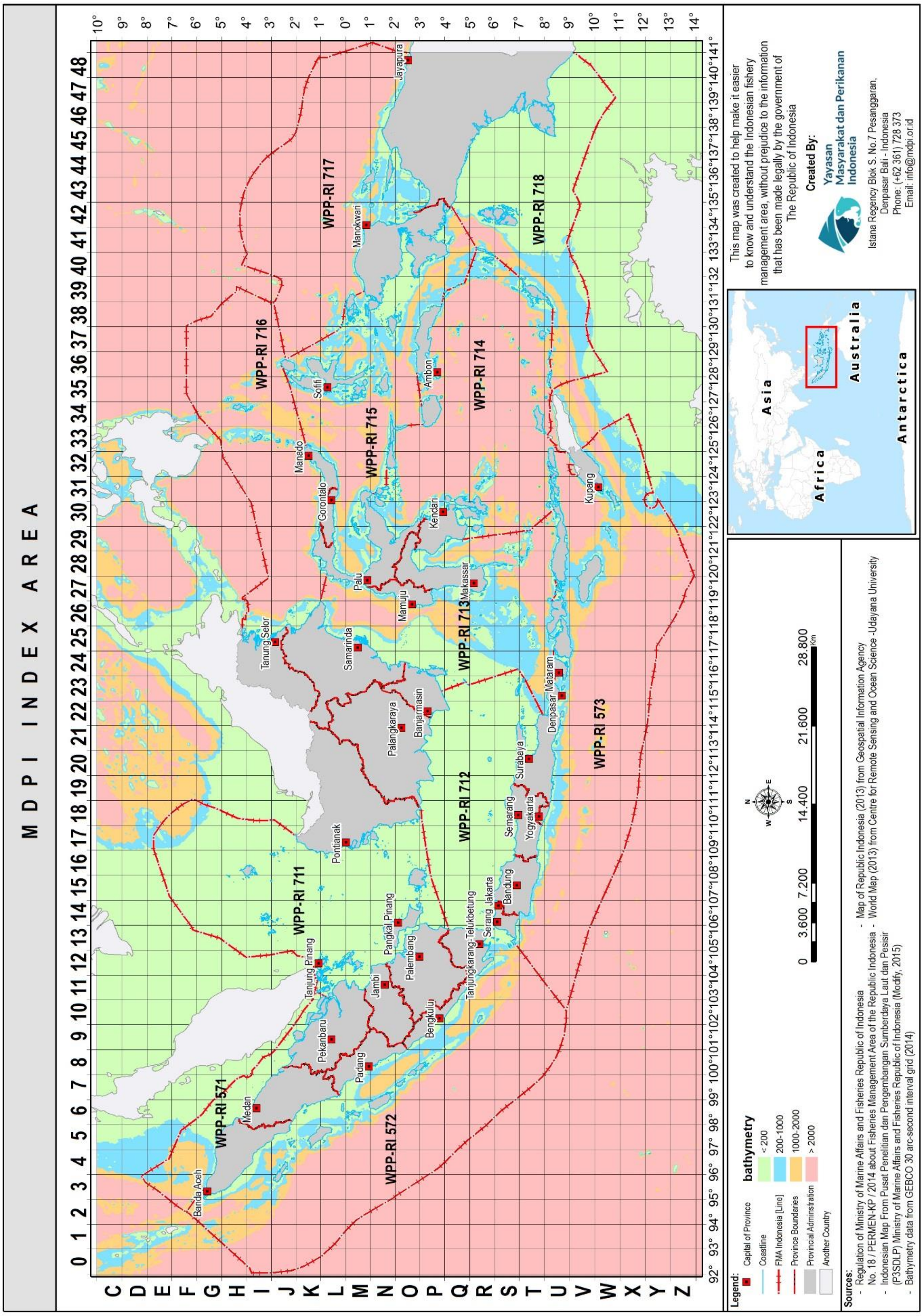

Figure 3. Tuna Fishing Ground Map for Indonesia

2.2. Standard Operating Procedure, SOP, II – Individual length measurements

The individual fish length is measured as the fork length. Fork length is a useful way of measuring fish as it does not need to accommodate for errors that occur when measurements are taken to the end of tail rays, which are often damaged. Fork length is measured from the tip of the upper jaw to the centre of the forked tail (Figure 4.a), except for billfish. Billfish (sailfish, marlin and swordfish) have a long upper "beak" and fork length measurements for these species are from the tip of the bottom jaw to the centre of the forked tail (Figure 4.b). Only whole fish are measured. Decapitated fish and fish without tails are not measured. Fork length of large individuals (≥10 kg) is measured using a calipers and fork length of smaller individuals is measured with a measuring board.

The front of the calipers is placed at the tip of the jaw and the movable arm is extended to reach the centre of the fork in the tail. The fork length is read from the small arrow (Figure Figure 5) and rounded down to the nearest whole cm, i.e. 69.9cm is recorded as 69 cm. The calipers are 1m in length and an extension of 1m is available.

(a) (b)

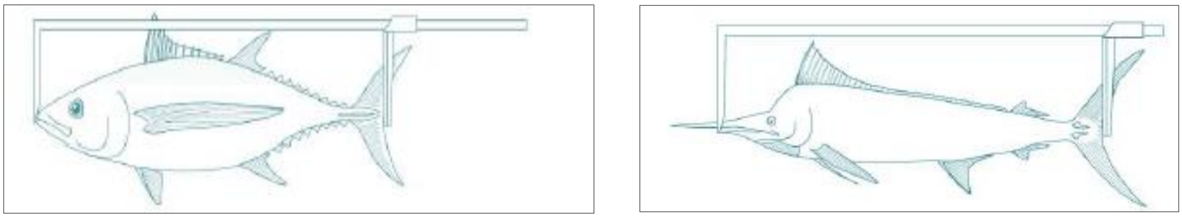

Figure 4: (a) Fork length is measured from the tip of the upper jaw to the centre of the fork in the tail. (b) For all billfish the fork length is measured from the tip of the lower jaw to the centre of the fork in the tail.

(a) (b)

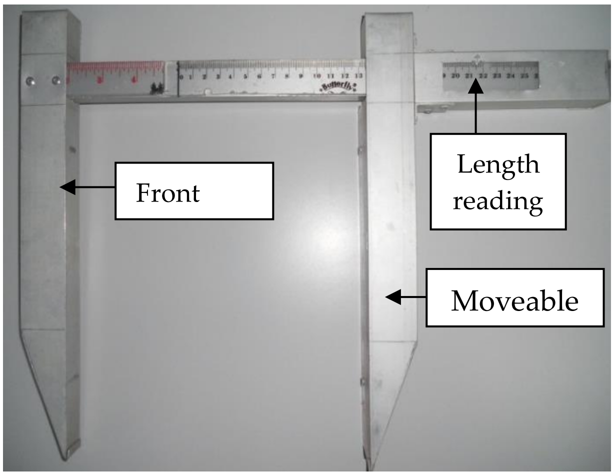

Figure 5: Calipers. (a) The measurement is read from the small arrow highlighted. Front and moveable arm of calipers are marked and (b) demonstration of the use of calipers. (© MPDI)

The measuring board is 60cm long. The tip of the jaw is placed against the front of the board and the centre of the tail lies over the steel measuring tape. The fork length is read from the centre of the fork on the tape (Figure 6).

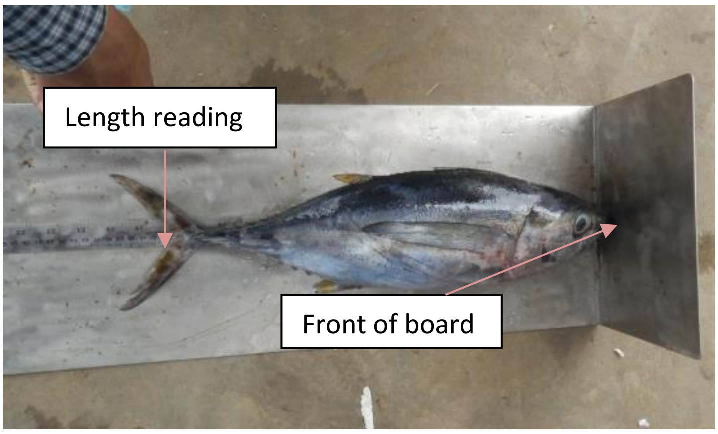

Figure 6: The fork length of a juvenile yellowfin tuna measured with a board. (© MPDI)

In some locations in Indonesia it is common to land large tuna as loins (Figure 7), i.e. the meat is cut from the body in four pieces and stored in a cool box. The carcass is also landed. This usually occurs when the fishing boats are small, typically 1GT, and there is not enough room to store the whole fish on ice. In sites where this occurs, the length and weight of the top right loin or left is recorded (Figure 8), in addition to the length of the whole carcass (Figure 9).

Figure 7: An example of a yellowfin tuna loin in a processing plant (©MDPI).

Figure 8: Demonstration of measuring the length of top loin (©MDPI)

Figure 9: Demonstration of measuring carcass (©MDPI)

2.3. Standard Operating Procedure, SOP, III – Species Identification

The main catch contains a variety of species and it is important Sustainability Facilitators recognize each species and that the correct species is recorded. Misidentification of species leads to invalid data. Sustainability Facilitators are responsible for ensuring all sampled fish are identified to species level. If there is doubt as to the identification of a fish the following steps should be taken:

- This protocol should be consulted and the "new" fish compared to the list below. If the fish is not on the list, the fishermen/transit staff/supplier should be consulted as to the identification of the fish. This may result in the fish being identified with a local name, which should be recorded and reported to the supervisor. The supervisor should ensure the new species is included in the list of species.
- If the fish cannot be identified a detailed description of external features of the fish should be recorded and a picture taken for reference. This should be forwarded to relevant supervisors/manager.

2.3.1. FAO Identification Codes

Each species is recorded with an FAO identification code (Table 1). This identifier code is used globally for species identification, making the information transferable to other organizations and interest groups. Using FAO codes will avoid confusion arising from the use of local names or the use of the same name for multiple similar species. English or local names should only be used as a last resort if there are problems with species identification.

Table 1. FAO identification codes, English names and local names of species

FAO code	English name	Local name	FAO code	English name	Local name
YFT	Yellowfin tuna	Madidihang	WAH	Wahoo	Tenggiri
SKJ	Skipjack tuna	Cakalang	RRU	Rainbow runner	Ikan salam
BET	Bigeye tuna	Tuna Matabesar	YTC	Yellowtail amberjack	
ALB	Albacore tuna	Albakor	DOL	Dolphin fish	Mahi-mahi
CNT	Canthidermis maculate		SFA	Sailfish	Ikan layar
DOT	Dogtooth tuna		SWO	Swordfish	Ikan pedang
EBS	Brilliant pomfret		SSP	Shortbill spearfish	Ikan todak
ECS	Manyspotted flying fish		BUM	Blue marlin	Marlin
EFT	Tomato hind		BLM	Black marlin	Setuhuk hitam
EMO	Leopard coral grouper		MLS	Striped marlin	Setuhuk loreng
LXN	Yellowlip emperor		KAW	Mackerel tuna, Kawa-kawa	Tongkol komo
MEN	Black triggerfish		BLT	Bullet tuna	Tongkol lisong
NNF	Doublewhip threadfin bream		FRI	Frigate tuna	Tongkol banyar

NXI	Giant trevally		OIL	Oilfish	Ikan Setan, Jambangan
NXT	Tille trevally		LOB	Tripletail	Mujair Laut
SJE	Chinaman fish		ONI	Red-toothed triggerfish	Pogot
SXH	Longfin escolar		CXS	Bigeye Trevally	Kwe, Bubara, Cotex
YTL	Longfin yellowtail		GBA	Great barracuda	Barakuda, Piskada, Kuda
COM	Spanish mackerel	Tenggiri	BSH	Blue shark	Hiu
GUT	Indo-Pacific King Mackerel	Tenggiri papan			

2.3.2. Species Descriptions

A description of the main target species and other retained species is given below. A list of Endangered, Threatened and Protected species is provided in Appendix III and a description of bait species is provided in SOP VII for bait data. The anatomy of fish, with all fins labeled, is shown in Figure 10.

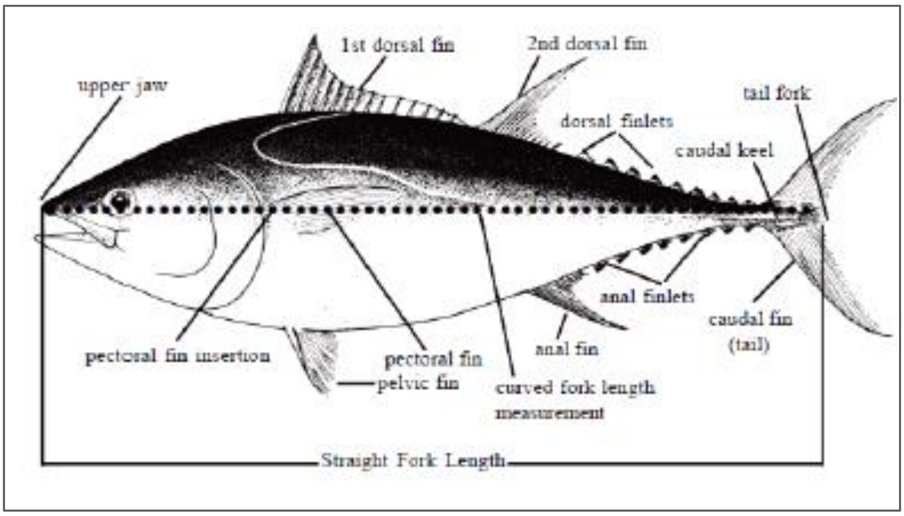

Figure 10. General fish anatomy for identifying specific fins.

Main target species:

1. *Thunnus albacares /* Yellowfin tuna / Madidihang / YFT

The maximum fork length of yellowfin tuna is ~180cm and the length at first maturity is 103.3cm. The second dorsal fin and the anal fin of yellowfin tuna can be very long, sometimes measuring ~20% of the total fork length (Figure 11). Yellowfin tuna are black/blue on the dorsal side, changing to silver on the ventral side, with a yellow mid-lateral line. The ventral side has ~20 broken vertical lines, which may appear as columns of small white/silver dots. The dorsal and anal finlets are bright yellow and sometimes have a very narrow black outline.

Juvenile yellowfin tuna often associates with skipjack at water depths of less than 50m, with adult yellowfin tuna found deeper in the water column, usually between 50-250m.

Figure 11. *Thunnus albacares* / Yellowfin Tuna / Madidihang / YFT

2. *Katsuwonus pelamis* / Skipjack tuna / Cakalang / SKJ

Skipjack tuna are a fast growing species, possibly measuring 42cm fork length after 150 days, and can reach a maximum length of 120cm (Rice et al. 2014). Skipjack tuna do not have scales, except for the corselet and lateral line (Figure 12). The dorsal side is dark purple/blue and the ventral side and belly are silver. The ventral side has a number of noticeably dark horizontal stripes, usually 4-6. There are between seven and nine finlets after the second dorsal fin.

Figure 12. *Katsuwonus pelamis* / Skipjack Tuna / Cakalang / SKJ

3. *Thunnus obesus* / Bigeye tuna / Tuna Matabesar / BET

Bigeye tuna have a maximum fork length of ~200cm. Bigeye tuna have a distinctively large eye and have a deep rounded body (Figure 13). The ventral side is white and the dorsal side is black, edged with a thin blue line. The ventral and dorsal sides are separated by a golden/yellow mid-lateral line. Broken vertical lines are usually present on the ventral side and sometimes extend above the mid-lateral line. The finlets are bright yellow with a thick black edge.

Figure 13. *Thunnus obesus* / Bigeye Tuna / Tuna Matabesar / BET

4. *Thunnus alalunga* / Albacores / Albakor / ALB

The maximum length for albacore tuna is ~140cm. Albacore tuna has very small scales and a noticeably long pectoral fin compared with other tuna species (Figure 14). The pectoral fin can sometimes extend beyond the anal fin in larger individuals and has a pointed tip. The dorsal side is black, the ventral side is white and the finlets are dark.

Figure 14. *Thunnus alalunga* / Albacore / Albakor / ALB

Other retained species:

5. *Canthidermis maculata* / Rough triggerfish / CNT

The Rough triggerfish can reach a maximum size of 50cm, more commonly found at lengths of 35cm. In adults, the head body and fins are a dark blue/grey or black colour whereas in juveniles, long white spots are visible, which disappear with growth (Figure 15). The dorsal and anal fins are longer than other fins. The caudal fin is rounded in juveniles but double concave in adults. The tail base does not have any ridges or spines the mouth is pointed into a snout and there is a groove around the eye.

Figure 15. Juvenile *Canthidermis maculata* / Rough triggerfish / CNT

6. *Gymnosarda unicolor* / Dogtooth tuna / DOT

The Dogtooth tuna can reach a maximum length of 248cm but lengths of 190cm are more common. Dogtooth tunas have large mouths, with the upper jaw extending to the middle of the eye (Figure 16). The dorsal and upper sides of the body are blue/black and the belly is silvery. There are no markings on the body, i.e. no lines, no spots. The lateral line is curved, dipping towards the tail end of the fish. The dorsal and anal fins may have small white tips. The body is streamlined and long. There are a series of small, dark-coloured finlets from the dorsal fin to the base of the caudal fin.

Figure 16. *Gymnosarda unicolor* / Dogtooth tuna / DOT

7. *Eumegistus illustris /* Brilliant pomfret / EBS

Brilliant pomfrets can grow to ~47cm. They are dark brown/ black in colour, with large scales on the body but scaleless areas above and behind the eye (Figure 17). The caudal fin is rounded in juveniles but forked in adults. The eye is large and the mouth small and dipping downwards towards the pelvic fin. The anal and dorsal fins have a peak and extend towards the caudal fin, with a darker edge. The pectoral fins extend past the base of the dorsal fin. The body is rounded at the head and then tapers towards the tail.

Figure 17. *Eumegistus illustris* / Brilliant pomfret / EBS (White et al. 2013).

8. *Cheilopogon spilopterus* / Manyspotted flyingfish / ECS

The Manyspotted flyingfish can reach lengths of ~30cm. The body is long and cylindrical with a small head, blunt snout, small mouth and big eye (Figure 18). The pectoral fins are large, extending beyond the anal fin and with many small dark spots. The caudal fin is forked with the lower lobe longer than the upper lobe. The dorsal side is deep blue and the ventrall side is white/silver.

Figure 18. *Cheilopogon spilopterus* / Manyspotted flying fish / ECS (White et al. 2013)

9. *Cephalopholis sonnerati* / Tomato hind / EFT

The Tomato hind can grow to 57cm but lengths of 30cm are more common. The Tomato Hind is light red to yellow/brown in colour, often with small brown/red spots on the head and fins (Figure 19). The caudal fin is rounded. The beginnings of the dorsal and anal fins have spines and then taper into a smooth rounded fin. The pectoral and pelvic fins are also rounded. The Tomato hind has a large head and mouth, with a large lower jaw.

Figure 19. *Cephalopholis sonnerati* / Tomato hind / EFT (White et al. 2013).

10. *Plectropomus leopardus* / Leopard coralgrouper / EMO

The Leopard coral grouper can grow to 120cm but sizes of 60cm are more common. Leopard coral groupers are reddish/brown in colour, at times orange/red (Figure 20). The ventral side is paler in colour and there are many dark-edged blue spots around the head and body (not on throat or belly). The highest concentration of spots is on the cheeks. There is a nearly complete blue ring around the eye and a thin, white margin along the caudal fin. The caudal fin is slightly convex and the dorsal fin has a number of spines and then extends towards the base of the caudal fin in a smooth shape. The head is rounded.

Figure 20. *Plectropomus leopardus* / Leopard coral grouper / EMO (White et al. 2013).

11. Lethrinus xanthochilus / *Yellowlip* emperor / LXN

The Yellowlip emperor can grow to lengths of 70cm but lengths of 59cm are most common. This fish gets its name from the yellow colour of the lips: the colour in the upper lip is more intense than the lower lip (Figure 21). Yellowlip emperors have a yellow/grey body with irregular dark spots. There is usually a red spot at the base of the pectoral fins, with the fin colour being yellow or grey. The fins are grey in colour with a red edging. The caudal fin is slightly concave. The Yellowlip emperor has a big head, which tapers into a pointed snout. There are large scales on the body.

Figure 21. *Lethrinus xanthochilus*/ Yellowlip emperor / LXN (White et al. 2013)

12. Melichthys niger / Black triggerfish / MEN

The Black triggerfish has an oval shaped, compressed body. And can grow to 50cm but lengths of 30cm are more common. Black triggerfish are mainly black in colour, but with green or purple overtones (Figure 22). There may be a yellow blotch near the head. There is a pale blue line along the base of the dorsal and anal fins. The caudal fin is concave with each lobe ending in a point. The first dorsal fin is erect and short whereas the second dorsal fin is soft, long and rounded, same as the anal fin. The pelvic fins are small and the head is large with small eyes and mouth. There are grooves along the cheeks.

Figure 22. *Melichthys niger* / Black triggerfish / MEN

13. Nemipterus nematophorus / Doublewhip Threadfin Bream / NNF

The Doublewhip threadfin bream can reach lengths of 20cm but lengths of 15cm are more common. The pectoral and pelvic fins are very long, extending to between the anus and the start of the anal fin (Figure 23). The first two spines of the dorsal fin are very close together and extend in a long filament. The upper lobe of the caudal fin also extends in a long filament. The Doublewhip threadfin bream is pinkish in colour, with a silver/white belly. There are a number of yellow stripes on the main body and the long filaments have a yellow tinge.

Figure 23. *Nemipterus nematophorus* / Doublewhip Threadfin Bream / NNF (www.eol.org).

14. Caranx ignobilis / Giant trevally / NXI

The Giant trevally can grow to 170cm but lengths of 100cm are more common. The body is oblong and compressed, with a steep forehead (Figure 24). The dorsal side is dusky golden or black and the ventral side is silver/grey. There are many small dark spots along the body, from grey to black in colour. The first dorsal fin is low, with a low number of spines. The second dorsal fin has a steep first few spines, which then becomes much shorter and extends towards the caudal fin. The anal fin is similar to the second dorsal fin, with a peak followed by a low fin towards the caudal fin. The eye is large and the mouth dips downwards towards the pelvic fin. The lateral line is curved.

Figure 24. *Caraanx ignobilis* / Giant trevally / NXI (White et al. 2013).

15. Caranx tille / Tille trevally / NXT

The Tille trevally can grow to lengths of 80cm but lengths of 50cm are more common. The dorsal side of the Tille trevally varies in colour from olive green to blue/grey and the ventral side is white/silver (Figure 25). There is a dark black spot behind the eye, located up from the base of the pectoral fin. The first dorsal fin is greyish and slightly shorter than the second dorsal fin. Like the giant trevally, the body is oblong and compressed. The dorsal side is rounded but the head is not quite as steep as the Giant trevally. The caudal fin is forked, with a dark coloured upper lobe and yellow/grey coloured lower lobe. The anal fin is pointed and then becomes shorter, extending towards the caudal fin, with a grey/yellow colour. The mouth is smaller than the Giant trevally and the eye medium size.

Figure 25. *Caranx tille* / Tille trevally / NXT (White et al. 2013).

16. Symphorus nematophorus / Chinaman fish / SJE

The Chinaman fish can grow to lengths of 100cm but lengths of 35cm are most common. The Chinaman fish has a steep forehead and a pointy snout, with the mouth extending to approximately the middle of the eye (Figure 26). The first dorsal fin has a number of short spines and the second dorsal fin has longer spines, with some extending into filaments in young fish. The pectoral fins extend to the start of the anus. Juvenile individuals have a white ventral side. Young have bright blue stripes on the sides and are brown/black in colour. Adults are yellow/brown to red in colour, sometimes with a faint vertical barring pattern. The caudal fin is slightly concave and red/brown in colour without the blue stripes.

Figure 26. *Symphorus nematophorus /* Chinaman fish / SJE (White et al. 2013).

17. Scombrolabrax heterolepis / Longfin escolar / SXH

The Longfin escolar has large eyes, large, fang-like teeth and is dark brown in colour. The pectoral fins are long, almost reaching the start of the anal fin (Figure 27). The caudal fin is forked. The fins are grey/translucent in colour. The maximum size for the Longfin escolar is 30cm.

Figure 27. *Scombrolabrax heterolepis* / Longfin escolar / SXH (White et al. 2013).

18. Seriola rivoliana / Longfin yellowtail / YTL

The Longfin yellowtail can grow to a size of 160cm by lengths of 90cm are more common. The most distinguishing feature is the dark diagonal bar across the eye (Figure 28). The snout is pointed with a deep body and the anal and second dorsal fins are tall. The lateral line is curved, arching over the pectoral fin. The dorsal side is green/black and the ventral side is silver/white. Juveniles may have up to six dark bars on the sides. There is a faint amber/yellow stripe running along the lateral side of the body. The caudal fin is forked and dark brown in colour.

Figure 28. *Seriola rivoliana* / Longfin yellowtail / YTL

19. *Scomberomorus commerson /* Spanish Mackerel / Tenggiri / COM

Spanish mackerel, also known as the Narrow-barred Spanish mackerel, can grow to >200cm and have a long, narrow, elongated body (Figure 29). The dorsal side is dark grey and the ventral side is silver/grey. The snout is long and pointy. Numerous broken vertical lines extend from the ventral side to the dorsal side but may not always reach the top of the dorsal side. The second dorsal fin may be the same height as or higher than the first dorsal fin. The pelvic fin is small compared with the anal fin. Juveniles have large oval spots along the body.

Figure 29: *Scomberomorus commerson /* Spanish Mackerel / Tenggiri / COM

20. *Scomberomorus guttatus* / Indo-Pacific King Mackerel / Tenggiri papan / GUT

The Indo-Pacific King Mackerel can grow to fork lengths of ~75cm and reaches maturity at lengths of 42-53cm, depending on the geographic location. The flanks are silver/white and above the lateral line there are a number of rows of dark brown spots (Figure 30). The first dorsal fin membrane is black and the pectoral, second dorsal and caudal fins are dark brown. The pelvic and anal fins are silvery/white. The dorsal side is blue/grey metallic and the ventral side is silver/white. There are usually eight finlets between the second dorsal fin and the caudal fin.

The Indo-Pacific King Mackerel can appear similar to the Narrow-banded Spanish mackerel in general appearance. However, the Indo-Pacific King Mackerel has noticeable spots along the flank instead of narrow bands. Additionally the Indo-Pacific King Mackerel has deeper body, with the ventral side more rounded than that of the Narrow-banded Spanish Mackerel.

Figure 30. *Scomberomorus guttatus* / Indo-Pacific King Mackerel / Tenggiri papan / GUT

21. *Acanthocybium solandri /* Wahoo / WAH

The body of the wahoo is long, elongated and narrow, with a silver ventral side, a blue/grey dorsal side and very small scales (Figure 31). The maximum fork length can be 250cm. Wahoo also has vertical blue lines along the body, which may not always reach the fully to the bottom of the ventral side and which fade in colour after death. The second dorsal fin may be the same height as or higher than the first dorsal fin and located towards the posterior of the body. The snout is long and pointy and the teeth are smaller than that of the Spanish Mackerel. Wahoo is similar to the Spanish Mackerel but can be distinguished by a fold of skin that covers the jaw when the mouth is closed; this is absent in the Spanish Mackerel.

Figure 31. *Acanthocybium solandri* / Wahoo / WAH

22. *Elagatis bipinnulata /* Rainbow runner / Ikan Salam / RRU

Rainbow runners can reach lengths of 180cm but individuals of 80cm are more common. The dorsal side of the Rainbow Runner is green/blue and the ventral side is yellow/white (Figure 32). The ventral and dorsal sides are separated by two light blue horizontal stripes, with a green/blue section in between these two lines. The Rainbow Runner has pointy snout, a small eye and a sharply forked tail. The fins are short, with two separate finlets behind both the dorsal and anal fins.

Figure 32. *Elagatis bipinnulata* / Rainbow runner / Ikan Salam / RRU

23. *Seriola lalandi* / Yellowtail Amberjack / YTC

Yellowtail Amberjack has an elongated, compressed body, with a pointy snout (Figure 33). It can grow to ~190cm but smaller individuals are more common. It is blue on the dorsal side and upper flanks and silver to white on the ventral side. The dorsal and ventral sides are separated by a bronze lateral stripe along the body, which becomes more yellow towards the tail. All fins are yellow, the pectoral fin is short and there are no individual finlets after the dorsal and anal fins (small fins joined together).

Figure 33. *Seriola lalandi* / Yellowtail amberjack / YFC

24. *Coryphaena hippurus* / Dolphin fish / Mahi-mahi / DOL

The Dolphin fish can grow to sizes of 200cm but individuals of 100cm are more common. It is a fast growing species, with the age at first maturity three or four months. The bodies of dolphin fish are compressed vertically, with a single, long dorsal fin, extending from the head to just before the tail (Figure 34). No finlets are present beyond this large dorsal fin. Dolphin fish are brightly coloured, with a bright blue/green dorsal side, bright yellow ventral side and the pectoral fins are blue. Blue spots are present laterally. The tail is deeply forked and bright yellow. These bright colours fade after death, changing to yellow-grey colours. Mature males have a prominent forehead whereas females have a smaller, rounded head.

Figure 34. *Coryphaena hippurus* / Dolphin Fish / Mahi-mahi / DOL

The different head shape of the female and male can be seen.

25. *Istiophorus platypterus* / Sailfish / Ikan Layar / SFA

The sailfish is a species of billfish, meaning that the upper jaw extends further than the lower jaw (Figure 35). The elongated upper jaw (bill) is round in cross-section. Sailfish can grow to more than 340cm but individuals measuring 140-240cm is more common. The sailfish has a very large first dorsal fin, often higher than the body depth. The membrane of the large first dorsal fin is deep blue in colour, with smaller dark spots scattered across it. The second dorsal fin is much smaller. The pelvic fins are very long and narrow, sometimes reaching as far as the anus. The body is slender and compressed vertically. The dorsal side is metallic blue and the ventral side is silver/white. There are ~20 vertical stripes along the flanks of sailfish, each composed of small blue dots. The flanks sometimes have a brownish tinge.

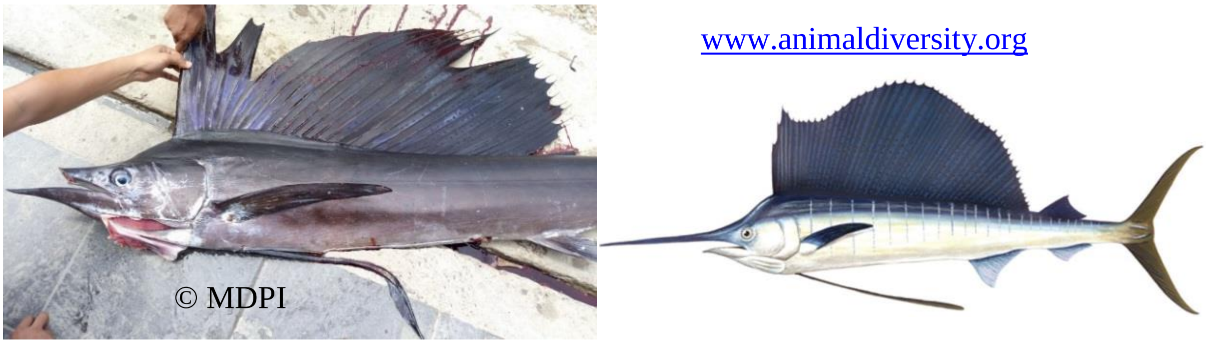

Figure 35. *Istiophorus platypterus* / Sailfish / Ikan Layar / SFA

26. *Xiphias gladius* / Swordfish / Ikan Pedang / SWO

The bill of swordfish is usually longer than those of other billfish species and is flattened instead of circular (Figure 36). Swordfish can reach lengths of ~440cm but individuals measuring 120-190cm are more common. The swordfish has a cylindrical, elongated body with two widely separated dorsal fins, the first much higher than the second. Adult swordfish have no teeth or scales and have a large eye. Juveniles have a lateral line which fades as the individual matures. Pelvic fins are absent and the pectoral fins are located lower towards the ventral side. A horizontal keel extends from either side of the caudal peduncle. The dorsal side is black/brown which fades to light brown/silver on the ventral side and the fins are black/brown.

Figure 36. *Xiphias gladius* / Swordfish / Ikan Pedang / SWO

27. *Tetrapturus angustirostris /* Shortbill Spearfish / Ikan todak / SSP

Shortbill spearfish are a rare species and can reach maximum lengths of 230cm but individuals of 190cm are more common. The bill is small compared with bills of other billfish species (Figure 37). The first dorsal fin is long with a triangular peak at the beginning. The second dorsal fin is much smaller. The dorsal side and dorsal fin are dark blue whereas the ventral side and anal fins are silver. The pectoral fins are small whereas the pelvic fins are long and narrow, approximately twice the length of the pectoral fins. Brown blotches may be present on the flanks.

Figure 37. *Tetrapturus angustirostris* / Shortbill Spearfish / SSP

28. *Makaira mazara* / Indo-Pacific blue marlin / BUM

Indo-Pacific blue marlin has a slightly compressed body shape with a highly elevated nape (Figure 38). They have a long bill which is round in cross section. The first dorsal fin is long with a triangular peak at the anterior section, the remainder of the dorsal fin is much shorter. The second dorsal fin is smaller. The pectoral fins are long and thin and the pelvic fins are shorter than the pectorals. Two horizontal keels are present on the caudal peduncle. The lateral line is present in juveniles but difficult to distinguish in adults. The dorsal side is dark blue and the ventral side is silver/white. Pale blue stripes, ~15, are present on the flanks, which are composed of smaller dots.

Figure 38. *Makaira mazara* / Indo-Pacific blue marlin / BUM

29. *Istiompax indica* / Black Marlin / Setuhuk hitam / BLM

Black marlins can grow to >450cm, with females reaching larger sizes than males. They have a slightly rounded body with a shorted bill than other billfish. The first dorsal fin is long with a rounded peak at the anterior section (Figure 39). Black marlins have two horizontal keels at the caudal peduncle. The pectoral fins stick out from the sides, are located lower towards the pelvic fins and cannot be flattened, unlike other billfishes. The pelvic fins are long and thin. The dorsal side is dark blue/black and the ventral side is silver/white. Faint blue lines may be present on the flanks.

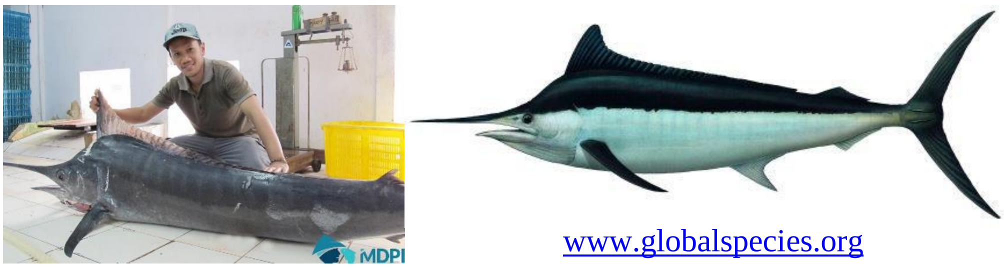

Figure 39. *Istiompax indica* / Black marlin / Setuhuk hitam / BLM

30. *Kajikia audax* / Striped Marlin / Setuhuk loreng / MLS

The striped marlin can grow to >420cm but smaller individuals are more common. Striped marlins have a compressed body and a very visible lateral line. The bill is long and round in cross-section. Like other marlins, Striped marlins have a high, pointed first dorsal fin, which is shorter as it continues long the body (Figure 40). The pectoral fins are long and narrow with a pointed tip. The pelvic fins are thin and roughly the same length as the pectoral fins, if not shorter. A horizontal keel is present at either side of the caudal peduncle. The dorsal fin is dark blue; all other fins are dark brown. The dorsal side is dark blue/black, the ventral side is silver/white and the lateral line is obvious. There are ~15 horizontal light blue stripes along the flanks, each consisting of smaller blue dots. Unlike other marlins, the horizontal stripes on a striped marlin remain visible after death.

Figure 40. *Kajikia audax* / Striped Marlin / Setuhuk loreng / MLS

31. *Euthynnus affinis* / Mackerel Tuna / Tongkol Komo / KAW

Mackerel tuna is a small tuna, usually not growing larger than 1m, and has a deeper body shape than bullet tuna (described below). Individuals have an oblique striped pattern on the dorsal side, blue/green in colour, which does not extend past the beginning of the first dorsal fin (Figure 41). There are between two and five dark sports above the pelvic fin. The anterior spines of the dorsal fin are much higher than spines further along the dorsal side.

Figure 41. *Euthynnus affinis* / Mackerel Tuna / Tongkol Komo / KAW

32. *Auxis rochei* / Bullet Tuna / Tongkol lisong / BLT

The maximum fork length for bullet tuna is ~50cm and the body is more elongate than mackerel tuna (Figure 42). Bullet tuna have a striped/blotch pattern on the dorsal side, which does not extend past the beginning of the first dorsal fin. The pelvic and pectoral fins have a purple tinge to them. The second dorsal fin and the anal fin are very small (smaller than those of the mackerel tuna).

Figure 42. *Auxis rochei* / Bullet Tuna / Tongkol lisong / BLT

33. *Auxis thazard thazard* / Frigate tuna, Frigate mackerel / Tongkol banyar / FRI

The maximum fork length for the frigate tuna is ~65cm. The dorsal side is dark blue, with a section of 15 or more narrow oblique, near horizontal wavy lines above the lateral line and reaching forward until the first dorsal fin and above the pectoral fin (Figure 43). The ventral side is white. The pectoral and pelvic fins are purple on the exterior side and black on the interior side. It is similar to *Euthynnus affinis* and *Auxis rochei*, but it has a larger distance between the dorsal fins, a lower spinous dorsal fin and a more slender shape.

Figure 43. *Auxis thazard thazard* / Frigate mackerel, Frigate tuna / Tongkol banyar / FRI

34. *Ruvettus pretiosus* / Oilfish / Ikan Setan / OIL

Oilfish are brown/black in colour and have a rough, scaly surface. Individuals can grow to a maximum of 2m and ~64kg. The lower jaw protrudes a little bit further than the upper jaw and the teeth are fang-like (Figure 44). The first dorsal fin has noticeable spines, second dorsal fin higher than the first. There are two finlets before the caudal fin and a lateral line present on the flanks. The tips of the fins may be white.

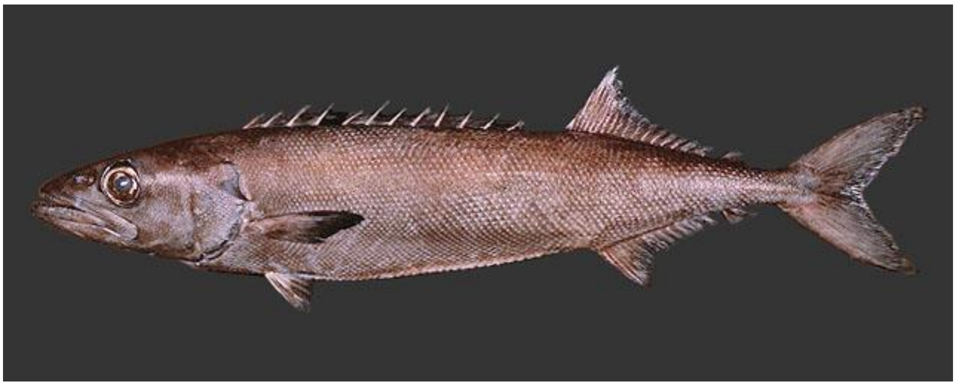

Figure 44. *Ruvettus pretiosus* / Oilfish / Ikan setan / OIL (Randall. 1997)

35. *Lobotes surinamensis* / Tripletail / Mujair laut / LOB

The tripletail gets its name from the rounded caudal fin and the large second dorsal and anal fin, which together give the appearance of a tripletail (Figure 45). The moth slants downwards, with the lower jaw protruding slightly beyond the upper jaw. The body is deep and compressed. There is a lateral line along the flanks and the body is dark brown/green in colour. The fins can be a darker colour than the body.

Figure 45. *Lobotes surinamensis* / Tripletail / Mujair laut / LOB

36. *Odonus niger* / Red-toothed triggerfish / Pogot / ONI

The Red-toothed triggerfish has noticeably red teeth; the two upper teeth are visible when the mouth is closed. This fish is dark blue/purple in colour, with pale blue margins (Figure 46). The first dorsal fin is short, with a peak at the anterior section. The second dorsal fin is longer and higher than the first. The anal fin is approximately the same size as the second dorsal fin.

The body is deep and compressed ventrally, with a large head and the mouth orientated upwards. The eye is large, with a deep groove present at the front.

Figure 46. *Odonus niger* / Red-toothed triggerfish / Pogot / ONI

37. *Caranx sexfasciatus* / Bigeye trevally / Kwe, bubara, cotex / CXS

The bigeye trevally has a noticeably large eye, with a well-developed eyelid. There is a small black spot behind the eye (Figure 47). The body is elongate and compressed. The bigeye trevally is silver/olive dorsally, with shades of iridescent blue/green. The ventral side is silver/white. The first dorsal fin is short, with the second dorsal fin having a peak followed by a lower section, extending to the base of the caudal fin. The anal fin has a peak for the first spines, and then continues lower, extending as far as the base of the caudal fin. There are not finlets after the second dorsal and anal fins. The caudal and second dorsal fin are dark/black, the other fins are white/clear. There is a strong lateral line along the flank.

Figure 47. *Caranx sexfasciatus* / Bigeye trevally, Kwe, bubara, cotex / CXS

38. *Sphyraena barracuda* / Great barracuda / Barakuda, paskada, kuda / GBA

The Great barracuda may reach lengths of 2m. The body is elongate and slim, torpedo-shaped, with the dorsal side green/grey and the ventral side while/silver (Figure 48). Irregular dark blotches may be present along the lower flanks, and a number of diagonal darks bars present on the upper flanks. The dorsal fins are widely separated, the anal fin is small. The caudal, anal and dorsal fins are dark with white tips. The snout is long and pointed, with a protruding lower jaw and many long, sharp teeth.

Figure 48. *Sphyraena barracuda* / Great barracuda / Barakuda, paskada, kuda / GBA

39. *Prionace glauca* / Blue shark / Hiu / BSH

The Blue shark has a slender body and a characteristic deep blue/indigo colour on the dorsal side (Figure 49). The colour changes to a bright blue on the sides and turns white on the ventral side. The snout is long and pointed, with large eyes and conical teeth. The pectoral fins are long and slightly curved. The second dorsal fin is much smaller than the first. The upper lobe of the caudal fin is elongated, with a notch below the tip. The lower lobe of the causal fin is short.

Figure 49. *Prionace glauca* / Blue shark / Hiu / BSH

40. *Lepidocybium flavobrunneum* /Escolar/ Gindara / LEC

The escolar can growth until 180 cm. The body is dark in color, elongate shape and has a single wavy lateral line (figure 50). Pelvic fin growths well and has a central single keel on the base of caudal fin. This fish can be identified from its family on the finlet (has 4 or more fnlet). Gindara is epipelagic and mesopelagic and lives in 0-200 m.

Gambar 50. *Lepidocybium flavobrunneum* / Escolar/ Gindara/ LEC

2.4. Standard Operating Procedure, SOP, IV – Differentiating between yellowfin and bigeye tuna, juvenile and loin

2.4.1. Differences between juveniles of species

While adult yellowfin and bigeye tuna are easy to differentiate, it is not as easy to differentiate between juveniles of these species. This is especially the case when fish is frozen onboard vessels or when it is not in a completely fresh state, as colorings become less conspicuous and fins and other characteristics become damaged. A number of internal and external features can help differentiate between the species. These are explained in more detail in "Buku Penuntun untuk Identifikasi Madidihang dan Matabesar dalam Keadaan Segar, tetapi Kondisinya Kurang Ideal" and in "FISHING & LIVING: A Guide to the Tunas (and Tuna-like Species) found in Indonesian waters". Sustainability facilitators must be in possession of these booklets and undergo training in the differences of the two species. Training must be refreshed every year to ensure misreporting or under-reporting does not occur. The most useful and common ways to differentiate between juvenile yellowfin and bigeye tuna are as follows (Itano 2004), was used as a source for the information and photos relating to external and internal differences):

External differences

Feature	Yellowfin Tuna	Big Eye Tuna
Body markings (Figure 51)	• Obvious pattern of closely spaced vertical silver stripes • Solid stripes alternate with stripes of fainter dots • Stripe pattern is present from tail to beneath the pectoral fin and above the mid-lateral line	• Irregular, vertical and widely spaced white stripes • Some dots in line format are present but irregular • Stripe pattern broken and usually present below the mid-lateral line

Figure 51: Two comparisons of yellowfin and bigeye tuna.

Body shape (Figure 51)	• Body elongate, long tail • Body slightly compressed between second dorsal and caudal fin and between anal and caudal fin	• Body deep and rounded • Body outline rounded, creating smooth ventral and dorsal arc between snout and caudal peduncle
Head and eye shape (Figure 52)	• Shorter head length and depth vs. fork length than bigeye • Smaller eye diameter compared to bigeye of same fork length	• Greater head length and depth vs. fork length than yellowfin • Greater eye diameter compared to yellowfin of same fork length

Yellowfin

Bigeye

Figure 52. Close up of the differences between the head and eye shape of yellowfin and bigeye

Pectoral fin characteristics (Figure 53)	• Short pectoral fin, extending to base of second dorsal fin • Thick, stiff and rounded at the tip	• Long pectoral fin, extending beyond the base of the second dorsal fin • Pointed tip, flexible, often curves downward

Figure 52. Differences in pectoral fin characteristics

Caudal fin characteristics (Figure 54)	• Centre of tail fork forms distinct notch, with two raised ridges on either side	• Centre of tail fork forms flat or very faint crescent shape. Two small mounds may be present

Figure 54. Differences between caudal fin characteristics. The differences between the finlets can also be seen.

Coloration: Important to note: after death color fades very quickly and both species will appear similar (Figure 51)	• Fresh Yellowfin have a bright yellow mid-lateral line • Dark/black dorsal side separated from the golden ventral side by a thin blue band (not always present) • Fins are bright yellow, the anal fin sometimes silver • Flanks and ventral aide are silver/ white • Bright yellow finlets with no or very little black edges	• Golden/bronze mid-lateral line • Dark/black dorsal side edged with a bright metallic blue line, separating two distinct colors of dorsal and ventral sides • Fins yellowish, anal fin may have silvery appearance • Caudal fin black/grey • Flanks and ventral side silver/white • Yellow finlets with thick black edge

Internal differences

Feature	Yellowfin	Bigeye
Liver morphology and appearance (Figure 55)	• Right lobe longer and thinner than other lobes • Smooth lobes, no striations	• Three rounded lobes of ~ equal size • Ventral surface striated

Figure 55. Differences between livers

Feature	Yellowfin	Bigeye
Swim bladder (Figure 56)	• Only in anterior section of body cavity • Not obvious, usually deflated or slightly inflated	• Occupies almost entire body cavity • Large and conspicuous, often inflated

Figure 56. Differences between swim bladders.

2.4.2. Loin Differences

As mentioned in SOP II, some locations in Indonesia land tuna as loins rather than as the whole entire fish. This is done so that the meat can be stored on ice. Both yellowfin and bigeye tuna are loined in these sites. There are a number of differences between the loins of yellowfin and bigeye tuna (Table 2).

Table 2. The differences between yellowfin and bigeye tuna loins.

Yellowfin loin	Bigeye loin
- Long loin, not very thick - Pink in colour - Meat is durable and not easily damaged. The quality can be reached grade A - Meat does not have a greasy feel - The loin will be more than 70% from whole fish because small carcass. Ex: YFT 70 kg → 60 kg loin	- A wider loin, thick and not too long - Dark red in colour - Meat is easily damaged. It cannot be reached grade A. - Meat has a slightly greasy feel - The loin will be around 60% due to big head and carcass. The bigger fish is the weightier carcass is. BET 130 kg → 52 kg loin

2.5. Standard Operating Procedure, SOP, V – ETP Interaction

Endangered, Threatened and Protected species, ETP, cover a variety of species such as turtles, dolphins, whales, sharks, rays and birds. MDPI has an ETP program, to improve information/monitoring on the possible interaction between ETPs and handline tuna fisheries. According to the MSC pre-assessment report for Indonesian handline yellow fin tuna "Handline-fishing is highly selective due to the method and size of bait used." and "… it would appear highly unlikely that there are any associated ETP by-catch interactions with the handline fishery." For full-assessment, information is needed to confirm these assumptions. The ETP program and an ETP species list are described in more detail in the MDPI Protocol for Continuous Port Based Surveys. Guidelines are presented below on how the implementation should be conducted in the field, as a component of the port sampling activities.

For every fourth vessel unloaded per day, one questionnaire (ETP1) should be filled-in. For this fourth unloading, both a complete Port Sampling form and a complete ETP questionnaire are required, as shown below:

- **Vessel 1: Port Sampling form + ETP questionnaire (ETP1)**
- Vessel 2: Port Sampling form
- Vessel 3: Port Sampling form
- Vessel 4: Port Sampling form
- **Vessel 5: Port Sampling form + ETP questionnaire**
- **Vessel 9: Port Sampling form + ETP questionnaire**
- Etc.

Sustainability Facilitators keep a logbook of all unloading events, to avoid confusion over when ETP data should be collected. If, for any reason, ETP data cannot be collected on every fourth unloading, please collect ETP data of the next vessel and continue to collect ETP data according to the scheme, as shown below:

- **Vessel 5: Port Sampling form + ETP data FAILED**
- **Vessel 6: Port Sampling form + ETP data**
- Vessel 7: Port Sampling form
- Vessel 8: Port Sampling form
- Vessel 9: Port Sampling form
- **Vessel 10: Port Sampling form + ETP data**
- Etc.

One crew member of the unloading vessel, present on the last fishing trip, should be interviewed. Interviews should be arranged after the unloading activities, preferably at the fisherman's home, or another place where disturbance by other people in the community is less likely (e.g. at the MDPI field office). The ETP species FAO codes can be found in Appendix III.

The Fishing & Living ETP Guide should be used to aid in identification of ETP species. Additional identification aid may be found in the booklet "*Marine Species Identification Manual For Horizontal Long line Fishermen*", of which a copy should be available to all sustainability facilitators on site.

2.6. Standard Operating Procedure, SOP, VI – Bait Data

Live, dead and artificial bait are used in the tuna fisheries. Live bait is usually caught by the fishermen, on the way to or at the fishing ground. Artificial bait consists of home-made lures. The bait fishery should be regarded as a separate fishery from the main target fishery and undergo a separate evaluation. To determine whether the bait species is at risk of overexploitation, a risk-based assessment should be conducted. If a stock is considered at risk, mitigation measures should be determined and implemented. Every port sampling activity should include data collection on bait. Bait data is recorded in UL 1, Section 3 of the port sampling form. The following data is collected on bait:

- ❖ Bait Category
- ❖ Bait species
- ❖ Fishing ground
- ❖ Total catch (actual/estimate)
- ❖ Gear type

There are seven possible bait categories: A) squid; B) flying fish; C) tongkol species; D) scad; E) tuna, as dead bait, F) artificial bait and G) Other included to cover any additional species that may be used as bait. The possible bait species are described below. Jereb & Roper (2006) review of inshore squids was used to supplement the description of some of the squid species below. If the species can not be identified, the category of the bait should be recorded. The same gridded maps for identifying tuna fishing grounds can be used to identify bait fishing grounds. For additional information see the bait section described in "*Marine Species Identification Manual For Horizontal Long line Fishermen*", pages 145-152.

Category A – Squids

1. Chiroteuthis imperator

The mantle of this squid can measure up to 30cm and photophores are present on the arms (Figure 57).

Figure 57. *Chiroteuthis imperator*

2. Chiroteuthis picteti / KTP

This squid is medium sized and the most noticeable feature is the very long slender clubs when compared with other squids (Figure 58).

Figure 58. *Chiroteuthis picteti* / KTP

3. Idiotheuthis cordiformis

This squid can grow to one hundred centimeters but smaller individuals are used for bait purposes. The fin attached to the mantle is semi-circular in shape and wider than other squid species (Figure 59). The cuticle is covered in small, conical tubercules and is usually red in colour, which may be damaged during hauling. The suckers on the clubs are much larger than on other squid species, especially towards the posterior end.

Figure 59. *Idioteuthis cordiformis*

4. Loligo pickfordi / SQC

The mantle of this squid is slender, with a small fin at the tip. Arms II and III of males have enlarged suckers compared with the females. No photo available

5. Loliolus affinis

This squid has a short mantle, ~ 35mm, which is slightly compressed dorsoventrally. The arms are short, except for the club arms (Figure 60). The club sucker rings have between 15-20 small teeth.

Figure 60. *Loliolus affinis*

6. Loliolus hardwickei

This is a small squid, between 30-40mm, with a stout mantle, with rounded fins; the width of the fins is generally equal to or slightly larger than the length of the mantle (Figure 61). In the males the fins extend past the posterior end of the body and fuse together. The tentacles are short, with small clubs. This squid has no photophores

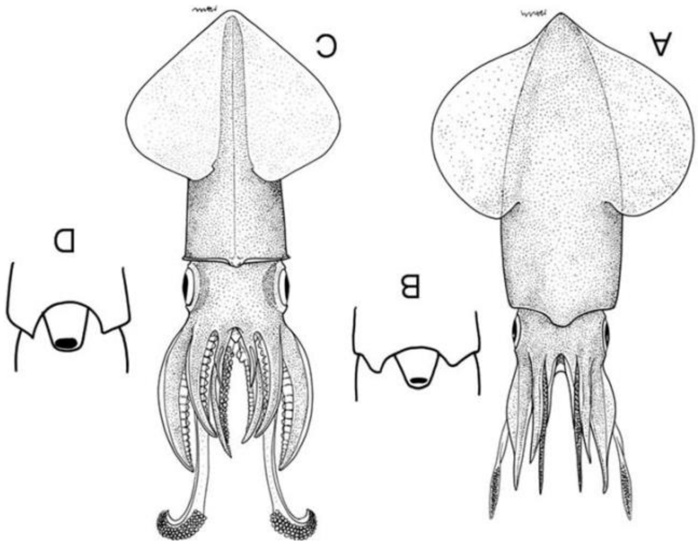

Figure 61. A and B – dorsal view and funnel of female *Loliolus hardwickei*. C and D – dorsal view and funnel of male *Loliolus hardwickei*. (Jereb & Roper 2006)

7. *Loligo chinesnis* / Mitre squid / OJH

This squid can grow to a maximum length of 30cm. The mantle is cylindrical, which tapers to a blunt tip (Figure 62). The fins are found on the posterior half of the mantle and are triangular in shape, with a rounded tip. The arms are long with the tentacles even longer. The clubs are long and slender with large suckers.

Figure 62. *Loligo chinensis* / Mitre squid / OJH

8. *Uroteuthis duvaucelii*

The mantle is long and slender, rounded for the majority of the body and then tapers into a blunt tip. The fins are widest in the middle point of their length (Figure 63). The arms are moderately long and the suckers of Arms II and III of males are larger than on females. The tentacles are long, measuring ~half the mantle length. This squid can have a red/brownish colour if in good condition when caught.

Figure 63. *Uroteuthis duvaucelii*

9. *Pterygioteuthis giardia* / Roundear enope squid / TID

This is a small squid species, usually measuring 25mm, rarely growing to 30mm. The mantle has a very pointy tip and the fins are small, semi-circular and do not extend to the end of the mantle (Figure 64). The arms are short and strong and the tentacles are long and thin with a small club. There are pink patches on the surface of adult individuals.

Figure 64. *Pterygioteuthis giardi* / Roundear enope squid / TIB

10. *Sepioteuthis lessoniana* / Bigfin reef squid / UHL

Bigfin reef squid can grow to ~33cm in length. The fin extends nearly fully around the mantle and is narrow and oval in outline (Figure 65). Both the arms are tentacles are long, tentacles longer with elongated, thin clubs

Figure 65. *Sepioteuthis lessoniana* / Bigfin reef squid / UHL

11. Sthenoteuthis oualaniensis / Purple back flying squid / YMO

The Purple back flying squid can grow to 30cm in length, with individuals >10cm usually having a large yellow organ under the skin (Figure 66). The mantle is long and robust with the fins occurring on the posterior section of the mantle. The width of the fins exceeds the length of the fins, and the fins are longest in the middle part of their length.

Figure 66. *Sthenoteuthis oualaniensis* / Purple back flying fish / YMO

12. Thysanoteuthis rhombus / Diamondback squid / YUR

This squid can grow to lengths of 100cm. It has very short arms and noticeably large triangular fins, which extend the full length of the mantle (Figure 67). It is usually ref in colour with big eyes, short arms and long tentacles.

Figure 67. *Thysanoteuthis rhombus* / Diamondback squid / YUR

13. Uroteuthis bartschi / Bartsch's squid / URB

This squid has an elongated body shape, with a narrow mantle and growing to lengths of 20cm. The posterior end of the mantle extends noticeably beyond the posterior section of the fins (Figure 68). The fins are located towards the posterior of the mantle and are pointy and triangular.

Figure 68. *Uroteuthis bartschi* / Bartsch' squid / URB

14. Uroteuthis sibogae

This squid has an elongated body and can grow to ~16cm. The mantle extends slightly beyond the posterior end of the fin (Figure 69). The fins are small, triangular and pointy, located at the posterior end of the mantle. The arms are short and the tentacles are long

.

www.quazoo.com

Figure 69. *Uroteuthis sibogae*

15. *Uroteuthis singhalensis* / Long barrel squid / OJN

The mantle of this squid is long and narrow, tapering into a pointed tip. The fins are just over half the length of the mantle, narrow and extend to the limit of the pointed mantle tip. The arms and tentacles are slender and short, with small clubs (Figure 70).

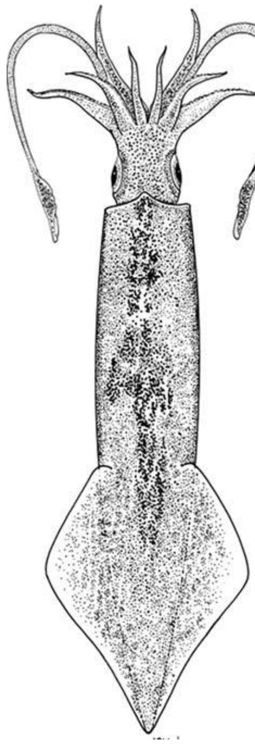

Figure 70. *Uroteuthis singhalensis* (Jereb & Roper 2006)

16. *Uroteuthis edulis*

This species can grow to measure 40cm. The fins are large and triangular, present along 50-70% of the mantle length, with the mantle and fin, finishing in a blunt tip (Figure 70). The arms are short and the tentacles long with a large club. Accurate identification of this species is difficult due to its polymorphic nature, i.e. a variety of 'forms' exist depending on locality and season.

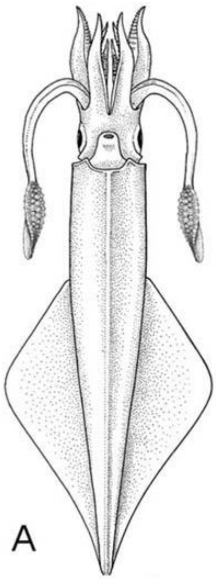

Figure 71. *Uroteuthis edulis* (Jereb & Roper 2006)

17. Abralia andamanica / BLK

This squid is a small species, usually not measuring more than 50mm. The mantle is short and conical, ending in a short pointed tail (Figure 72). The fins are located on the posterior section of the mantle extending along ~40% of the mantle length. The fins are triangular and pointed and do not extend the full length of the mantle.

Figure 72. *Abralia andamanica* / BLK

18. Abralia renschi

This is a small species of squid, usually, not measuring more than 45mm. The mantle is slender, tapering into a blunt end. The fins are triangular and located at the mantle posterior where they extend along ~60% of the mantle length (Figure 73).

www.zen-ika.com

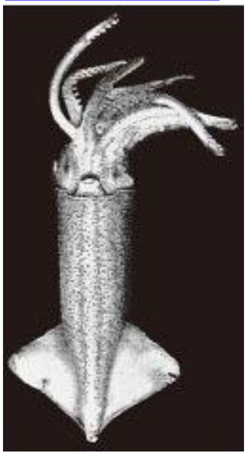

Figure 73. *Abralia renschi*

19. Pholodoteuthis boschmai

The mantle of this species can grow to lengths of ~60cm. The mantle is cylindrical, and the fin diamond shaped, extending to the end of the mantle. The tentacles are long and the club is generally not much wider than the tentacle, may be slightly compressed in adults. No figure available for this species.

20. Enoploteuthis reticulata

This species can grow to mantle lengths of 130mm. The mantle is conical, measuring approximately half of the total body length, and with approximately six longitudinal rows of photophores (Figure 74). The fins are triangular and pointed, with the mantle extending beyond the fin end. The arms and head constitute approximately half of the total length. The arms are long and thick whereas the tentacles are thin and weak. The club of the tentacle is narrow and small.

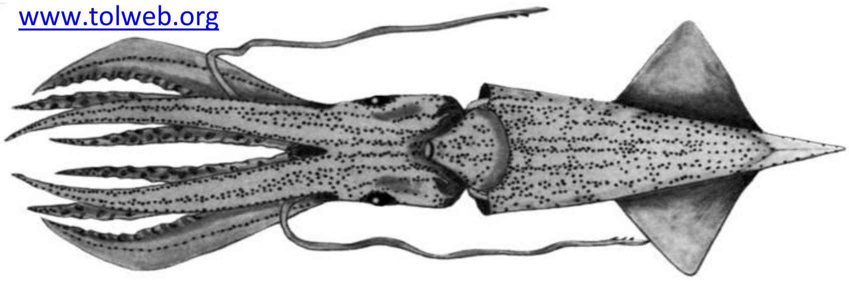

Figure 74. *Enoploteuthis reticulata*

21. Galiteuthis pacifica

There is a lack of information on this species. Mantle lengths could measure as much as 33cm. The arms and tentacles are short. The fins are triangular, slightly rounded and small and are located on the posterior section of the mantle (Figure 75). The mantle is conical, extending slightly beyond the end of the fins.

Figure 75. *Galiteuthis pacifica*

22. Taonius belone

This species can measure ~660mm in mantle length. The fins are long, narrow and tapering, with the mantle extending beyond the end of the fins (Figure 76).

Figure 76. *Taonius belone* (juvenile)

Category B – Flying Fish

23. Cheilopogon abei / Abe's flying fish

Abe's flying fish can grow to a maximum length of ~22cm. The body is elongate and cylindrical, with a small head, large eye, blunt snout and small mouth. The lower jaw may sometimes extend past the upper jaw. Flying fish have noticeable larger and wider pectoral fins than other fish species, which can reach as far as the base of the caudal fin, and which are used for flying. The pectoral fins of *Cheilopogon abei* have an orange/cream band across the width. The pelvic fins are located closer to the anus than in other fish (Figure 77) and are also larger and wider than usual. This fish is dark blue/green dorsally and silver ventrally. The lower fork of the tail is slightly longer than the upper fork.

Figure 77. *Cheilopogon abei* / Abe's flying fish

24. Cheilopogon arcticeps / White-finned flying fish

The White-finned flying fish can grow to ~21cm. The body is cylindrical and wide, with a small head and mouth, big eye and a slightly pointed snout (Figure 78). The pectoral fin is large, wide and white in colour. The pelvic fin is located towards the posterior of the body, is larger and wider than usual and white in colour. The dorsal side is dark blue/green and the ventral side is silver. The lower fork of the tail is longer than the upper fork.

Figure 78. *Cheilopogon arcticeps* / White-finned flying fish (White et al. 2013)

25. Cheilpogon antoncichi

Little is known about this species. Like other flying fish species it has large and wide pectoral and pelvic fins. The head is small with a big eye and the lower jaw extends slightly further than the upper jaw. The lower fork of the tail is longer than the upper fork and both have a white tip (Figure 79).

www.eol.org / © Smithsonian Institute

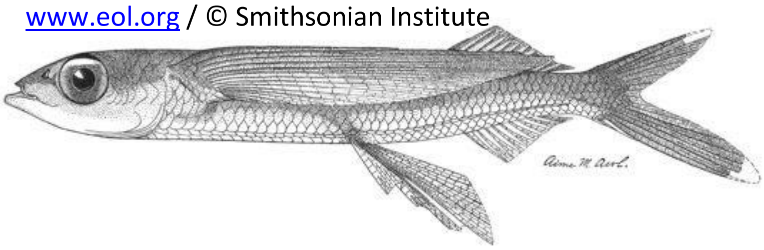

Figure 79. *Cheilopogon antoncichi*

26. Cheilopogon atrisignis

This flying fish can grow to lengths of 33cm. The body is elongate and cylindrical. It has a short head, big eye, small mouth, with the lower jaw sometimes extending further than the upper jaw. The pectoral fins are large and wide, with many small black spots present (Figure 80). The pelvic fins are located towards the anus and are large, wide and white/grey in colour. The lower fork of the tail is longer than the upper fork. The dorsal side is grey/black and the ventral side is white/silver.

Figure 80. *Cheilopogon atrisignis*

27. Cheilopogon intermedius

Little is known about this species. It can grow to lengths of 22cm. The body is elongate and deep close to the head. The head is short, with a big eye, small mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, with large black/brown spots present (Figure 81). The pelvic fin is also large and wide, located towards close to the anus and is grey/white in colour. The lower fork of the tail is longer than the upper fork.

Figure 81. *Cheilopogon intermedius* (White et al. 2013)

28. Cheilopogon katoptron

Little is known about this species. It can grow to lengths of 18cm. The body is elongate and deep close to the head. The head is short, with a big eye, small mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, with a band of paler colour present (Figure 82). The pelvic fin is also large and wide, located towards close to the anus. The lower fork of the tail is longer than the upper fork.

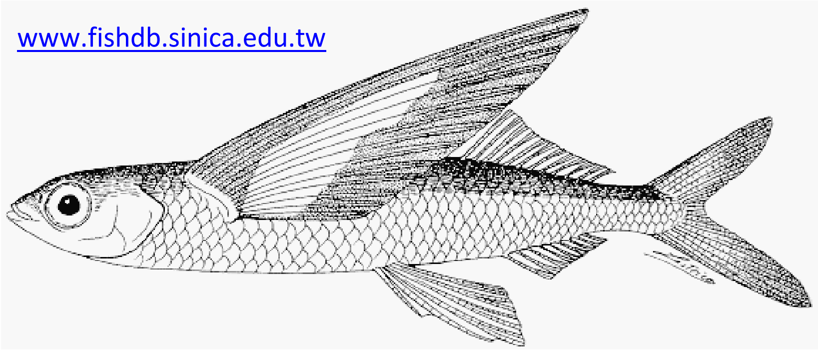

Figure 82. *Cheilopogon katoptron*

29. Cheilopogon unicolor

This species can grow to lengths of 38cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, and are white or translucent (Figure 83). The pelvic fin is also large and wide, located towards close to the anus and is grey/white in colour. The lower fork of the tail is longer than the upper fork. The dorsal side is dark blue/green and the ventral side is silver/white.

Figure 83. *Cheilopogon unicolor*

30. Cypselurus hexazona

This species can grow to lengths of 18cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide. They are mainly dark in colour but with a narrow paler band around the edge (Figure 84). The pelvic fin is also large and wide, located towards close to the anus. The lower fork of the tail is longer than the upper fork. The dorsal side is dark blue/green and the ventral side is silver/white.

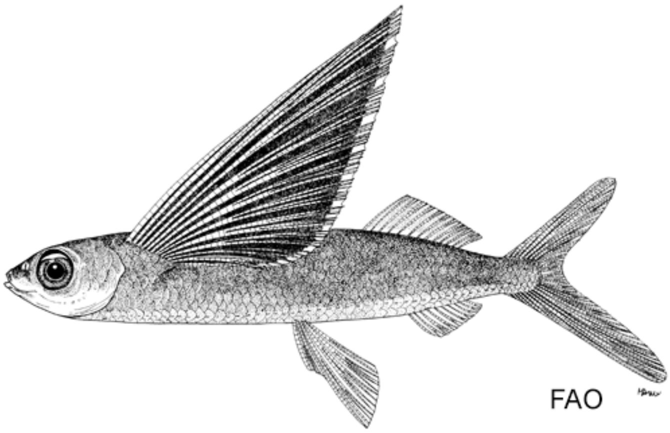

Figure 84. *Cypselurus hexazona* (www.fishbase.org)

31. Cypselurus oligolepis

This species can grow to lengths of 18cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, and are black/grey in colour (Figure 85). The pelvic fin is also large and wide, located towards close to the anus, and is translucent with a black section near the tip. The lower fork of the tail is longer than the upper fork. The dorsal side is black and the ventral side is silver/white.

Figure 85. *Cypselurus oligolepis*

32. Cypselurus opisthopus / YPX

This species can grow to lengths of 18cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide. The pelvic fin is also large and wide, located towards close to the anus. The lower fork of the tail is longer than the upper fork. No picture available.

33. Cypselurus poecilopterus / Yellow flying fish / ECP

This species can grow to lengths of 27cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, and are brown/yellow in colour with multiple brown spots (Figure 86). The pelvic fin is also large and wide, located towards close to the anus and is grey/white in colour. The lower fork of the tail is longer than the upper fork. The dorsal side is dark blue/green and the ventral side is silver/white.

Figure 86. *Cypselurus peocilopterus* / Yellow flying fish / ECP (White et al. 2013)

34. Hirundichthys albimaculatus

The body of this fish is elongate, flattened ventrally and can grow to 23cm. The pectoral fins are very long, reaching almost as far as the base of the caudal fin. The pelvic fins are also long, located close to the anus and extending beyond the origin of the anal fin. No picture available.

35. Hirundichthys oxycephalus / Bony flying fish / FFZ

This species can grow to lengths of 18cm. The body is elongate, with a short head, a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, and are grey in colour, with a thin white edge (Figure 87). The pelvic fin is also large and wide, located towards close to the anus and is grey in colour, with a thin white edge. The lower fork of the tail is longer than the upper fork. The dorsal side is dark grey and the ventral side is silver/grey.

Figure 87. *Hirundichthys oxycephalus* / Bony flying fish / FFZ (White et al. 2013)

36. Parexocoetus brachypterus / Sailfin flying fish / PXB

This species can grow to lengths of 20cm. The body is elongate and cylindrical. The head is short, with a big eye, a small, blunt mouth and the lower jaw sometimes extends past the upper jaw. The pectoral fins are large and wide, and are white or translucent (Figure 88). The dorsal fin is larger than other flying fish and is clear in colour with a black blotch near the edge. The pelvic fin is also large and wide, located towards close to the anus and is grey/white in colour. The lower fork of the tail is longer than the upper fork. The dorsal side is dark blue/green and the ventral side is silver/white. The caudal fin has a red tinge, with the lower fork longer than the upper fork.

Figure 88. *Parexocoetus brachypterus* / Sailfin flying fish / PXB

Category C – Tongkol Species

37. Euthynnus affinis / Mackerel Tuna / Tongkol Komo / KAW

Mackerel tuna is a small tuna, usually not growing larger than 1m, and has a deeper body shape than bullet tuna (described below). Individuals have an oblique striped pattern on the dorsal side, blue/green in colour, which does not extend past the beginning of the first dorsal fin (Figure 89). There are between two and five dark sports above the pelvic fin. The anterior spines of the dorsal fin are much higher than spines further along the dorsal side.

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Figure 89. *Euthynnus affinis* / Mackerel Tuna / Tongkol Komo / KAW

38. Auxis rochei / Bullet Tuna / Tongkol / BLT

The maximum fork length for bullet tuna is ~50cm and the body is more elongate than mackerel tuna (Figure 90). Bullet tuna have a striped/blotch pattern on the dorsal side, which does not extend past the beginning of the first dorsal fin. The pelvic and pectoral fins have a purple tinge to them. The second dorsal fin and the anal fin are very small (smaller than those of the mackerel tuna).

Figure 90. *Auxis rochei* / Bullet Tuna / Tongkol / BLT

39. Auxis thazard / Frigate tuna, Frigate mackerel / Tongkol banyar / FRI

The maximum fork length for the frigate tuna is ~65cm. The dorsal side is dark blue, with a section of 15 or more narrow oblique, near horizontal wavy lines above the lateral line and reaching forward until the first dorsal fin and above the pectoral fin (Figure 91). The ventral side is white. The pectoral and pelvic fins are purple on the exterior side and black on the interior side. It is similar to *Euthynnus affinis* and *Auxis rochei*, but it has a larger distance between the dorsal fins, a lower spinous dorsal fin and a more slender shape.

Figure 91. *Auxis thazard thazard* / Frigate mackerel, Frigate tuna / Tongkol banyar / FRI

40. Gymnosarda unicolor / Dogtooth tuna / DOT

The Dogtooth tuna can reach a maximum length of 248cm but lengths of 190cm are more common. Dogtooth tunas have large mouths, with the upper jaw extending to the middle of the eye (Figure 92). The dorsal and upper sides of the body are blue/black and the belly is silvery. There are no markings on the body, i.e. no lines, no spots. The lateral line is curved, dipping towards the tail end of the fish. The dorsal and anal fins may have small white tips. The body is streamlined and long. There are a series of small, dark-coloured finlets from the dorsal fin to the base of the caudal fin.

Figure 92. *Gymnosarda unicolor* / Dogtooth tuna / DOT

Category D – Scads

41. Selar crumenophthalmus / Bigeye scad / Bentong, selar, kembung / BIS

The Bigeye scad has a large eye, covered with a fatty eyelid (Figure 93). The body is elongate, fusiform and moderately compressed. This fish can grow to lengths of 30cm. The dorsal side is metallic blue/green and the ventral side it white. A yellow stripe sometimes extends along the lateral line. The dorsal fins are close together, with the first dorsal fin marginally higher than the second. The anal fin is small and there are no finlets after it. The caudal fin is a dark colour, with the remaining fins white/silver in colour.

Figure 93. *Selar crumenophthalus* / Bigeye scad / Bentong, selar, kembung / BIS

42. Decapterus russelli / Indian scad / Layang / RUS

The Indian scad can grow to lengths of 45cm. The body is elongate and compressed. The dorsal side is blue/green and the ventral side is white/silver (Figure 94). There is a small black spot at the top of the opercle. The caudal fin is hyaline/yellow. The dorsal fins are hyaline at the base becoming dusky at the edges. The pelvic and pectoral fins are clear/white.

www.eol.org / © Randall, J. E.

Figure 94. *Decapterus russelli* / Indian scad / Layang / RUS

43. Decapterus macrosoma / Shortfin scad / Layang /DCC

Shortfin scad are small, slender fish, with a maximum total length of 35cm. The dorsal side is metallic blue and the ventral side is silver, separated by a thin dark lateral line (Figure 95). They have a small black mark above the base of the pectoral fin. The top of the head is scaleless. The fins are almost transparent and have a glassy appearance. Separate finlets occur after the dorsal and anal fins.

Figure 95. *Decapterus macrosoma* / Shortfin Scad / Layang

44. Decapterus kurroides / Red tailed scad / momar ekor merah / DCK

Redtail scad are a small fish, with a deep body compared with other species of similar length (Figure 96). There is a small dark blotch above the base of the pectoral fin. Redtail scads are a blue-green colour dorsally and silver ventrally. The most distinguishing feature is the bright red caudal fin.

Figure 96. *Decapterus kurroides* / Red Tailed Scad / Momar Ekor Merah / DCK

45. Decapterus macarellus / Mackerel scad / Layang biru, Malalugis / MSD

Mackerel scad can grow to a maximum length of 46cm but smaller individuals are usually recorded. Mackerel scad have an elongated body, which is dark blue/metallic on the dorsal side and silver on the ventral side (Figure 97). Like other *Decapterus* species, they have a small dark blotch above the base of the pectoral fin. There are no spots on the lateral line. They have a small, detached dorsal and anal fin located between the main dorsal fins and the tail. The caudal fin may have a reddish colour.

Figure 97. *Decapterus macarellus* / Mackerel Scad / Layang biru, Malalugis / MSD

46. Selaroides letolepis / Yellowstripe scad / Selar Kuning / TRY

This fish grows to lengths of 22cm, with smaller individuals used for bait purposes. The body of this fish is slightly compressed ventrally, with a rounded belly (Figure 98). The dorsal side is metallic blue/green and the ventral side is silver/white. There is a thick yellow stripe along the lateral line, thicker than the yellow stripe in *Selar crumenophthalmus*. The lateral line arches towards the anterior of the body. There is a dark spot behind the eye, above the gills. This fish is similar to *Selar crumenophthalmus*, but the fins do not have a dusky edging, the caudal fin does not have dark tips, the head is higher with a smaller eye and the upper and lower edges of the eye do not have a dark colour.

Figure 98. *Selaroides leptolepis* / Yellowstripe scad / Selar Kuning / TRY

Category E – Tuna, as dead bait (skipjack, yellowfin tuna and bigeye tuna)

Tuna species are often used as bait. Juvenile skipjack and yellowfin tuna are commonly used. When known, the species of tuna should be recorded in the port sampling form.

Category F – Artificial bait

Artificial bait can be bought or handmade from materials, such as brightly coloured plastic to attract the tuna (Figure 99).

Figure 99. Artificial bait used for tuna fishing

Category G – other species

47. Sardinella gibbosa / Goldstripe sardinella / Tembang / SAG

This species can grow to lengths of 17cm but lengths of 15cm are more common. It has a small blunt snout and a small head (Figure 100). The dorsal side is dark blue and the ventral side is silver. There is a golden midlateral line along the flank and the dorsal and caudal fin margins are dusky black. The pelvic and pectoral fins are white/silver.

Figure 100. *Sardinella gibbosa* / Goldstripe sardinella / Tembang / SAG (White et al. 2013)

48. Sardinella lemuru / Bali sardinella / Lemuru / SAM

This fish can grow to lengths of 23cm but lengths of 20cm are more common. The body is elongate and slightly cylindrical, with a rounded belly. It is distinguishable from other *Sardinella* species by the number of rays in the pelvic fin; one unbranched and eight branched, whereas other species have one unbranched and seven branched. There is a faint golden spot near the gill opening and a noticeable black spot near the border of the gill (Figure 101). The dorsal side is dark blue/green, the ventral side is silver golden and there is a faint mid-lateral golden line. The caudal fins may have small black tips.

Figure 101. *Sardinella lemuru* / Bali sardinella / Lemuru / SAM

49. Rastrelliger kanagurta / Indian mackerel / Banyar, Kembung lelaki / RAG

The body depth of the Indian mackerel is shorter than the length of the head and the mouth is large (Figure 102). Indian mackerels can grow to lengths of 35cm. There is a black spot near the lower margin of the pectoral fin. The body is a silver/white colour, with a number of dark stripes on the dorsal side. Some of these dark stripes may break into smaller spots. The second dorsal fin is smaller than the first. The dorsal fins are yellowish with black tips and the pectoral fins are yellowish.

Figure 102. *Rastrelliger kanagurta* / Indian mackerel / Banyar, Kembung lelaki / RAG

50. Rastrelliger brachysoma / Short mackerel / Kembung perempuan / RAB

The Short mackerel can grow to a maximum size of 35cm. It has a small, pointed snout. The dorsal side is solver/green and the ventral side is white/silver (Figure 103). The dorsal fins are hyaline, with a black mark at the tip. The pelvic and anal fins are clear and the caudal fin is dusky colour with a dark spot at the tip of the upper lobe.

Figure 103. *Rastrelliger brachysoma* / Short mackerel / Kembung perempuan / RAB

Chapter 3 – Data Collection and upload to I-Fish

This section focuses on the collection process of fishery-dependent data from Indonesian ports and landing sites for use in stock assessments. This data will be the basis for designing improved management systems that will move Indonesian tuna fisheries towards sustainability. The process of uploading the data to I-Fish is described.

In collaboration with district DKP and the owner / supplier of the vessels, the following vessel data should be recorded:

- vessel name
- captain name
- origin
- registration number
- vessel size class (GT)
- engine capacity (HP)
- number of fishermen employed
- gear used
- main fishing ground

This process is conducted annually in most ports, through an automatic renewal system for registration, which may result in vessel/gears changes being unrecorded. Therefore this information should be recorded at the start of each year for each vessel participating in data collection activities.

Operational level catch and effort data relates to information gathered in a logbook. Logbooks are compulsory for vessels >30 GT and compulsory logbook implementation for the entire Indonesian fleet (including all registered vessels >5GT) will be implemented over the coming years. Information on length of trip may be collected by DKP in various ports but collected irregularly across the country. A logbook system has recently been deployed for artisanal tuna fisheries. To support logbook integration, sustainability facilitators should conduct a socialization process, covering:

- Logbook explanation, use and benefit
- Overview of logbook requirements
- Continuous support and encouragement to fishermen to ensure gradual adoption and acceptance of logbook by all active vessels.

Fish quality codes are used to differentiate between catch quality. Each supplier will have a way of categorizing his catch according to size / quality / species. Category codes should be no longer than 10 characters and site-specific categories should always be used. When dealing with small delivery vessels, the number of the unloading vessel should be recorded.

3.1. General Direction

The field site team for data collection consists of at least two staff: Site Supervisor and Sustainability Facilitator. As the leader in the field, the Site Supervisor is the main person responsible for data collection activity and is helped by *Assistant Site Supervisor* in the larger areas. The quality of data will be ensured by the Site Supervisor by following instruction on Chapter 3, Sub Chapter 3.2 – 3.4. The Site Supervisor will make sure the attendance of the Sustainability Facilitator in the landing site in each unloading process. The Sustainability Facilitator collects the data directly from fisherman. Each team has duty and role as follow:

Site Supervisor:

- Lead and manage small team in the field
- Ensure all data collection activity conducted properly according to the relevant protocol of data collection
- Check all the data before going to I-Fish
- Uploading all the data to I-Fish
- Build and maintain good relationship with all stakeholders such as supplier, the worker of supplier, fishers, processor, port authority
- Report all problem to line up manager

Sustainability Facilitator:

- Collect the data in high quality
- Report problem to Assistant Site Supervisor (if there is no Assistant, directly report to Site Supervisor)

The successful of daily data collection activity is greatly determined by all parties involved in catch unloading activity. So it should build good communication with them by following these instructions:

1. To obtain and maintain respect and cooperation with captain, vessel owner, and with all parties involved during data collection in the port, make sure that you are always respectful, polite and not demanding.
2. Make sure that you are welcomed by captain, fisher or vessel owner before getting up to the vessel, if you need to get in to the vessel. Do not think that you are allowed by them to get in to the vessel or using vessel equipment. Ideally you have your own equipment, including everything tool for doing data collection, measuring length fish and each fish biological sampling.

3. Build good communication and good relation with captain and crew by informing them about sampling program and biological sampling and appreciate their experience and their capability as fisherman. However you do not need to explain previous sampling activity, in other locations or vessels from different company / other owners (due to confidentiality)
4. Make sure that you have your own all gears to do data collection in fishing port, including drinking water. Make sure that you look after well the gears of data collection and clean up every finishing data collection activity.
5. Clean up the sampling area after measuring the subsampling length or after biological sampling. Including in the vessel or fishing port (TPI)
6. Your role as enumerator is not obedience. You are not enforcement officer. You are MDPI's staff to collect the data and information scientific goal, not for government interest (for example for tax) or for private company. Some data can be given to fishing authority, government institution or private company through official rule of MDPI and KPDP TCT Province. Exception for individual vessel, vessel owner and company allow their data to be informed.
7. Find properly place and good condition when fisher is relax to do interview, as much as possible decrease intervention answer from the others that can affect to the accuracy data
8. To make interview with fisher effective and efficient, make sure that you always bring fish identification book and fishing ground map
9. Make sure that you are allowed by supplier or supplier staff in fish unloading process before measuring fish, and find good position in order to not disturb unloading process.
10. The safety of field team is the main priority. If you have accident or getting sick when doing daily sampling activity, please stop it (depend on accident level) after reporting it to site super visor. It should be important to have first aid kit in each site office.

3.2. Daily Port Sampling Form

The daily port sampling form is used to collect data from unloading events from individual vessels on a daily basis. One form is used per vessel per day. Two sampling designs are available, the use of each depending on the size of the vessel and the volume of the catch. Effort is made to collect data from 20% of landing events in the port sampling sites, to be compatible with WCPFC data reporting requirements. This coverage is considered a representative sample of all vessel landings as well as a feasible amount to survey by sustainability facilitators.

The first sampling design is for vessels between 3-15GT, which land a large volume of fish. With these catches it is not possible to record data on every individual fish and a subsampling system is developed, specifically for section 6 (described below in more detail). Aside from the target large yellowfin tuna, which are dealt with separately, the small tune from these catches are landed in boxes. A box sampling approach is used until a maximum of 200 fish have been measured. All fish from Box 1, Box 5, Box 10 and every fifth box thereafter will be sampled, until the maximum of 200 fish have been sampled. If 200 fish have been measured after sampling Box 1 and 5, sampling ends. Similarly, if 200 fish have been measured after sampling Box 1, Box 5 and half of Box 10, sampling should end halfway through Box 10.

Only boxes containing species of fish that occur in large amounts (>5%) should be sampled. It is important that subsampling is conducted on unsorted fish. If Sustainability Facilitators notice that the fish is being sorted by size, approach the transit staff/supplier and request reasoning. Discontinue sampling and contact supervisor. Either alternative subsampling must be devised or transit staff/supplier will be asked to return to non-sorting.

The following two methods pertain to the manner in which the 'small tuna', <10kg, is sampled, specific to section 6 of the sampling form. Other sections of the sampling form and details are described below.

Method 1 – Subsampling for larger catches

- Measure the length of all individual fish from Box 1, Box 5, Box 10 and every fifth box after this (i.e. 1, 5, 10, etc.), until a maximum of 200 fish have been sampled.
- If a box of fish containing species that occur in small amounts, e.g. Mahi-mahi appears in the unloading sequence (i.e. box 1, 5, 10, etc.) this box should be discarded and not counted in the sequence.
- Fork Length is measured from the tip of the upper jaw to the center of the fork in the tail. Only whole fish should be measured. The fork length should be rounded down to the nearest whole cm → 69.9cm recorded as 69 cm (see SOP II for more details).
- The weight of the box should be recorded.

The second sampling method is for small vessels catching a low number of individual fish per trip. In this case the subsampling system is not implemented and instead data on the entire catch is recorded.

Method 2 – sampling for small vessels, <3GT, which tranship catch or unload on land

- Record the number of each fish, i.e. 1, 2, 3, etc,
- The fork length of a maximum of 10 individual fish of each category should be recorded in a random fashion
- If fish are landed in a processed state the fork length of the carcass should be recorded as well as the length and weight of a top right or left loin

The following is a description of the data that should be recorded in each section of the port sampling form, (the port sampling form can be found in Appendix I):

UL1, Section 1 – general information

Tempat Pendaratan	-	Name of the port/landing site
Nama Perusahaan	-	Name of the supplier/company
SF 1, SF 2	-	Names of the sustainability facilitators
Number of hooks	-	Record whether in the fishing trip caught tuna > 10kg using “Single (Figure 104), “Many (Figure 105)” and “Combination”

Figure 104. Hooks “Singgle”

Figure 105. Hooks “Multiple”

Nama Kapal	-	Vessel name. If no vessel name is available record the name of the vessel owner
Nama Kapten	-	Name of Captain
Daerah	-	Fishing area using the grid maps (Figures 2 and 3, see *SOP I*)
Penangkapan	-	If fishing has been conducted in two or more fishing area grids, please record all squares where fishing was conducted
Total Penangkapan	-	Total catch weight, kg, of the unloaded fish per vessel, or per collection vessel, excluding bait. The total catch weight includes data from catches of other species (*Form UL, Section* 4), catches of small tuna species, <10kg, (*Form UL2, Section* 6)

		and catches of large tuna species, >10kg, (*Form UL4, Section 8*).
Estimasi ikan yang tidak didaratkan	-	Total estimate of lost target fish, kg. This is the estimated weight of fish that is not recorded in the total catch, e.g. fish eaten, given away or discarded (exclude bait).
Tgl sampling	-	Sampling date, format dd/mm/yy
Waktu sampling	-	Time of sampling, format hh:mm
Lama trip	-	The total number of days of the fishing trip (both fishing days and traveling days)
Jumlah hari memancing	-	Number of days spent fishing, i.e. five days at sea, but only three of those days had fishing activity. Three is the number recorded
Penggunaan BBM	-	Amount of fuel used during the trip, L
Kapasitas Kapal	-	Vessel capacity, in gross tonnage, GT
Panjang Kapal	-	Vessel length, in metres, m
Kapasitas mesin	-	Engine capacity, in horse power, HP/PK
Pengguaan Es	-	Total amount of ice used on the trip, kg
Teknik pencarian lokasi tuna	-	Tuna locating technique, i.e. birds, dolphins, kites, FAD, fish finder, fish etc.
Jumlah awak kapal	-	Number of crew per vessel (all crews without captain)
Bahan kapal	-	Vessel material, wood or fibre
Rumpon	-	Rumpon, whether a Rumpon was used, 'F'- all fishing conducted around rumpon, 'X' – some fishing conducted around rumpon, 'N' – no fishing around rumpon
Alat Tangkap	-	If handline gear was used troll line, mark with an 'x'. If another gear besides handline was used, write the name of the additional gear here
Jumlah rumpon yang dikunjungi	-	Number of FAD visited during the fishing trip
Jumlah palka	-	Number of fish storage
Kapasitas palka	-	The capacity of fish storage (kg)
Cahaya	-	The intensity of light used for aggregating the fish (watt)

Implementasi teknologi	-	Choose the technology implemented on the boat TLC, Fly wire, PDS, Spot Trace, Trackfish dan GPS
Kapal Andon	-	Choose whether the boat is from different province
Asal Kapal Andon	-	Chose the province if the vessel is andon
Kedalaman mimimum	-	Write the minimum depth of line operated during the trip (m)
Kedalaman maksimum	-	Write the maximum depth of line operated during the trip (m)
Kelompok Nelayan FT	-	Write the FA name if the fisher is FT member

UL1, Section 2 – small delivery vessels (<3GT)

No.	-	Delivery vessel number (in order of daily unloading)
Nama Kapal / Kapten	-	Vessel name or captain name
Total Penangkapan	-	Total catch, kg
Estimasi ikan yang tidak didaratkan	-	Total estimate of lost target fish, kg. This is the estimated weight of fish that is not recorded in the total catch, e.g. fish eaten, given away or discarded (exclude bait).
Lama trip	-	Trip length, including day of departure and day of return. Record in hours or days
Penggunaan BBM	-	Amount of fuel used during the trip, L
Kapasitas mesin	-	Engine capacity, in horse power, HP/PK

UL1, Section 3 – bait information

Kategori	-	Bait category, recorded as one or more of the seven bait categories: A) squid, B) flying fish, C) tongkol species, D) scad species, E) tuna, dead bait pieces/live bait whole and F) artificial bait and G) other.
Spesies	-	Bait species, if known (see *SOP VI*)
Daerah Penangkapan	-	Fishing ground for bait. Use the gridded maps from *SOP I*
Total Umpan	-	Total catch of bait, kg.

Estimasi Umpan - Record an estimate if the actual catch is not available

Alat tangkap Umpan - Gear type used to catch the bait

Tangkapan domestic / import - Whether the bait sourced from domestic fisheries (still from Indonesian water), D, or imported, I (abroad)

UL1, Section 4 – other types of catches

Nama species - Species name of other catches

No. - Number of individuals caught per species

Kg - Weight of total individuals caught

Perkiraan - Is the weight an estimate, Y / N

UL2, Section 5 – category summary of small tuna species, individuals <10kg

Kode - Supplier quality code

Deskripsi - A brief description of the meaning of the quality code, i.e. skipjack good quality

Total Berat - Total weight of each category

UL 2, Section 6 and UL3, Section 6 cont. – random length sampling of individuals <10kg

Berat basket - Record the total weight of the box, kg (after eliminate the weight of bascket)

Spesies - Record the species contained in the box based on FAO code

Panjang - Record the length of each individual in the box, cm (see *SOP II* and *III*), see description above in section 3.1.

UL4, Section 7 – category summary of large individuals, >10kg

Kode - Supplier quality code

Deskripsi - A brief description of the meaning of the quality code, i.e. skipjack good quality

Total Berat - Total weight of each category (kg)

UL4, Section 8 and UL5, Section 8 cont. – measurements for individuals >10kg, whole or processed

No. Ikan	-	Record the fish number
Spesies	-	Species, either yellowfin tuna, bigeye tuna or albacore
Kode	-	Category code from section 7 above
Berat Utuh	-	Total weight of whole fish, kg.
Panjang Utuh / Karkas	-	Fork length of the whole/processed fish, cm (same as for Section 6 above)
Berat Loin 1	-	If the fish is processed, record the weight, kg, of the top right or left loin. The weight should be recorded to one decimal place
Panjang Loin 1	-	If the fish is processed, record the length, cm, of the top right or left loin. The same top loin must be measured for the loin length and weight.
Termasuk Insang	-	Gills included in the weight – Y/N
Termasuk Isi Perut	-	Stomach contents included in the weight – Y/N
Termasuk Daging Perut	-	Belly included in the weight – Y/N

3.3. Monthly Unloading Form

The monthly unloading form is used to collect monthly summary data on each vessel in a landing site. Monthly unloading forms are to be completed by suppliers, with the assistance of sustainability facilitators when necessary. The following is a description of the data that should be collected in each column of the monthly unloading forms (the monthly unloading form can be found in Appendix II):

No.	-	No. of the recorded vessel per month
Nama Kapal	-	Name of the vessel
Lokasi Pendaratan	-	Name of landing site
Tgl Mendarat	-	Date of landing, month and year
Waktu	-	Time of sampling
Lama trip	-	The total number of days of the fishing trip (both fishing days and traveling days)

Jumlah hari memancing	-	Number of days spent fishing, i.e. five days at sea, but only three of those days had fishing activity. Three is the number recorded
WPP Lokasi	-	Fishing ground location
Komposisi Tangkapan		
Total Tangkapan	-	Total weight of all catch, not included bait and lost fish (kg)
Tuna kecil	-	Record the total weight of all small tunas <10kg (total YFT, BET and total SKJ)
Tuna Besar	-	Berat utuh : The weight of tuna YFT and BET >10 kg in whole condition (kg)
	-	Loin kotor : The weight of total loin including the skin of YFT and BET (kg)
	-	Loin bersih : The weight of total loin without skin of YFT and BET (kg)
	-	ALB : The weight of tuna ALB in whole condition (kg)
Tangkapan lain	-	Where possible, record the total weight of each of the following species: BUM, BLM, MLS, SSP, SWO (kg)
ETP	-	Whether there was any ETP interaction
Port form	-	Whether a port sampling form was completed for this vessel
Fair Trade	-	Whether the fisher is the member of FT

3.4. Data storage and analysis

All data collected in these forms will be checked by the site supervisor, who then enters the data into spreadsheets on a computer every day. Data are entered into spreadsheets on the same day that they are collected to ensure discrepancies or data errors can be addressed and corrected while the information is still fresh. The site supervisor will then upload the data to I-Fish every month.

The sampled data can be analysed to create graphs and tables showing different types of information, such as:

a. Total produksi per alat tangkap
b. Total produksi per kategori spesies
c. Cakupan Sampling dari total produksi
d. Komposisi tangkapan spesies target

e. Komposisi tangkapan dari total tangkapan
f. Komposisi spesies tangkapan
g. Frekuensi Panjang target tangkapan (YFT, SKJ, BET)
h. Persentase % dari target tangkapan dewasa vs dewasa (berdasarkan panjang fishbase.org pada saat jatuh tempo pertama)
i. Hubungan Panjang / berat spesies target (YFT)
j. Tangkapan per Upaya Unit (Kg / L bahan bakar)
k. Tangkapan per Upaya Unit (Kg / Jam (hari) di laut)
l. Penggunaan Umpan dan Komposisi Spesies Umpan
m. Tangkapan per Kg Umpan
n. Komposisi Kualitas Tangkapan (Penggunaan es, Lamanya waktu di laut, Bahan bakar yang digunakan)
o. Komposisi Tangkapan per Fishing Ground (1 ° x 1 ° bujur sangkar)
p. Komposisi Tangkapan per WPP
q. Produktivitas per Fishing Ground (FG)
r. Produktivitas per WPP
s. Kapasitas per Site (jumlah kapal aktif per kategori GT)
t. Frekuensi Interaksi dengan Hewan Langka, Terancam dan Dilindungi
u. Nasib Interaksi ETP
v. ETP per FG / WPP

These graphs and tables can be shared with stakeholders using the I-Fish automatic reporting system and used for discussion at the DMC meetings.

Appendix I – Port sampling form

UL1	MDPI/IMACS FORM SAMPLING TUNA DI PELABUHAN		Versi : Februari 2019	
				Hal : dari
		Bagian 1 : Informasi Kapal Utama		
Tempat Pendaratan:	Nama Perusahaan :	SF 1:	SF 2:	Jumlah mata pancing
Nama Kapal:	Nama Kapten:	Daerah Penangkapan:	Total Penangkapan (Kg):	Estimasi Ikan Hilang (Kg):
Tgl sampling (dd/mm/yy):	Waktu sampling (jj:mm):	Jumlah hari memancing:	Lama Trip:	Penggunaan BBM (Liter):
Rumpon:	Kapasitas kapal (GT):	Panjang Kapal (m):	Kapasitas mesin (PK):	Penggunaan Es (Kg):
Jumlah rumpon yang dikunjungi :	Bahan kapal:	Jumlah Palka/Box :	Kapsitas palka/box (Kg):	Penggunaan daya cahaya (watt) :
Teknik mengetahui lokasi tuna :	Jumlah awak kapal:	Implementasi teknologi		
		TLC :	PDS :	GPS :
Kapal Andon :	Asal Kapal Andon :	Spot Trace :	Fly Wire :	Merk GPS :
		Kedalaman minimum (m) :		Kedalaman maksimal (m) :
Alat Tangkap Handline Troll	Lain	Kelompok Nelayan FT :		

Bagian 2 : Informasi Kapal Kecil: Bongkar ke Kapal Utama															
No	Nama Kapal/ Kapten	Total Penang kapan (Kg)	Estimsi Ikan Hilang (Kg)	Lama Trip (Hari/ Jam)	Penggu naan BBM (Lt):	Kapasit as mesin (PK):	No	Nama Kapal/ Kapten	Total Penang kapan (Kg)	Estimsi Ikan Hilang (Kg)	Lama Trip (Hari/ Jam)	Penggu naan BBM (Lt):	Kapasi tas mesin (PK):
1							6						
2							7						
3							8						
4							9						
5							10						

Bagian 3: Informasi Umpan

Kategori	Spesies	Daerah Penangkapan	Total Umpan (Kg)	Estimasi Umpan (Kg)	Alat tangkap Umpan	Import / Domestik
A Cumi-Cumi						
B Ikan Terbang						
C Spesies Tongkol						
D Spesies Layang						
E Spesies Tuna						
F Umpan Tiruan						
G Lain-Lain						

UL2 MDPI/IMACS FORM SAMPLING TUNA DI PELABUHAN Versi : Februari 2019

Hal : dari

Bagian 4: Jenis hasil tangkapan lain (Perkiraan total tangkapan)

Nama Spesies							
Jumlah ekor							
Kg							
Perkiraan?							

Deskripsi sampling

Bagian 5: Ringkasan Per Kategori Tangkapan Utama (Termasuk semua jenis tuna<10kg)

Kategori		**Total Berat (Kg)**	**Kategori**		**Total Berat (Kg)**
Kode	**Deskripsi**		**Kode**	**Deskripsi**	

Bagian 6: Sampling Acak Panjang Tangkapan Utama (Termasuk semua jenis tuna<10kg)

Berat basket	**Spe-sies**	**Panjang (cm)**	**Berat basket**	**Spe-sies**	**Panjang (cm)**	**Berat basket**	**Spe-sies**	**Panjang (cm)**	**Berat basket**	**Spe-sies**	**Panjang (cm)**

UL3	MDPI/IMACS FORM SAMPLING TUNA DI PELABUHAN	Versi: Februari 2019
		Hal : dari

Bagian 7: Sampling Acak Panjang Tangkapan Utama (Termasuk semua jenis tuna<10kg) - Sambungan

Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)

Hal : dari

Bagian 8: Sampling Acak Panjang Tangkapan Utama (Termasuk semua jenis tuna<10kg) - Sambungan

Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)	Berat basket	Spe-sies	Panjang (cm)

Deskripsi mengenai sampling

Kesesuaian dengan protocol :

Kendala Nelayan selama di laut :

Bagian 9 : Ringkasan Per Kategori (Tuna >10kg)

Kategori		Total Berat (Kg)	Kategori		Total Berat (Kg)
Kode	Deskripsi		Kode	Deskripsi	

Bagian 10 : Tuna >10kg Utuh dan Dalam Keadaan Sebagian Diproses

No.	Spesies	KODE	Berat Utuh (Kg)	Panjang Utuh/ Karkas (cm)	Berat Loin atas (Kg)	Panjang Loin atas (cm)	TermasukInsang? (Y/T)	Termasuk Isi Perut? (Y/T)	TermasukDagingPerut? (Y/T)

UL5 **MDPI/IMACS FORM SAMPLING TUNA DI PELABUHAN** **Versi: Februari 2019**

Hal :

dari

Bagian 11 : Tuna >10kg: Utuh dan Dalam Keadaan Sebagian Diproses - Sambungan

No.	Spesies	KODE	Berat Utuh (Kg)	Panjang Utuh/ Karkas (cm)	Berat Loin atas (Kg)	Panjang Loin atas (cm)	Termasuk Insang? (Y/T)	Termasuk Isi Perut? (Y/T)	TermasukDaging Perut? (Y/T)

Appendix II – Monthly Unloading Form

Yayasan
Masyarakat dan Perikanan
Indonesia

Catatan Pendaratan Kapal Bulanan (Monthly Unloading) 2017

Semua kapal harus dicatat dalam log,
walaupun Enumerator tidak ada saat unloading.
File ini dapat diupload ke ifish

No.	Nama Kapal	Lokasi Pendaratan	Tgl Mendarat (DD/MM/YY)			Waktu (00:00)	Lama Trip (Hari/Jam)	Jumlah hari memancing	WPP Lokasi	Komposisi Tangkapan															ETP	Port Sampling	Fair Trade
										Total Tangkapan	Tuna Kecil			Tuna Besar						Tangkapan Lain							
														YFT			ALB	BET									
			Tanggal	Bulan	Tahun						YFT	SKJ	BET	Loin Kotor	Loin Bersih	Berat Utuh		Loin	Utuh	BUM	BLM	MLS	SSP	SWO			

Appendix III – FAO codes for ETP species

Sharks, Skates and Rays	FAO code
1.1 Pelagic Thresher Shark (VU)	PTH
1.2 Bigeye Thresher (VU)	BTH
1.3 Common Thresher Shark (VU)	ALV
1.4 Whitetip Oceanic Shark (VU)	OCS
1.5 Dusky whaler	DUS
1.6 Tiger shark (NT)	TIG
1.7 Blue shark (NT)	BSH
1.8 Sicklefin Weasel Shark (VU)	HEH
1.9 Fossil Shark/ Snaggletooth shark (VU)	HEE
1.10 Shortfin Mako (VU)	SMA
1.11 Longfin Mako (VU)	LMA
1.12 Crocodile shark (NT)	PSK
1.13 Silvertip shark (NT)	ALS
1.14 Bignose shark (DD)	CCA
1.15 Spinner shark (NT)	CCB
1.16 Silky shark (NT)	FAL
1.17 Common Blacktip Shark (NT)	CCL
1.18 Sharptooth Lemon Shark (VU)	NGA
1.19 Pondicherry Shark (CR)	CCK
1.20 Hooktooth Shark (VU)	HCM
1.21 Broadfin Shark (EN)	LMT
1.22 Sandbar shark (VU)	CCP
1.23 Pigeye Shark (DD)	CCF
1.24 Scalloped Hammerhead (EN)	SPL
1.25 Great Hammerhead (EN)	SPK
1.26 Smooth hammerhead (VU)	SPZ
1.27 Deepwater Spiny Dogfish (VU)	DGS
1.28 Megamouth Shark (DD)	LMP
1.29 Whale shark (VU)	RHN
1.30 Giant Manta Ray (VU)	RMB
1.31 Coastal Manta Ray (VU)	RMA
1.32 Londheaded Eagle Ray (EN)	MAF
1.33 Pelagic stingray (LC)	PLS
1.34 Common shovelnose ray (VU)	RBQ
1.35 Narcine prodorsalis (DD)	TNO
1.36 Narcine timlei (DD)	TNQ

Marine Mammals	
2.1 Blue whale (EN)	BLW
2.2 Fin whale (EN)	FIW
2.3 Sei whale (EN)	SIW
2.4 Bryde’s whale (DD)	BRW
2.5 Minke whale (LC)	MIW
2.6 Humpback whale (LC)	HUW
2.7 Sperm whale (VU)	SPW
2.8 Orca (DD)	KIW
2.9 False killer whale (DD)	FAW
2.10 Pilot whales (DD)	GLO
2.11 Melon headed whale (LC)	MEW
2.12 Risso’s dolphin (LC)	DRR
2.13 Oceanic dolphins --> only a grouping, not a type	
2.14 Humpback dolphins - Coastal dolphins (NT)	DHI
2.15 Irrawaddy dolphin – Coastal dolphins (VU)	IRD
2.16 Finless porpoise – Coastal dolphins (VU)	PFI
2.17 Bottlenose dolphins – Coastal dolphins (DD & LC)	
2.18 Cuvier’s beaked whale (LC)	BCW
2.19 Ginkgo-toothed beaked whale (DD)	TGW

2.20 Dugong (VU)	DUG
Sea Turtles	
3.1 Olive Ridley Sea Turtle (V)	LKV
3.2 Loggerhead Sea Turtle (E)	TTL
3.3 Green Sea Turtle (E)	TUG
3.4 Leatherback Turtle (CE)	DKK
3.5 Hawksbill Sea Turtle (CE)	TTH
3.6 Flat Back Sea Turtle (DD)	FBT
Birds	
4.1 Barau's Petrel (EN)	PTZ
4.2 Bulwer’s Petrel (LC)	PTZ
4.3 Matsudaira’s Storm-petrel (DD)	PTZ
4.4 Abbott's Booby (EN)	SZV
4.5 Red-footed Booby (LC)	SZV
4.6 Masked Booby (LC)	DSQ
4.7 Lesser Frigatebird (LC)	
4.8 Christmas Island Frigatebird (CE)	
4. 9 Greater Frigatebird (LC)	
4.10 Chinese Crested Tern (CE)	SVZ
4.11 Bridled Tern (LC)	SVZ
4.12 Aleutian Tern (LC)	SVZ

Appendix IV Sampling Form of ETP

Kapal/ No		Pewawancara		Tanggal	

1. Umur			
2. Sudah berapa tahun bekerja dalam dunia perikanan?			
3. Jabatan dalam kapal pada trip terakhir?	*a. Kapten*	*b. Nelayan*	*c. Lain :*

4. Apakah anda melihat:			
A. Hiu / Pari	**B. Lumba-lumba / Paus**	**C. Penyu**	**D. Burung**
YA *TIDAK*	*YA* *TIDAK*	*YA* *TIDAK*	*YA* *TIDAK*
5.A. Apakah ada interaksi antara hewan ini dengan kapal / kru/ alat tangkap? *YA* *TIDAK*	5.B. Apakah ada interaksi antara hewan ini dengan kapal / kru/ alat tangkap? *YA* *TIDAK*	5.C. Apakah ada interaksi antara hewan ini dengan kapal / kru/ alat tangkap? *YA* *TIDAK*	5.D. Apakah ada interaksi antara hewan ini dengan kapal / kru/ alat tangkap? *YA* *TIDAK*
6.A. Berapa banyak yang berinteraksi dengan hewan ini? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	6.B. Berapa banyak yang berinteraksi dengan hewan ini? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	6.C. Berapa banyak yang berinteraksi dengan hewan ini? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	6.D. Berapa banyak yang berinteraksi dengan hewan ini? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*
7.A. Berapa banyak yang didaratkan di atas kapal? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	7.B. Berapa banyak yang didaratkan di atas kapal? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	7.C. Berapa banyak yang didaratkan di atas kapal? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*	7.D. Berapa banyak yang didaratkan di atas kapal? Jumlah: Apakah ini perkiraan? *YA* *TIDAK*
8.A. Masing -masing hewan yang didaratkan : Apa yang akan terjadi / yang terjadi dengan spesies tersebut? *1a. Dibebaskan (hidup)* # *1b. Jika dibebaskan: Bagaimana kondisi spesies setelah interaksi?* *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* # *2. Dibuang (mati)* # *3. Dimakan* # *4. Dijual* # *5. Digunakan sebagai umpan* # *6. Saya tidak tahu* # *7. Lainnya:* #	8.B. Masing -masing hewan yang didaratkan : Apa yang akan terjadi / yang terjadi dengan spesies tersebut? *1a. Dibebaskan (hidup)* # *1b. Jika dibebaskan: Bagaimana kondisi spesies setelah interaksi?* *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* # *2. Dibuang (mati)* # *3. Dimakan* # *4. Dijual* # *5. Digunakan sebagai umpan* # *6. Saya tidak tahu* # *7. Lainnya:* #	8.C. Masing -masing hewan yang didaratkan : Apa yang akan terjadi / yang terjadi dengan spesies tersebut? *1a. Dibebaskan (hidup)* # *1b. Jika dibebaskan: Bagaimana kondisi spesies setelah interaksi?* *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* # *2. Dibuang (mati)* # *3. Dimakan* # *4. Dijual* # *5. Digunakan sebagai umpan* # *6. Saya tidak tahu* # *7. Lainnya:* #	8.D. Masing -masing hewan yang didaratkan : Apa yang akan terjadi / yang terjadi dengan spesies tersebut? *1a. Dibebaskan (hidup)* # *1b. Jika dibebaskan: Bagaimana kondisi spesies setelah interaksi?* *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* # *2. Dibuang (mati)* # *3. Dimakan* # *4. Dijual* # *5. Digunakan sebagai umpan* # *6. Saya tidak tahu* # *7. Lainnya:* #
9.A. Masing-masing hewan yang TIDAK didaratkan dikapal : Bagaimana kondisinya setelah interaksi? *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* #	9.B. Masing-masing hewan yang TIDAK didaratkan dikapal: Bagaimana kondisinya setelah interaksi? *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* #	9.C. Masing-masing hewan yang TIDAK didaratkan dikapal : Bagaimana kondisinya setelah interaksi? *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* #	9.D. Masing-masing hewan yang TIDAK didaratkan dikapal : Bagaimana kondisinya setelah interaksi? *1. Mati* # *2. Hidup, luka serius* # *3. Hidup, luka ringan* # *4. Hidup, tidak terluka* # *5. Saya tidak tahu* #
10.A. Dimana interaksi terjadi? *1. Rumpon* # *2. Perjalanan* # *3. Lainnya:* #	10.B. Dimana interaksi terjadi? *1. Rumpon* # *2. Perjalanan* # *3. Lainnya:* #	10.C. Dimana interaksi terjadi? *1. Rumpon* # *2. Perjalanan* # *3. Lainnya:* #	10.D. Dimana interaksi terjadi? *1. Rumpon* # *2. Perjalanan* # *3. Lainnya:* #
11.A. Alat tangkap apa yang berinteraksi dengan hewan tersebut? *1. Alat tangkap khusus untuk hiu/ pari,namanya :* *2. Alat tangkap khusus untuk spesies lain, namanya :* *3. tangan kosong* *4. Kapal* *5. Lainnya:*	11.B. Alat tangkap apa yang berinteraksi dengan hewan tersebut? *1. Alat tangkap khusus untuk lumba - lumba /paus,namanya :* *2. Alat tangkap khusus untuk spesies lain, namanya :* *3. tangan kosong* *4. Kapal* *5. Lainnya:*	11.C. Alat tangkap apa yang berinteraksi dengan hewan tersebut? *1. Alat tangkap khusus untuk penyu,namanya :* *2. Alat tangkap khusus untuk spesies lain, namanya :* *3. tangan kosong* *4. Kapal* *5. Lainnya:*	11.D. Alat tangkap apa yang berinteraksi dengan hewan tersebut? *1. Alat tangkap khusus untuk burung ,namanya :* *2. Alat tangkap khusus untuk spesies lain, namanya :* *3. tangan kosong* *4. Kapal* *5. Lainnya:*
12.A. Apakah anda tahu nama spesiesnya? *YA* *TIDAK*	12.B. Apakah anda tahu nama spesiesnya? *YA* *TIDAK*	12.C. Apakah anda tahu nama spesiesnya? *YA* *TIDAK*	12.D. Apakah anda tahu nama spesiesnya? *YA* *TIDAK*
13.A. Tuliskan nama spesies : Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	13.B. Tuliskan nama spesies : Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	13.C. Tuliskan nama spesies : Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	13.D. Tuliskan nama spesies : Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*
14.A. apakah spesies tersebut ada dalam panduan identifikasi? *1. Ya, namanya:* *2. Tidak* *3. Tidak tahu* Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	14.B. apakah spesies tersebut ada dalam panduan identifikasi? *1. Ya, namanya:* *2. Tidak* *3. Tidak tahu* Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	14.C. apakah spesies tersebut ada dalam panduan identifikasi? *1. Ya, namanya:* *2. Tidak* *3. Tidak tahu* Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*	14.D. apakah spesies tersebut ada dalam panduan identifikasi? *1. Ya, namanya:* *2. Tidak* *3. Tidak tahu* Seberapa yakin: *1. Sangat yakin* *2. Agak yakin* *3. Tidak yakin*

Appendix V Loin conversion factor

MDPI integrated a loin-to-whole fish conversion factor into the I-Fish database to get an estimated total weight for fish landed in loins. The required measurements for this factor are the length of a either the top right or top left loin, in cm (*Loin Length, LL*), and the *Total Fork Length (TFL)*.

There are two equations for available for calculating the *Total Weight (TW)* of a fish. The first is converting the *LL* to *TFL* (1) and the second is converting the *TFL* to *TW* (2).

$$(1) \qquad TFL = i\,(LL) + j$$

$$(2) \qquad TW = aTFL^{b}$$

The MDPI system proceeds as follows:

1. The I-Fish system checks for a *Total Weight* value recorded by the enumerators in the uploaded port sampling form
2. If no *Total Weight* value is available, the I-Fish system checks to see if a value for *Total Fork Length* was recorded by the enumerator
3. If a *TFL* value is available, the I-Fish system calculates the *TW* using formula 2 above and the calculated *TW* is used in the I-Fish database
4. If the *TFL* is not recorded, the I-Fish system checks for a recording of a *Loin Length*
5. If a *LL* is available, the I-Fish system calculated the *TFL* using formula 1 above. Using the output from that calculation, the *TW* is calculated using formula 2 above.

MDPI currently has a large data set of length and weight values for yellowfin, extending to 2013. The weight and length outliers removed were removed from the data (i.e. length recordings of >400cm and <60cm) and the time-series was used to calculate values of *a* and *b* for use in formula 2. The resulting values of *a* and *b* were:

$$a = 0.0000193 \qquad b = 2.984$$

The values of *i* and *j* were calculated from MDPI data, and are taken as:

$$i = 1.259 \qquad j = 28.4$$

Comparing different loin conversion factors

The loin conversion factor for calculating total weight and length of fish has been giving some unexpectedly low values. For example, for a loin of 45cm and 4kg the total weight was estimated at 9kg. TNC shared their method for determining the conversion factor and MDPI compared the results from different combinations of conversion factor and values of a and b.

To get an idea of what the total weight might be the weight of the four loins and the weight of the carcass were summed

$$\text{Loin and carcass weight} = L1 + L2 + L3 + L4 + CW$$

If the total fork length (TFL) of the carcass is available, the total weight (TW) is estimated using the following formula

$$TW = aTFL^b$$

where a and b are values estimated from the length-weight relationship of a species. At the moment the values of a and b are from FishBase.

$$a = 0.006 \qquad b = 3.19$$

MDPI currently has a large data set of length and weight values for yellowfin. Data from 2013 to present was used to re-estimate values of a and b (25211 recordings). This data has weight and length outliers removed (i.e. length recordings of >400cm and <60cm). The values of a and b estimated from the MDPI data differ from those currently used from Fishbase

$$a = 0.0000193 \qquad b = 2.984$$

When the total length is not available from the carcass, a conversion factor is used to calculate the total fork length using loin data. There are two possible conversion factors, one from MDPI and one from TNC.

MDPI conversion factor to calculate total fork length (TFL) from loin length (LL) is as follows

$$TFL = 1.259\,(LL) + 28.4$$

where LL is the length of one top loin (these values were originally from Lutfi and unable to find out where he got them from but they give a good result for our data).

TNC conversion factor to calculate total fork length (TFL) from loin length (LL) is as follows

$$TFL = 1.146(TLL) + 36.3$$

where TLL is the average length of the top two loins

Based on the two conversion factors (MDPI and TNC) and the two estimates of a and b (Fishbase and MDPI), the total weight was calculated for 221 fish. These 221 fish are from the I-Fish database, satisfying the criteria of: being from the Maluku region; at 2013; having length and weight values for all four loins and for the carcass. Outliers were removed. The results were plotted (Figure 1).

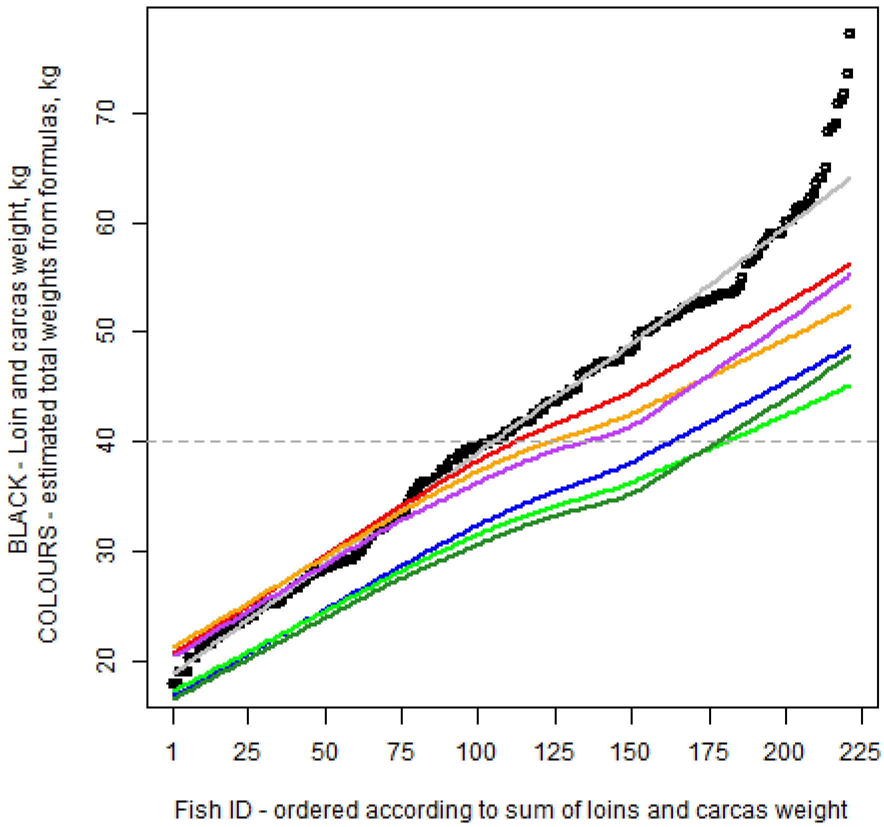

Figure 1. Comparison of different total weight estimates from different combinations of MDPI and TNC conversion factors and Fishbase and MDPI values of a and b. The dashed coloured lines are the estimates from each formula combination. The solid coloured lines are regression lines fitted to the data

Vertical = Weight of fish

Horizontal = Fish identity based on serial number from smallest to longest of fish length

Red line = MDPI values of a and b, MDPI conversion factor

Orange line = MDPI values of a and b, TNC conversion factor

Purple line = MDPI values of a and b, Total weight estimated from carcass length

Blue line = Fishbase values of a and b, MDPI conversion factor

Green line = Fishbase values of a and b, TNC conversion factor

Light green line = Fishbase values of a and b, Total weight estimated from carcass length

Important points

Choice of a and b values

Using the values of a and b from Fishbase, the estimates of total weights are always below the total weight of four loins and the carcass (blue, green and light green lines). Using the updated a and b values from MDPI data gives total weight estimates that very close to the total weight of four loins and the carcass, especially when the weights are <40kg (red, orange and purple lines).

Choice of conversion factor

The estimates from the MDPI conversion factor were always closest to the total weight of four loins and the carcass, regardless of what values of a and b were used (red and blue lines). It is a little bit strange that the Total weight estimated from the measured carcass length did not perform better than the conversion factors.

Divergence after ~40kg

Once the fish are larger than 40kg, (grey horizontal line), none of the conversion factors or values of a and b perform well, in terms of coming close to the black line. Maybe 40kg is close to the weight at which the fish become mature and when size differences become apparent between males and females (i.e. females become fatter than males).

Appendix VI Small fish sub-sampling conversion

MDPI records the number of small fish (i.e. those <10kg) by species in the small fish subsample. Weight is recorded per basket of the subsample, not by individual fish. Previously MDPI was giving the composition of small fish in terms of number of fish. However composition by weight is much more informative for fisheries management purposes. Additionally, MDPI was unable to determine the species composition of the total catch, only the species composition of the catch >10kg.

To resolve this issue, a small fish conversion factor has been added to the I-Fish system. The conversion factor calculates the weight (W) of a fish in the small fish subsample from the length (L) of the fish using the length-weight relationship:

$$W = aL^b$$

Where W is weight, L is length and a and b are coefficients. For each species in the I-Fish database the values of a and b must be calculated. The input data for calculating the a and b values is the compiled length and weight values of the 200 fish of BET, SKJ and YFT from all sites. The following values for a and b were chosen for each species:

YFT: a – 0.000136, b – 2.51

SKJ: a – 0.0000225, b – 2.97

BET: a – 0.000013, b – 3.12

These values of a and b are integrated into the I-Fish system with the following process:

1. Calculate the weight of each fish given the formula above and the species-specific a and b values. For example:

Species	Length	Weight calculation ($=aL^b$)	Final weight
YFT	40	$0.000136(40)^{2.51}$	1.42
YFT	45	$0.000136(45)^{2.51}$	1.92
YFT	38	$0.000136(38)^{2.51}$	1.25
YFT	22	$0.000136(22)^{2.51}$	0.32
BET	46	$0.000013(46)^{3.12}$	2
SKJ	60	$0.0000225(60)^{2.97}$	4.3
SKJ	37	$0.0000225\ (37)^{2.97}$	1.02
SKJ	40	$0.0000225\ (40)^{2.97}$	1.29
SKJ	55	$0.0000225\ (55)^{2.97}$	3.32

2. Calculate the total weight of each species in the small catch sample. **Note**: this calculated total may be different to the recorded total due to the formula used but should be almost equal.

Species	Length	Weight calculation (=aL^b)	Final weight	Total weight YFT
YFT	40	$0.000136(40)^{2.51}$	1.42	
YFT	45	$0.000136(45)^{2.51}$	1.92	4.91
YFT	38	$0.000136(38)^{2.51}$	1.25	
YFT	22	$0.000136(22)^{2.51}$	0.32	Total weight BET
BET	46	$0.000013(46)^{3.12}$	2	2
SKJ	60	$0.0000225(60)^{2.97}$	4.3	Total weight SKJ
SKJ	37	$0.0000225\ (37)^{2.97}$	1.02	
SKJ	40	$0.0000225\ (40)^{2.97}$	1.29	9.93
SKJ	55	$0.0000225\ (55)^{2.97}$	3.32	
Total weight all fish				16.84

3. Calculate the species composition of the small fish subsample by percentage.

% species X = (weight species X / total weight of small fish sample)*100

% YFT = (4.91/16.84)*100 = 29.2%

% BET = (2/16.84)*100 = 11.8%

% SKJ = (9.93/16.84)*100 = 58.97%

4. Apply the percentages calculated above to the total weight of all small fish to get the weight of different species <10kg

Total weight of all small fish = 3200kg

Weight YFT = 3200*(29.2/100) = 934.4kg

Weight BET = 3200*(11.8/100) = 377.6kg

Weight SKJ = 3200*(58.97/100) = 1887kg

5. The weights calculated above can be added to the species weights of fish >10kg and composition, by weight and by percentage, can be calculated for the whole catch (>10kg + <10kg fish)

Appendix VII length frequency raising factor

The lengths of a maximum of 200 fish are sampled from fish <10kg. However this is only a proportion of the total number of fish in the total small fish catch. When plotting a graph of length frequencies with the 200 fish lengths from every vessel, it will underestimate the true number of fish of certain lengths in the catch. Therefore, a raising factor must be applied to account for the sampling effect. The raising factor is calculated as:

Raising factor = total weight of all small fish < 10kg / weight of 200 fish in sample

Ex : The total weight of catch from a fishing trip is 1000 kg and the weight estimation of 200 fish sampled by using the formulation above is 250 kg. The raising factor will be :
Raising factor = 10000/250 = 4

The resulting value is applied to each length in the subsample. For example, if the raising factor is 4, then every fish of length 45cm in the sample counts for 4 fish in the length frequency graph.

Below is an example of length frequency graphs from Lombok, one with the raising factor and one without the raising factor. The graph with the raising factor shows a higher count, and therefore more realistic count, of the number of small fish in each length bracket (10cm categories). Without the raising factor, the number of small fish in the catch would be underestimated in the length frequency graphs.

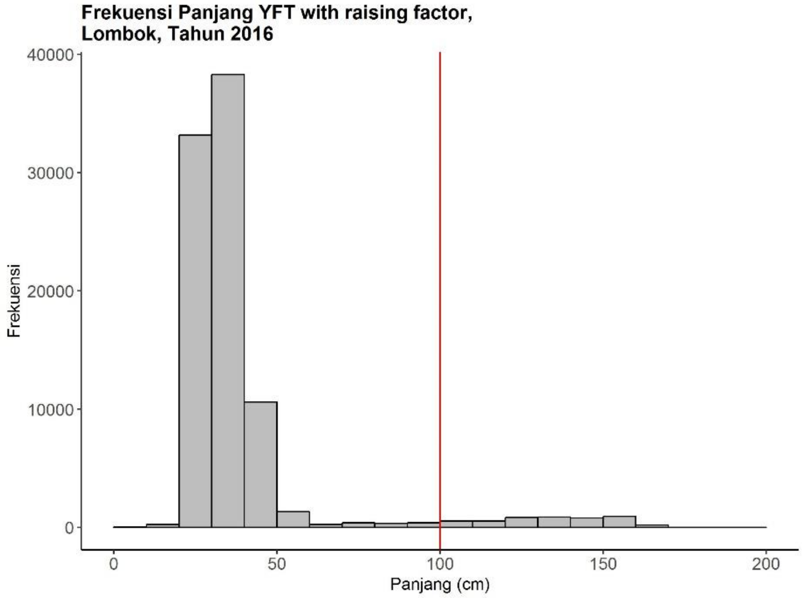

Figure 1. Length frequency with raising factor

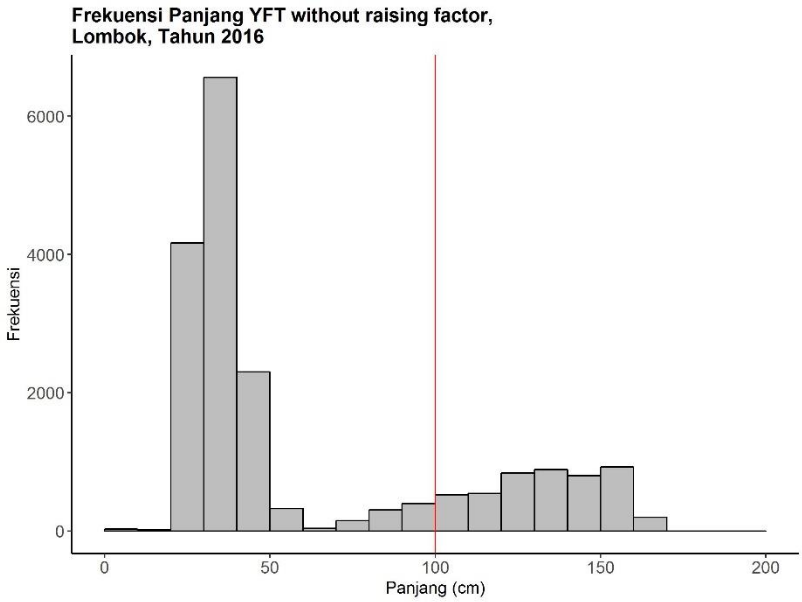

Figure 2. Length frequency without raising factor.

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