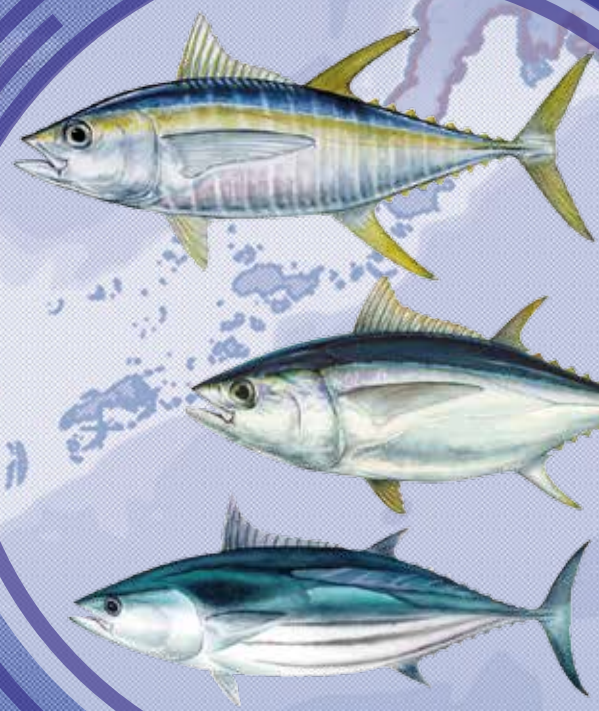
Standard Operating Procedures (SOPs) for assessing the status of tuna resources in region or sub-region waters in Southeast Asia

- FADs for Tuna Fisheries Study
- Tissue Collection and Preservation, Tuna Genetic Study in Sulu and Sulawesi Seas
- Tuna Spawning Ground Study in Sulu and Sulawesi Seas
- Tuna Stock Assessment in Sulu and Sulawesi Seas



TD/TRB/88

Joint Research Program on Tuna Resources in Sulu and Sulawesi Seas

Joint Research Program on Tuna Resources in Sulu and Sulawesi Seas

Standard Operating Procedures (SOPs)

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Southeast Asian Fisheries Development Center

TD/TRB/88 **November 2017**

Preparation and Distribution of this Document

This Standard Operating Procedures (SOPs) for assessing the status of tuna resources in region or sub-region waters in Southeast Asia was prepared by the Training Department of the Southeast Asian Fisheries Development Center (SEAFDEC/TD) in collaboration with the Scientific Working Group of the Joint Research Program on Tuna Resources in Sulu and Sulawesi Seas. This Report is distributed to the SEAFDEC Member Countries and Departments, partner agencies and other fisheries-related organizations, and to the public to make them aware of the activities of SEAFDEC and promote the visibility of the Center.

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Standard Operating Procedures For

FADs for Tuna Fisheries Study

General

Oceanic fishes such as tunas are often found gathered around floating logs and other drifting objects, sometimes in very large numbers. Having observed this behavior, fishermen learned that they often had higher catches when they found floating objects and fished near them than when they fished in the open ocean.

Some industrial fishing techniques rely on this tendency for tuna to gather near natural floating objects to improve their catch; many tonnes of tuna have sometimes been taken around even small bodies of floating debris.

TRADITIONAL FADs

In the early 1900s, fishermen in Indonesia and the Philippines began building floating rafts of bamboo and other materials to attract schools of fish. They moored these rafts to the sea-floor with natural fiber ropes secured to baskets of stones that served as anchors. These man-made structures were the first fish aggregating devices, or FADs (Figure 1).

The use of FADs by both small-scale fishermen and industrial fishing fleets is now very widespread. In the Philippines over 3,000 FADs are in use, and most Yellowfin tuna production comes from them.

Much research and effort has been put into improving FADs technology over the last 15 years. Most of these efforts have concentrated on successfully keeping FADs in place in the often harsh environment of the open ocean.

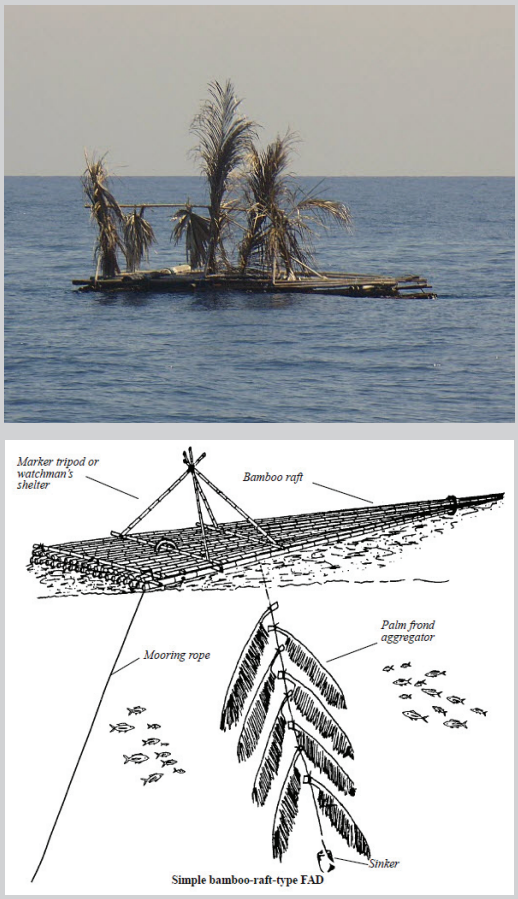


Figure 1. Traditional FADs
(Anderson J. and Paul G., 1996)

MODERN FADs

Modern FADs may be anchored in waters up to 2,000 m deep and be equipped with radar reflectors and solar-powered lights. FADs raft that were once built from natural materials are now commonly made from steel, aluminum and fiberglass. Some modern FADs designs use rafts that will submerge without damage under the effect of strong currents or storm conditions.

THE DEVELOPMENT, DESIGN AND RECENT STATUS OF ANCHORED AND DRIFTING FADs IN THE WCPO

The use of anchored Fish Aggregation Devices (FADs) appears to have started in the Philippines where simple bamboo rafts were in use before WWII to aggregate tuna for handliners (de Jesus 1982). Currently, FADs support thousands of fishing vessels in the Philippines and Indonesia. The use of FADS moored, or anchored to the bottom (referred to as AFADs in this report) has been promoted throughout the western and central Pacific to assist small-scale fisheries from Hawaii to Southeast Asia. In addition, networks of AFADs have been used for decades to promote larger scale domestic pole and line and purse seine fisheries in the Solomon Islands, Papua New Guinea, Indonesia and several Pacific Island countries (Itano 1995).

The use of anchored FADs (payaos) in the Philippines is widespread where thousands are anchored throughout the Moro Gulf, Sulu Sea and around the main islands to support subsistence, artisanal and commercial fisheries (Barut 1999). Dense networks of AFADs also exist throughout Indonesia to support artisanal fisheries, the large domestic pole and line skipjack fishery and joint venture and domestic purse seine fleets. In recent years, thousands of AFADs have been deployed in the waters of Papua New Guinea by purse seine companies working domestically but of Philippine origin (Kumoru 2002).

The use of drifting FADs (DFADs) by purse seine fleets has expanded rapidly to the point where many fleets or vessels rely almost exclusively on fishing their own or other vessels' DFADs. It is well known that both AFADs and DFADs tend to aggregate juvenile tuna and an assortment of finfish bycatch species including billfish and oceanic sharks. The incidental take of juvenile bigeye and yellowfin tuna has increased significantly with the expansion of DFADs assisted purse seining and has been a major concern of SCTB in recent years.

1. ANCHORED FADs (AFADs)

1.1 Anchored FADs – for artisanal and small–scale fisheries

1.1.1 The Philippine payao

De Jesus (1982) provides detailed line drawings of Philippine AFADs, or payaos as they are called in the Philippines,

and descriptions of the mooring systems. Payaos began as simple bundles of bamboo of the Bonbon and Arong type, later evolving into well constructed double layer bamboo rafts (Figure 2).

Bamboo rafts are still commonly used in coastal Philippine waters, but steel rafts are favored for use in exposed, offshore areas subject to rougher sea conditions. Rectangular "sled type" and cylindrical steel rafts are common (Figure 3). Payaos of this type are anchored to the bottom with polypropylene rope, steel cable and cement-filled oil drums in depths up to 5,000 m.

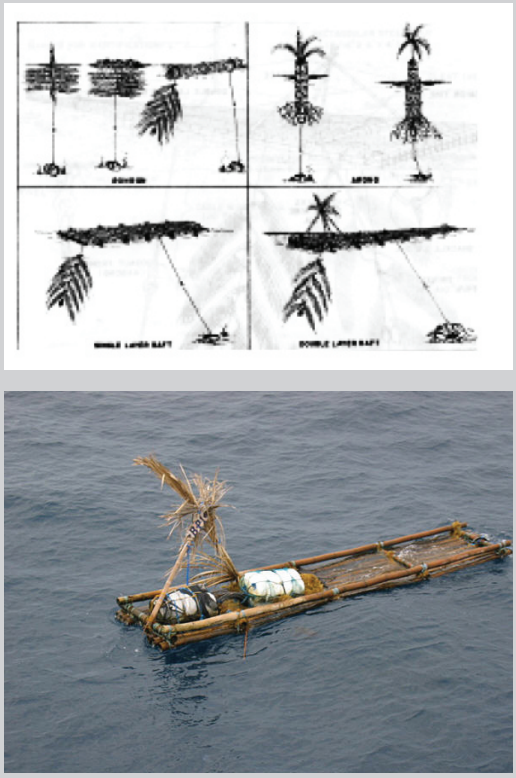


Figure 2. Philippine bamboo payaos
(Itano, D., S. Fukofuka and D. Brogan. 2004)

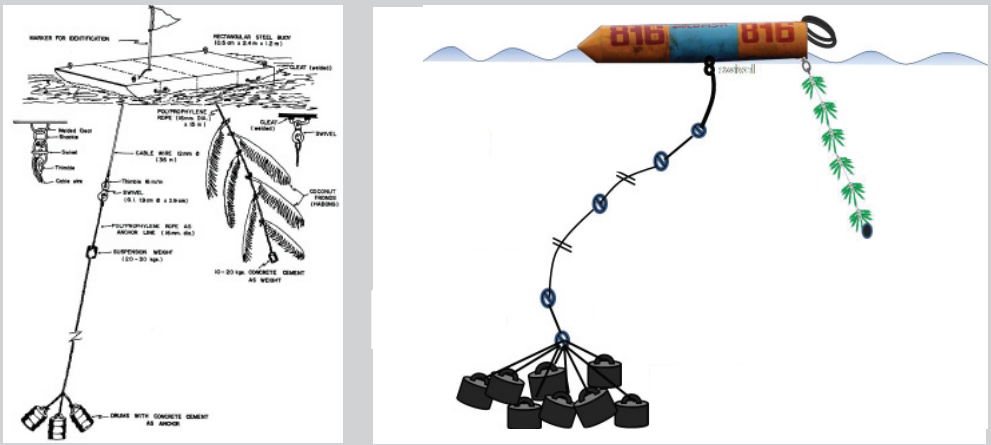


Figure 3. Philippine style rectangular and cylindrical steel payaos in the waters of the Philippine. (Malig B. J., A. S. D. Jessus and J. O. Dickson. 1991)

Anchored FADs support several small-scale fisheries in the Philippines; the most important of which is the artisanal handline fishery for large tunas. Double outrigger bancas target large yellowfin and bigeye tuna on payaos using handline gear. Small tunas, squids and scads are usually hooked at the AFADs and used to bait single hook handlines. Fishing formerly took place at night with gas lanterns for bait attraction but shifted to deep daytime fishing for security reasons. Figure 4 show a typical Philippine banca handline boat fishing on a cylindrical steel payao and a typical handline catch of large tuna being unloaded in the southern Philippines.


Figure 4. Philippine banca handline boat tied to a payao in the Moro Gulf and bancas unloading their catch at Lion Beach, General Santos, Mindanao (Itano, D., S. Fukofuka and D. Brogan. 2004)

1.1.2 Indonesian anchored FADs

The Indonesian pole and line skipjack fishery depends heavily on fishing tuna schools found in association with anchored FADs networks surrounding most of the inhabited islands of the archipelago. Figure 5 shows a typical Indonesian AFADs of the rectangular steel type with a coconut frond marker and skipjack fishing on the same FADs.


Figure 5. Indonesian domestic pole and line boat on anchored FADs and a similar boat poling skipjack on an anchored FADs (Itano, D., S. Fukofuka and D. Brogan. 2004)

2. DRIFTING FADs (DFADs)

The use of drifting FADs in the WCPO developed directly from the tendency of tuna to aggregate to natural drifting objects like logs or man-made flotsam or jetsam such as cable spools, crates, wooden pallets or discarded cargo nets. The Japanese first developed successful year around purse seining in the equatorial WCPO by developing techniques to capture tuna schools found in association with natural drift objects, similar to the logs pictured in Figure 6 (Watanabe 1983).

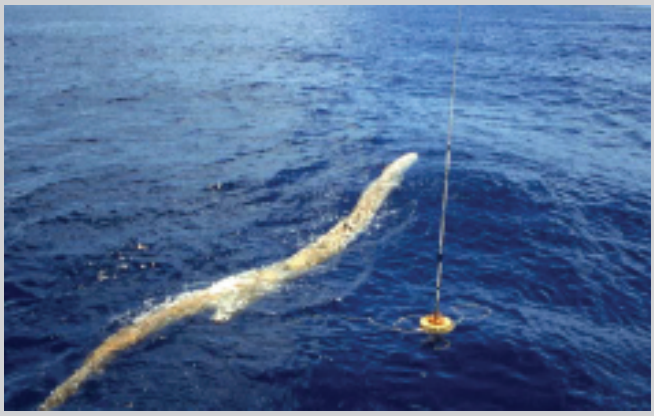



Figure 6. Natural drift log marked with a radio buoy and a log being towed out of the net during a purse seine set (photos D. Itano)

2.1 Different drifting FADs types

2.1.1 US. Drifting FADs

Figure 7. Example of a natural log enhanced with bamboo fl otation and net webbing to form a drifting FADs (photo D. Itano)

Figure 8. Drifting FADs made of PVC, purse seine floats and netting, marked with a GPS positioning radio buoy in PNG waters (photos S. Fukofuka)

2.1.2 Japanese Drifting FADs

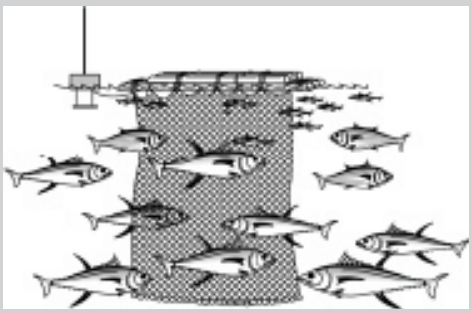



Figure 9. Graphic representation of a bamboo raft type drifting FADs, a Japanese drifting FADs in the WCPO (photo S. Fukofuka)

STUDY CONTENTS

Strengthen collaborative research among the three countries surrounding the Sulu-Sulawesi Sea, through the conduct of

1) Study on the use of FADs in SSS areas
2) Assessment of the status and trends of tuna stocks and the estimated maximum sustainable yield; and
3) Increase awareness of stakeholders on sustainable exploitation and management of tuna.

During the collaborative survey in SSS waters on board M.V.SEAFDEC 2. The content of **Study on the use of FADs in SSS areas** will be done by the following topics

- Distribution of FADs in SSS waters.
- Species Composition, sizes and relative depth of distribution in FADs.
- Types of FADs (designs and materials used, if possible investment costs)
- Importance of FADs in Fisheries (background and other information in evolution of technology in the region)

METHODOLOGY

1. Determining the relative concentration of FADs in SSS

- Inventory will be conducted along cruise track using binocular observation (daytime only) and scanning RADAR of M.V.SEAFDEC2 (Model FR-2165 DS).

  - The scanning RADAR will be used as the primary tool for the survey and the data recording will be confirm by using binocular.
  - In case of severe weather, the FADs observation do not perform

- A logsheet will be provided to record pertinent will be listed such as vessel's position when the *Payao* was sited, *Payaos* relative position to the vessel, its type, associated electronics, and etc. (**Appendix I**)

  Scanned floating objects were determined whether if boat, *Payao* or others and plotted using Plotting Software e.g. MAXSEA software, Google Earth, and etc. (free software)

- Type of FADs (Man made only; Anchored FADs and Drifting FADs) will be recorded.

- Binocular will be used to confirm the type of FADs

*2. Determining the **species compositions and size** of fish caught at FADs by using the appropriate fishing gear:*

FADs FISHING METHODS

There are several fishing methods that are particularly suited to use around FADs.

Trolling

Surface and sub-surface trolling with feathers, plastic lures or natural bait is a common and simple method. The gear is inexpensive and can be fished from a small boat (Figure 10). Recommend to use the surface trolling (splashing float) during the vessel sailing on the cruise track and the sub-surface trolling (diving board) will be used on the fish larvae and plankton net sampling operation (Figure 11, 12).

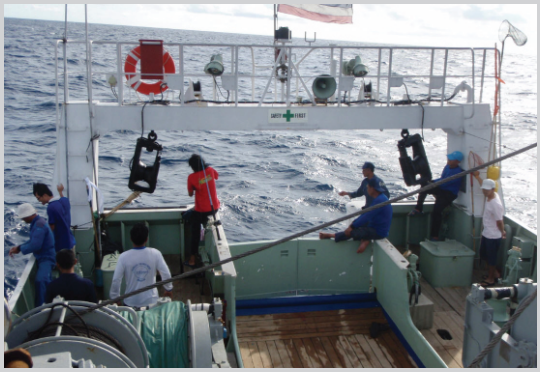
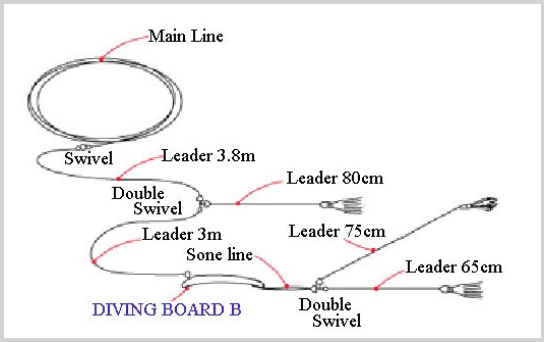


Figure 10. Trolling fishing on M.V.SEAFDEC2



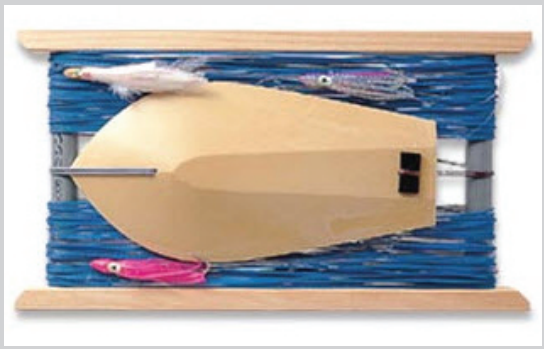


Figure 11. Trolling line construction and diving board

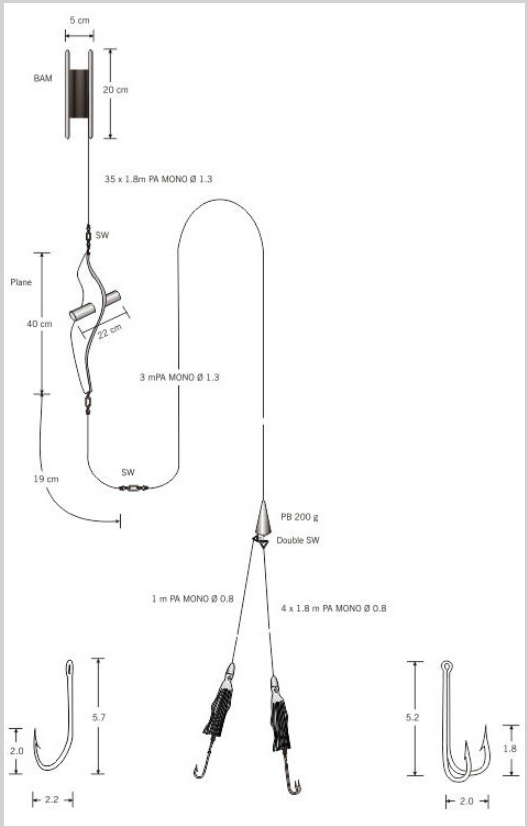


Figure 12. Trolling line with splashing float

Pole–and–line fishing

Pole-and-line fishing is a surface fishing method used by both artisanal and industrial-scale fishing vessels. Unbaited, barbless hooks tied on a fixed length of line attached to a fishing pole are jigged in an actively feeding surface school of yellowfin or skipjack tuna. In the industrial version of this method, as well as in certain small-scale pole-and-line fisheries, the fish are encouraged to bite by bringing them into a feeding frenzy using live bait cast into the water from the fishing boat.

Handline fishing

Handlining is a fishing method in which a line with a hook, usually baited, is lowered into the water from a drifting, anchored or moving boat or from a jetty, pier or rock on the shore overlooking the water. Handlining is just as its name implies — holding a line in the hand while waiting either actively or passively for a fish to take the bait. If there is a bite and a fish takes the hook, it can then be hauled in by hand. This apparently simple procedure involves a lot of forethought in order to select the hook, line and sinker that are suitable in size and strength to the fish that one intends to catch. In addition the fishing technique must be developed to ensure that fish attracted to take the bait are caught. Sometimes one may wish to catch a particular fish and exclude others, or one may want to catch a variety of fish of similar size and eating habits. To do this requires choices concerning the size, strength and type of hook and bait to use, the strength and type of line, and the knots used to secure hook, swivels and sinker so that neither hook, line or knot will fail and allow a fish to escape.

Drop–stone handlining

This is a fishing method that targets the larger, deep-swimming tunas. The drop-stone technique has long been used in the Pacific region to fish known areas of tuna aggregations, often called `tuna holes', and has proved to be an effective FAD fishing technique. Chopped bait is wrapped in a leaf or cloth, along with the baited hook, and a stone for weight. A slip knot is then tied around the package with the mainline. When the package of bait and the baited hook reach the target depth, the mainline is jerked to release the knot, the stone falls free and a cloud of bait and the hook drift free in the current at a depth where they are likely to be taken by large yellowfin or other tuna (Figure 13).

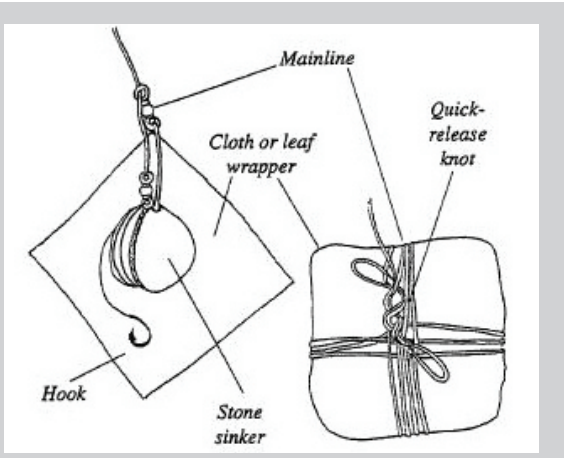


Figure 13. Fishing technique by drop stone handlining (Anderson J. and Paul G., 1966)

Longline fishing

General and Planning

Pelagic longline is normally not anchored to the sea bottom but drift freely in the sea. Between the end (Marker) buoys, the mainline is suspended in the sea by floats and float lines attached at intervals. Pelagic longline is mainly use in high-sea longline fisheries for pelagic species such as tunas, swordfish and marlin but also used in coastal waters for species such as Spanish mackerel, Sailfish and etc.

SEAFDEC standard Pelagic longline construction Figure 14. Mainline reel with automatic line casting system is used at least 500 hooks shall be deployed in an operation and number of hook should be constant in every operation during a research cruise. Number of hook per basket should be 6-15, which possible to adjust the number according to oceanographic data of fishing ground. Hook line interval distance shall be between 35-50 m and possible to adjust interval distance according to oceanographic data of fishing ground.

Pelagic Longline and their accessories

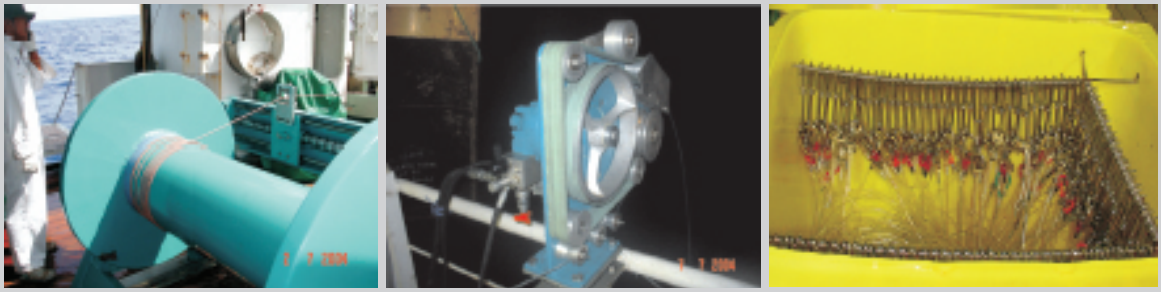


Figure 14. Smart Reel system onboard M.V.SEAFDEC2

Figure 15. Local baits such as Milk fishes

Bait type and size should be similar in every operation in a research cruise except there is any experiment on such topic.

Local bait found in fishing ground is the first priority to be used and strongly recommend to prepare the fresh bait. Experiment of Pelagic longline i.e. type of bait, Tori-pole or bird scar devise, shark scared devices, using of luminescent accessory or light stick and etc. Shall be agreed and detailed whilst the process of research survey planning.

The fishing operation, biology and oceanography related measurement; refer to the Book of *M.V.SEAFDEC2 Standard Operation Procedures.*

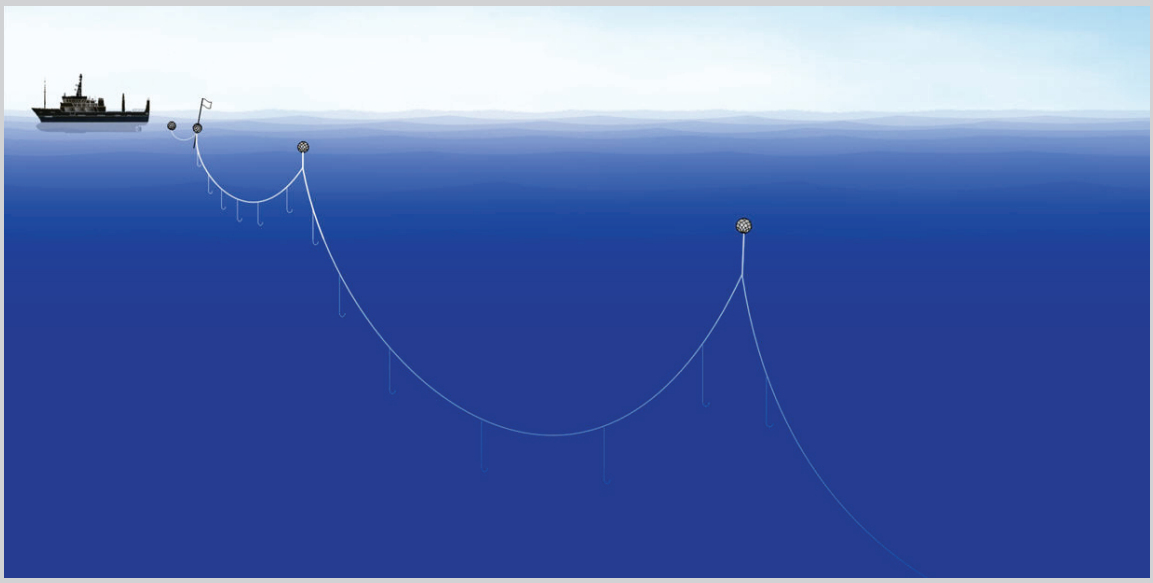


Figure 16. Pelagic longline fishing construction

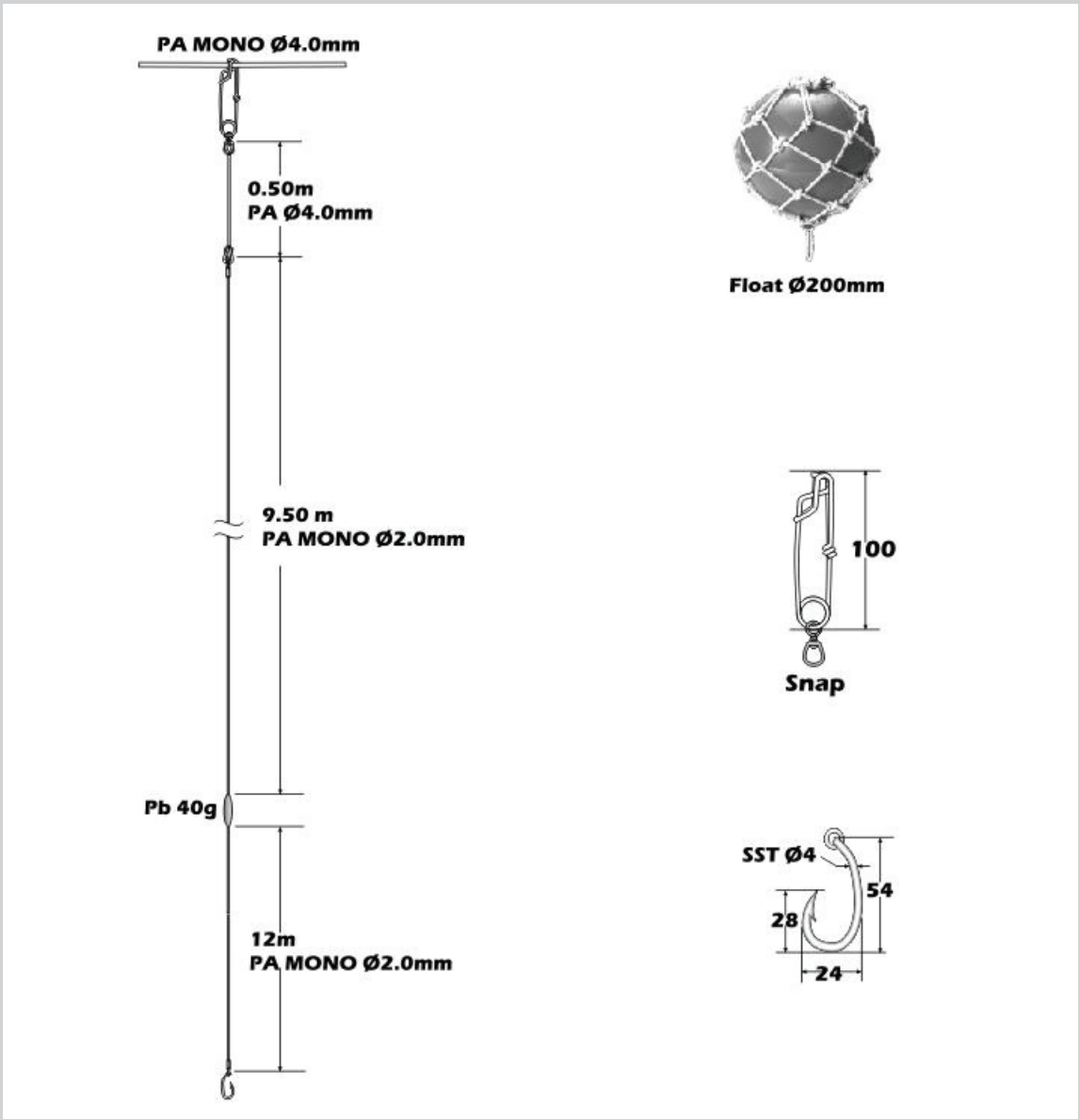


Figure 17. Construction of branch line

- Sampling gear during the collaborative research survey in SSS will be use **handline, troll line and short–longline** on M.V.SEAFDEC2 (in selected FADs only).

Fishing operation

1. Handline fishing: fishing operation will be conduct in selected FADs and during the vessel drifting in daytime / night time.

2. Trolling line: the fishing operation will be conduct during the vessel sailing near the FADs and during the fish larvae operation; driving board type will be used when conduct the larvae net and the splashing float type will be used when conduct the Bongo net.

3. Short-longline: the fishing operation will be selected at least one or two operation in each period. At least 150 -200 hooks shall be deployed in an operation, to avoid the main line will tangled with FADs.

Biology and measurement

Catch sampling and recording procedure

Catch hauled on board should be individual classified and measured. Recommended not to sampling but if catches of each species is more than 100, sample 100 catches for the measurement. Fishing logsheet is essential for recording the operation and catch information.

Measurement procedure

Refer to **Appendix II**, all catches shall be individually classified an measured and catch data should include order of hook, which caught that fish, in the basket (in case of short longline).

- Fish hauled on board should be identified to species. Common name and scientific name shall be record in logsheet.
- Fish hauled on board shall be weighted in unit of Kilogram (kg) with one decimal place and must be measured the total length, fork length and girth length in the unit of centimeter (cm) with one decimal places except.
- Stomach content of fish hauled on board shall be determined and recorded.

- Fish, which fall off the hook during hauling and incomplete specimen which bitten by other fish, shall be counted in the hook rate if researcher or crew could identify its species. Length and Weight estimation is needed if possible.
- Other data (if any) should be recorded such as position of hooking, condition of catch (dead, alive of bitten by other fish and etc.).

Indicator of Abundance

Hook rate is calculated by individual number of target fish caught per 1,000 hooks deployed. (concerned researcher must specify 'target fish' and 'non-target fish' in research proposal)

- Other data sources such as from the national observer program of Member-Countries (IMP).

References

Anderson, J. and P. D. Gates. 1996. South Pacific Commission Fish Aggregating Device (FAD) Manual, Volume I Planning Fad Programmes. 46 pp.

Itano, D., S. Fukofuka and D. Brogan. 2004. The development, design and recent status of anchored and drifting FADs in the WCPO. SCTB 17 Working paper. INF-FTWG-3.

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Standard Operating Procedures For

Tissue Collection and Preservation, Tuna Genetic Study

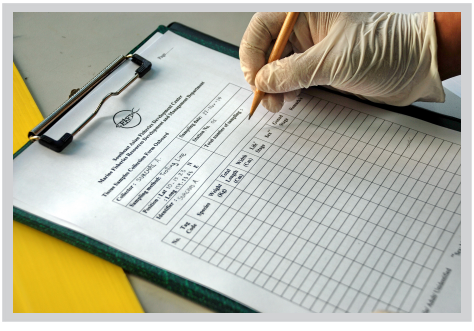
in Sulu and Sulawesi Seas

List of materials

1. Data form
2. Set of forceps and scissors
3. Wash bottle
4. Tray
5. Vial bottle and rack
6. Tissue paper
7. Disposable gloves
8. Permanent marker
9. Weight scale
10. Measuring tape
11. Distilled water
12. Ethanol (95%)
13. Mask

Method for Tissue Collection and Preservation

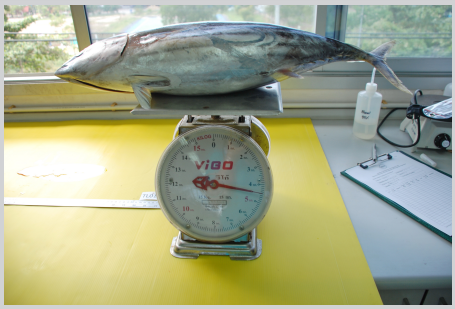
1. Record all general information of specimen including sampling date, sampling method, sampling site, latitude, longitude.



2. Label the vial with species, year, sample site, sample number and tag number

3. Take picture of the specimen with scale and tag number

4. Weigh and measure total length and body width of the sample



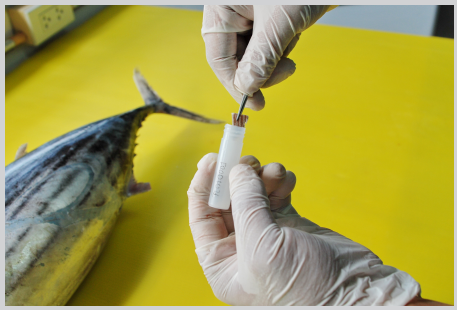
5. Wipe the sample fish with tissue paper

6. Wash forceps and scissors with distilled water and then wipe with tissue paper

7. Wash forceps and scissor with 95% ethanol

8. Cut approximately 1.5 cm X 0.5 cm (length x width) of 2nd dorsal fin of the fish

9. Immediately, by using forceps, place the cut tissue into a vial that contain 95-100% ethanol



10. Screw the vial cap the vial tightly place in a safe container (Each tube must contain only the tissue of one specimen of a species, not more, as they can be confused).

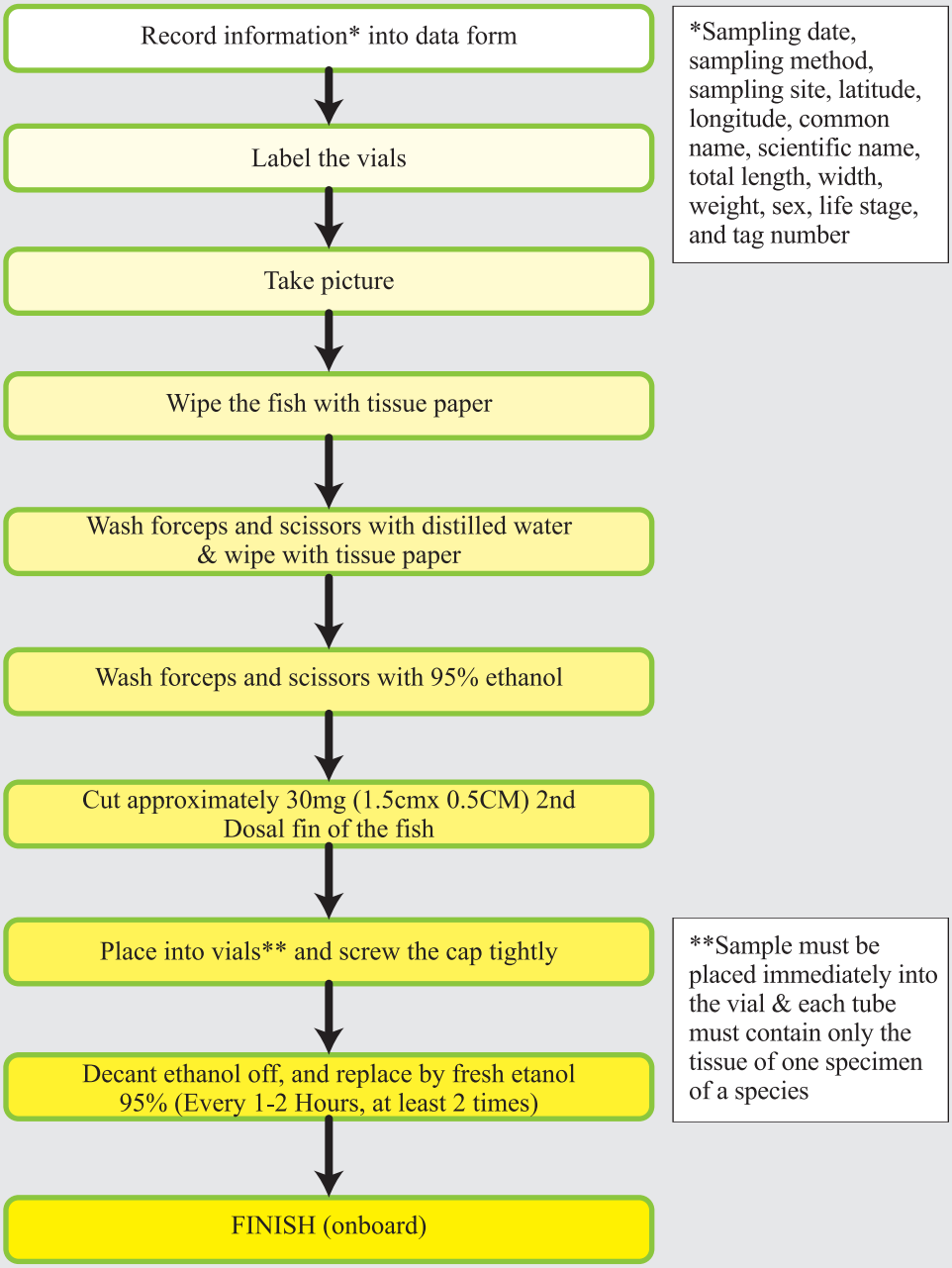
11. Check sample life stage, sex, and gonad stage of the sample (see **Appendix VIII**)

12. Change the ethanol every 1-2 hours in all of the tubes and replace with fresh 95-100% ethanol.
    A final change should be done after another 6-8 hours. This will be done until ethanol is clean (at least 2 times).

13. Keep the samples as cool as possible in storage. Maintaining samples at a cooler temperature prolongs the life of the usable DNA.

    [From Standard Operating Procedures for Tissue Sample Collection and Preservation: points of concern about sample storage temperature. The vials containing tissue sample in buffer (ethanol) can be stored at room temperature. Once preserved in ethanol samples can be stored for many years. Ethanol should be checked periodically for evaporation. Therefore, storage in fridge or freezer will reduce ethanol evaporation.]

Flow chart of tissue sample collection and preservation



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Southeast Asian Fisheries Development Center
Marine Fisheries Resources Development and Management Department

Tissue Samples Collection Form Onboard

Collector	**Sampling daate:**
Sampling method:	**Station No.**
Position :Lat N	**Species**
:Long E	
Common name:	**Total Number of Sampling:**
Identifier:	

No.	Tag Code	Weight (Kg)	Total Length (cm)	Width (cm)	Sex*	Life** Stage	Gonad Stage	Remark/s

*Sex: Male / Female / Unidentified

**Life Stage: Juvenile / Adult / Unidentified

Standard Operating Procedures For

Tuna Spawning Ground Study

in Sulu and Sulawesi Seas

FIELD OPERATION PROCEDURES

List of materials

1. Bongo Net 500 µm (and 330 µm) mesh size
2. Neuston Net 1 mm mesh size
3. Net sonde
4. Flow meter (Totally 6 pieces, 3 pieces from SEAFDEC and 3 pieces from Malaysia)
5. Depressor 21 kg
6. Winch (diameter >4mm)
7. Water Jet spray
8. Sample bottle (Plastic bottle 1 liter approximately 200 pieces)
9. Formalin
10. Sticker label
11. Permanent marker
12. Sample box
13. Measuring cylinder

The Sampler

Larval fish sampling will be conducted during the day and night depending on the arrival of the vessel at the station.

- Horizontal towing by Neuston net: square shape 100 cm x 70 cm with 1 mm mesh size.
- Oblique towing by Bongo net 500 µm will be used for larvae sampling (Bongo net has 2 mesh sizes: 500 µm and 330 µm; country will decide which mesh size to be used - both or only 500 µm)

Method for Larval Fish Sampling

1. Data to be collected for each station (use Form F1): Date, Station no., Position (Latitude, Longitude), Mesh size, Sampling method, Time (Start, Stop), Water Depth (m), Flow meter Reading (Start & End)

2. Procedures for horizontal towing

- Before start towing, attach a flow meter in front of the mouth above center frame. Record flow meter readings before and after each towing.
- When the Neuston net is already at the sea surface, tow the net for 30 minutes at speed of the vessel at 2-3 knots.

Form F1 : Data collection (to be used during field sampling)

No:	**No:**
Date:	**Date:**
Station no.:	**Station no.:**
Position : Lat: **Long:**	**Position : Lat:** **Long:**
Mesh size:	**Mesh size:**
Sampling method:	**Sampling method:**
Time: Start: **Finish:**	**Time: Start:** **Finish:**
Water depth (m):	**Water depth (m):**
Maximum Depth: **(From depth sensor)**	**Maximum Depth:** **(From depth sensor)**
Flow-meter Reading: Start: **End:**	**Flow-meter Reading: Start:** **End:**
Note:	**Note:**

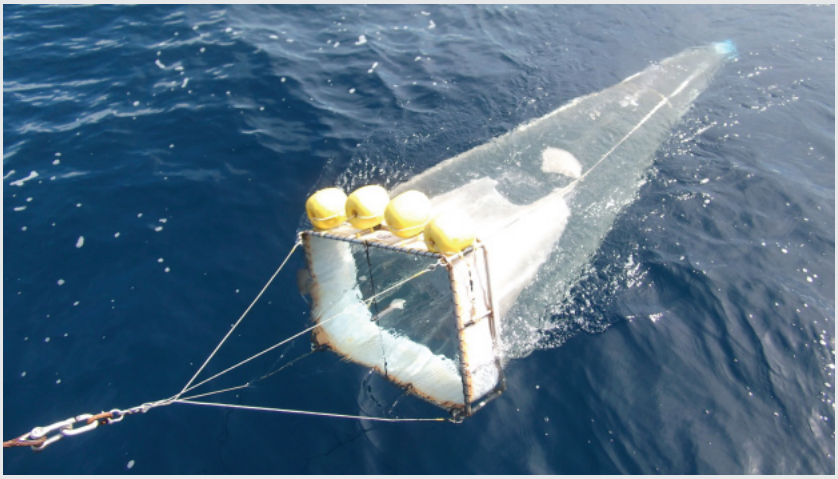


Figure 1. Neuston net attached with flow meters

3. Procedures for oblique towing
    - Before start towing, attach two flow meters on each mouth of ring frame, and attach depressor and net sonde to Bongo net. Record flow meters readings for both flow meters before and after each towing.
    - While the vessel is moving at speed of 2 knots, lowering the Bongo net 60 cm in diameter with 500 µm and/or 330 µm mesh size down to the sea. The time to lower down the net is 15 minutes. Bongo net will be lowered down to 5 m above sea bottom or maximum depth at 150 m.
    - When the net is already at the required depth, lift it up to the water surface. The time to retrieve the net is 15 minutes.

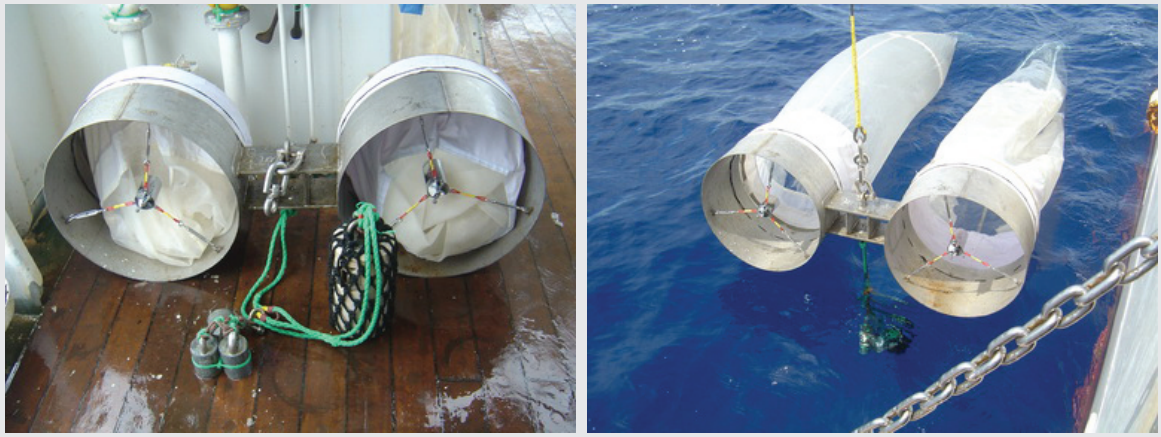


Figure 2. Bongo net attached with flow meters, depressor and net sonde

4. Lift the Bongo net up to the deck.
5. Washing of net: while the net is still hanging, spray seawater jet outside the net so that all the planktons will be accumulated in the cod-end.

Handling the Sample at Sea

1. Sampling preservation: Samples for both Neuston net and Bongo nets are separately kept in 1 liter plastic bottle and preserved immediately with 10% formalin added borate.
2. Labeling and storage of samples:
    - ◇ Labeling will use sticker (write on the body of bottle) and water proof paper inside the bottle.
    - ◇ Labeling should include
        - Type of sample: Fish larvae
        - Station: St. 1
        - Date:

Fish Larvae
St.1 / Phi / C1
Date:
OB/500

- Location of sampling: Philippines (Phi)
- Cruise No.: 1 (C1)
- Type of towing: Oblique (use OB), Horizontal (use HO)
- Mesh size: 500 µm or 330 µm for Bongo net, 1,000 µm for Neuston net
- After labeling, put the bottles in a sample box

LABORATORY PROCEDURES (Sorting and identification)

- Sorting will be conducted in the laboratory
- Fish larvae and eggs are sorted out from unwanted material and put in different vial and preserve with 5% formalin or 70% ethanol and label (Form F2).
- Tuna larvae will be identified to the species level and others fish larvae will be identified to the family level or lower while for the eggs, only the number will be recorded (Form F3).
- Fish larvae and eggs density will be expressed in no./100 m^3 according to the formula:

$$\frac{No.\ of\ larvae}{A \times B \times C} \times 100$$

where, A = no. of revolutions of flow meter
B = 0.3m (distance of one revolution of flow meter)
C = area of mouth opening of larvae net

Form F2: Sorting (to be used in the laboratory)

No.	Date	Station	Tow Type	No. of Fish Larvae		No. of Eggs	
				Telemark	Total	Telemark	Total

Form F3: Identification (to be used in the laboratory)

Date of Sampling: _____ **Name:** _____
Station: _____ **Date:** _____
Mesh size: _____
Tow type: _____

No.	Family name	Scientific name	Telemark	Total

Data analysis: each country will send the Chief Scientist the result of the tuna larvae identified from the stations for analysis and mapping.

Standard Operating Procedures For

Tuna Stock Assessment

in Sulu and Sulawesi Seas

Agreed topics and data to be collected from the Meeting in May 2014

	Topics	Data to be collected	Remark
1	Profile	total no. of boats, total no. of gear, major landing sites	Historical data
1.1	Catch landing	monthly total weight by species and gear	Historical data
1.2	CPUE	nominal catch and effort by species / by fishing gear	Historical data
1.3	Length frequency	monthly length distribution by species and gear	1-2 years
1.4	Weight frequency	monthly average weight distribution by species and by gear	
2	Growth pattern	monthly length frequency by species	
3	Gonad*	monthly stage of maturity by species	Sampling also onboard M.V. SEAFDEC2
4	Stomach contents*	stomach content analysis by species	
5	Genetic		

- Each country analyzes their respective data before SR-Working Group meeting
- Chief Scientist should facilitate the analysis of regional data
- Items 4 and 5 can be undertaken using samples collected during the cruise survey
- Item 4 depends on decision of each country whether to collect or not
- Historical data would be collected for Items 1.1 and 1.2 (based on format agreed upon during the August 2014 Meeting)
- *Period of sampling up to 12 months, subject to available funding from SEAFDEC or other sources.

DATA COLLECTION AND ANALYSIS

FISHING OPERATION AND CATCHES DATA COLLECTION AND ANALYSIS

1. **Catches Data Collection and Format**: (see Fishing Operation and Catches Data Sheet for Example)

List of materials

1. Spring weighing balance
2. Data sheet

Method for catch data collection

a. Interview the skipper/master fisherman of the boat in order to get information on Fishing Operation (no. haul/ trip, no. of day/trip, no. of trip/month) total catch/trip and fishing ground or refer to Logbook.
b. Samples should be randomly obtained from the total catch for species composition studies.
c. Record the total number and total weight of each species of tuna (yellowfin, bigeye, and skipjack tuna) from gear other than Purse Seine (only total weight of catch).
d. All data must be recorded in **Microsoft Excel Format** for easy and convenience calculation for the semi-processed data output.
e. A minimum sample of 10% of boat landing by gear type on monthly basis

Fishing Operation and Catch Data Sheet

Interviewer..... Date.....

Vessel Owner Questionnaire

A. General Information

Country	Fishing Ground	Name of Landing Port
	○ Sulu ○ Sulawesi	
Total number of active boats in the area by gear type		
Estimate no. of boats in operation in a day		
Estimated no. of boats in operation in the month		

B. Fisheries Information

Section 1 : Fishing Vessel

Vessel Name / Registration:		Flag State:
Engine Type: ○ Inboard ○ Outboard	Vessel speed: nm/h	Engine Power: hp
Vessel size: GRT/GT	Length (LOA):	meters

Section 2 : Fishing Gear

Type of gear:	
○ Purse Seine	length and depth
○ Handline	no. of hooks
○ Longline	no. of hooks
○ Pole and Line	no. of poles (hooks)
○ Gill Net	length of net
Remark:	

Section 3 : Fishing Operation

Fishing method :	○ Free school ○ FADs (Anchored/Drifting)	○ Luring light ○ Other.....
Fishing Ground : (Area name)		GPS position Latitude..... Longitude..... **[or attch 1x1 grid map]**
Distance from shore.....Nautical miles		Fishing time: ○ Day ○ Night

Frequency of fishing operation	Fishing efffort	
No. of haul per trip.....	Purse Seine:	catch per haul
No. of day per trip.....	Handline:	catch per no. of units per trip
No. of fishing trip in the month.....	Longline:	catch per no. of hooks per haul
	Pole and Line:	catch per day
	Gill Net:	catch per haul (soaking time)
Estimated total catch (Kg per trip) (Estimated total catch per day)		
Estimated total catch per month		
CPUE (KG/month/haul) Catch per day		

Section 4 : Catch Data

Catch Details	Number (Pcs.)	Total Weight (kg)	Sp. Composition (%)
Yellowfin tuna (*Thunnus albacares*)			
Bigeye tuna (*Thunnus obesus*)			
Skipjack tuna (*Katsuwonus pelamis*)			
Other tuna species			
Other fish group			

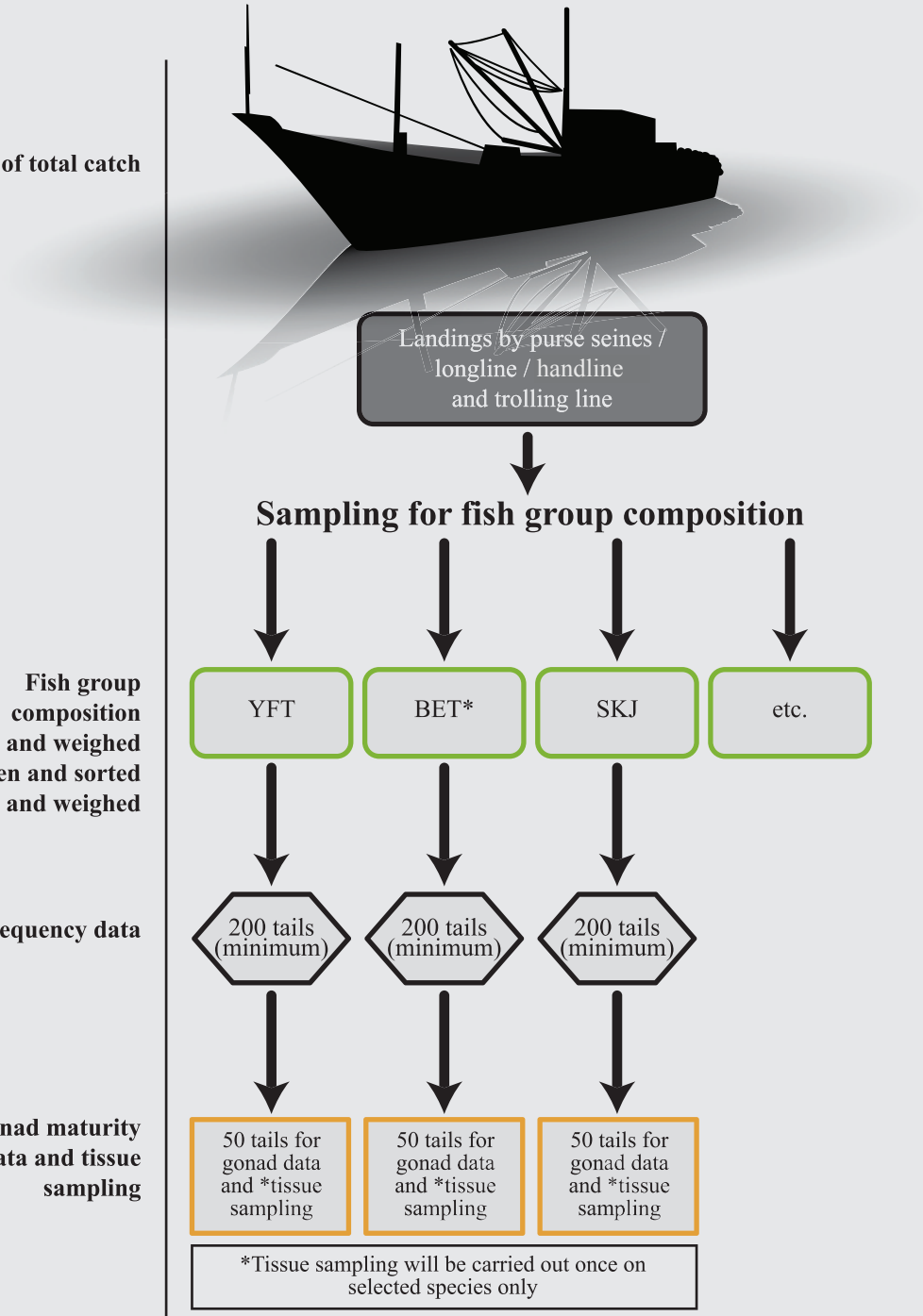
Section 5 : Market Data (Optional)

Top 5 species with the highest income	**Income/trip (day)**	**Selling price (US$/kg)**		
		Small	**Medium**	**Large**
Yellowfin tuna (*Thunnus albacares*)				
Bigeye tuna (*Thunnus obesus*)				
Skipjack tuna (*Katsuwonus pelamis*)				
Other tuna species				
Other fish group				
After collect catch, what will you do?	○ Sell at fresh market ○ Sell to whole seller ○ Sell directly to restaurant ○ Sell to fish industries ○ Consume in family			

Note: Fish price by length class or by size category (please indicate length of each size)

Flow Diagram of Sampling Method

Flow diagram of fish group composition, species composition, length-frequency and gonad maturity data collection



*For BET, get as much sample as possible because of lower catch.

Fishing Operation and Catches Data Sheet: Data Analysis

Fishing Operation and Catches Data Sheet

Country:
Sea areas:
Fishing areas:
Grid area: (Referred to Grid number from SOPs M.V.SEAFDEC2)
Name of sampling port:
Date:
Name of enumerator:

Estimated no. of boat in operation in a day
Estimated no. of boat in operation in the month

Fishing Operation

No. of Boats Sampled	1	2	3	Total	Average
No. of haul per trip					
No. of fishing trips in the month					
No. of day per trip					
Estimated total catch (Kg) per trip					
Estimated total catch per day					
Estimated total catch per month					
CPUE (Kg/month/haul)					
CPUE (Kg per day)					

Species Composition

				%Spp Com	
Samples Weight (kg)					
Weight of *Thunnus albacares*					
Weight of *Thunnus obesus*					
Weight of *Katsuwonus pelamis*					
Other tuna species					
Other fish group					

BIOLOGICAL DATA COLLECTION AND ANALYSIS

1. Length–frequency data collection for growth and mortality of tuna species

List of materials

1. Measuring tape/board
2. Weighing balance
3. Data sheet

Method for Length–frequency data collection

Port Sampling

a. Sampling is carried out at landing sites in a monthly basis, and sampling **at least 10% of total number of boats by gear type**. See the flow diagram of sampling method.
b. Measure Fork Length (FL) of **at least 200 tails per species per month** using measuring tape/board and recorded the length on a standard format of the Length Frequency Data Sheet.
c. Record the samples weight of all fish measured from type of boat category.
d. Prepare length frequency data set for further analysis.

2. Length–Weight relationships

Fork Length (FL) of some fish samples, from the smallest to biggest sizes, should be measured in centimeters (cm) and individually weighed to the nearest grams (g). A set of data should be obtained from each sampling port. At least 200 tails per species per country (except Bigeye Tuna) should be sampled.

Biological Sample Data Sheet (Length-Weight)

Collector name:	Vessel name/ID:	Trip/Cruise No.:	Sheet ID:

Station No.:	Position: Lat. N Long. E	Date:	Fish Sampler No.:

No.	Species	Length (cm)	Weight (g)	No.	Species	Length (cm)	Weight (g)	No.	Species	Length (cm)	Weight (g)
1				31				61			
2				32				62			
3				33				63			
4				34				64			
5				35				65			
6				36				66			
7				37				67			
8				38				68			
9				39				69			
10				40				70			
11				41				71			
12				42				72			
13				43				73			
14				44				74			
15				45				75			
16				46				76			
17				47				77			
18				48				78			
19				49				79			
20				50				80			
21				51				81			
22				52				82			
23				53				83			
24				54				84			
25				55				85			
26				56				86			
27				57				87			
28				58				88			
29				59				89			
30				60				90			

Length-Frequency Data Sheet

Collector name:	Vessel name/ID:	Trip/Cruise No.:	Sheet ID:

Station No.:	Position: Lat. N Long. E	Date:	Fish Sampler No.:

No.	Species	Length (cm)	No.	Species	Length (cm)	No.	Species	Length (cm)	No.	Species	Length (cm)
1			31			61			91		
2			32			62			92		
3			33			63			93		
4			34			64			94		
5			35			65			95		
6			36			66			96		
7			37			67			97		
8			38			68			98		
9			39			69			99		
10			40			70			100		
11			41			71			101		
12			42			72			102		
13			43			73			103		
14			44			74			104		
15			45			75			105		
16			46			76			106		
17			47			77			107		
18			48			78			108		
19			49			79			109		
20			50			80			110		
21			51			81			111		
22			52			82			112		
23			53			83			113		
24			54			84			114		
25			55			85			115		
26			56			86			116		
27			57			87			117		
28			58			88			118		
29			59			89			119		
30			60			90			120		

Length-Frequency Semi-process data sheet

Country:
Fishing ground:
Fishing Area:
Name of sampling port:
Date:
Time:
Type of fishing boat:
Name of Species:
Total catch of species (kg):
Total weight of species (kg):
Sample weight of species (kg):
Name of enumerators:
Raising factor:

Lower limit MM	Upper limit MM	Mid-length MM	Lt-Freq.	Raising Freq.	Lt-Freq.	Raising Freq.	Pool Freq.
Total							

Note: This format is easy for raising and pooling the length frequency in that particular month and sampling site

3. Gonad maturity data collection for "reproductive biology of tuna"

List of materials

1. Measuring board
2. Spring weighing balance
3. Digital weighing balances
4. Scissors
5. Forceps

Figure 1. Materials for Gonad Maturity data collection.

1. Collect fish samples (size at maturity: more than 80 cm for yellowfin, more than 80 cm for bigeye, and more than 35 cm for skipjack) at least 50 tails for each species per port (Refer to **Appendix VIII** for table of Five-point maturity scale for partial spawners).
2. Measure and record fork length (FL) in centimeters and body weight (BW) in gram and gonad weight (GW) to the nearest 0.01 gram.
3. Identify sex and gonad stage of fish visually. For the characteristic of gonad stages, refer to the standard maturity scale as attached (**Appendix VIII** for table of Five-point maturity scale for partial spawners).
4. Record the data in the standard format in Gonad Maturity Data Sheet.

Gonad Maturity Data Sheet

Country: Fishing Ground:
Fishing Area:
Name of sampling port: Date: Time:
Type of fishing gear (PS/HL/LL/PL/Gill net):
Total catch of boat:
Sample Weight:
Name of Enumerators:
Species name:

Sample no.	TL (cm)	BL (cm)	FL (cm)	SL (cm)	BW (g)	Sex & Stages	GW (g)	GSI

Total GSI Males
Average GSI Males
S.D. of males
Total GSI Females
Average GSI Females
S.D. of females

Note: GSI=GW/BW*100
Average GSI Males=SumGSI/number of males
Average GSI Females=SumGSI/number of females

4. Stomach contents "Food composition of Tuna"

List of materials

1. Surgical kits
2. Ruler or measuring tape/measuring board
3. Spring weighing balance
4. Digital weighing balances
5. Plastic bottle
6. Formalin 10%
7. Stereo microscope

Method for Stomach contents:

1. Measure Fork Length: FL
2. Weighing of fish
3. Preserve stomachs (freeze or preserve in 10 % formalin)

In the laboratory, then a three-step analysis will be conducted:

(a) The total weight of the stomach contents
(b) The content in the stomach by large categories (fish, molluscs, crustaceans)
(c) The weight of each category

DATA SUBMISSION AND COMPILATION

1. All data should be stored in ***Microsoft Excel*** format.
2. Data should be processed into a **semi–processed** form and sent through e-mail or fax and by diskettes to the National Technical Officers. The National Technical Officers will then send the data to the Technical Coordinator at SEAFDEC Departments.
3. Four sets of data should be compiled and submitted: a) Fishing operation and catches, b) Length frequency, c) Gonad data, and d) Stomach contents.

DATA ANALYSIS

1. Technical Scientists (SRWG Members) of each country are responsible to analyze all types of data at the national level. Chief Scientists are responsible for regional analysis of the data.
2. Optionally, combined Length-frequency data from the three countries can be analyzed using FiSAT to obtain growth and mortality parameters and other parameters.
3. Gonad maturity data should be analyzed in order to obtain:
   i. Length-weight relationships,
   ii. Sex ratio,
   iii. Spawning season through GSI,
   iv. Length at first maturity using Udupa, 1986.

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Sulu Sulawesi Seas: Sub-regional Technical meeting for finalizing Workplan of Activities for SEAFDEC Joint Program on Tuna Research in Sulu Sulawesi Sea, 18-21 August 2014 at Tawau-Sabah Malaysia.

Appendix I
Inventory of FADs logsheet

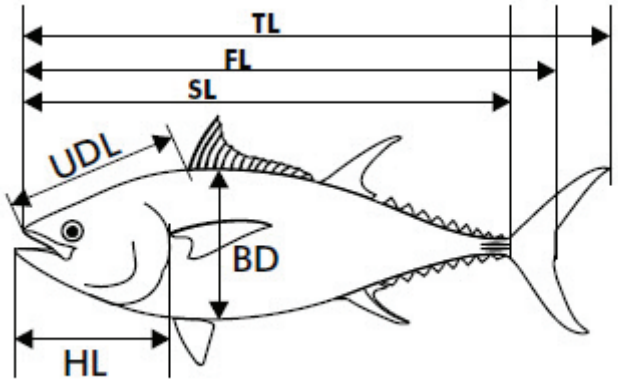
Inventory of FADs in Sulu and Sulawesi Seas

No.	Date	Station	Time	Location		Distance (mile)	Remark
				Lat.	Long.		

Appendix II
Standard Methodology for Length Measurement

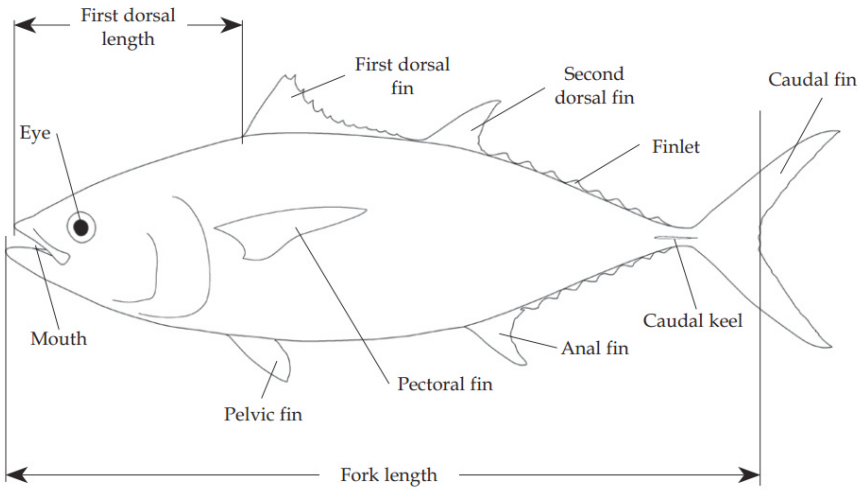
Tuna and tuna-like species

Total length (TL)	The greatest dimension between the most anteriorly projecting part of the head and the farthest tip of the caudal fin
Fork length (FL)	The distance form the most anteriorly projecting part of the head to the forked point of the caudal fin
Standard length (SL)	The distance from the most anteriorly projecting part of the head to theend of the vertebral column
Upper jaw-1 st anterior dorsal length (UDL)	The distance form the most anterior part of the upper jaw to the base of the 1st dorsal fin
Body depth (BD)	The greatest dimension, exclusive of the fleshy or scaly structureswhich pertain to the fin base



Appendix III

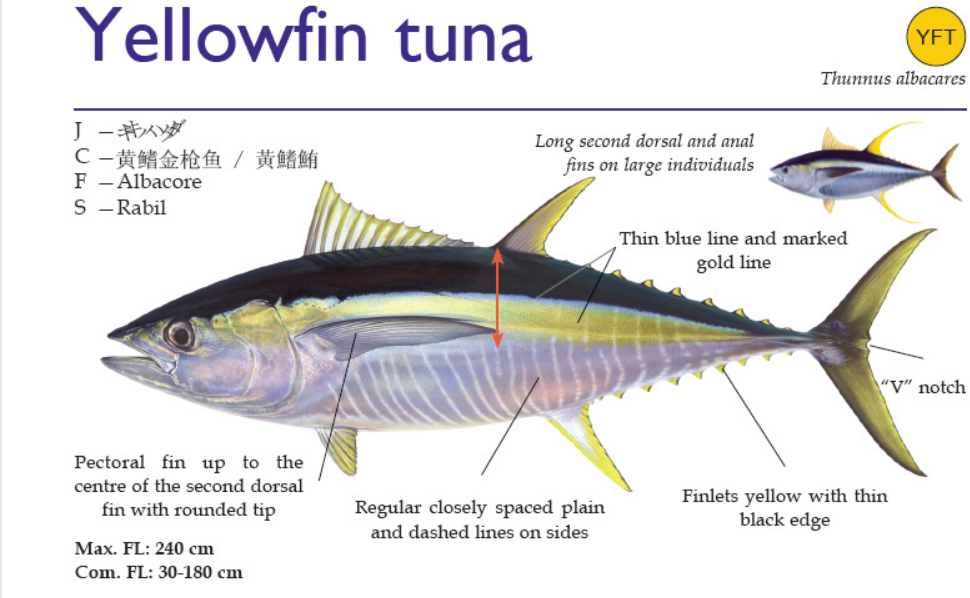
Standard Methodology for length measure & Targaet tuna species figures and descriptions



Source: http://www.iotc.org/sites/default/files/.../IOTC_IDTuna_vfinal4(E).pdf

Measurements used for tuna:

- Fork length (FL)
- First dorsal length or predorsal length (FD1)

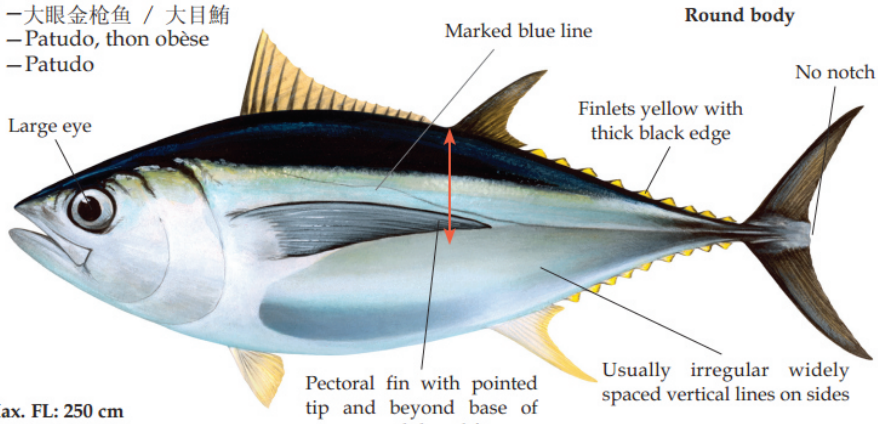


Bigeye tuna

BET

Thunnus obesus

J –メバチ
C –大眼金枪鱼 / 大目鮪
F –Patudo, thon obèse
S –Patudo



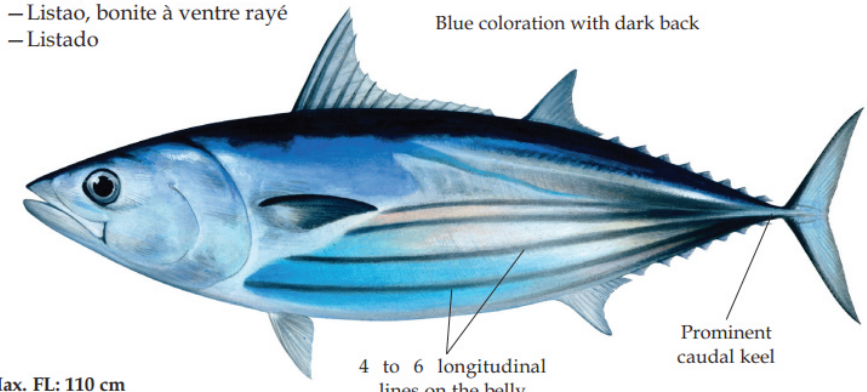
Max. FL: 250 cm
Com. FL: 30-180 cm

Skipjack tuna

SKJ

Katsuwonus pelamis

J –カツオ
C –鰹鱼 / 正鰹
F –Listao, bonite à ventre rayé
S –Listado



Max. FL: 110 cm
Com. FL: ≤ 80 cm

Appendix IV

Example of Fishing Operation and Catches Data Analysis

Fishing Operation and Catches Data Sheet

Country:	Malaysia
Sea areas:	Sulu Sea
Fishing areas:	Tawau
Grid area	(Referred to Grid number from SOPs M.V.SEAFDEC2)
Name of sampling port:	
Date:	15-Dec
Name of enumerator:	

Estimated no of boat in operation in a day	10
Estimated no of boat in operation in the month	45

Fishing Operation

No of Boats Sampled	1	2	3	Total	Average
No of haul per trip	2	3	2	7	2.3
No of fishing trips in the month	22	20	18		20
No of day per trip	2				
Estimated total catch (Kg) per trip	500	600	400	1500	500
Estimated total catch per day					
Estimated total catch per month					
CPUE (Kg/month/haul)					
CPUE (Kg per day)					

Species Composition					**% Spp Com**
Samples Weight (kg)	30	59	35	41.33	100.01
Weight of *T. albacares*	7	10	12	9.67	23.39
Weight of *T. obesus*	4	6	3	4.33	10.48
Weight of *T. pelamis*	5	25	8	12.67	30.65
Other tuna species	2	1	2	1.67	4.03
Other fish group	10	14	7	10.33	25.00

Record the total catches from unsampled boats at sampled landing site.
Record how many boats landing in that sampled day.

Appendix V

Example of Length-Frequency semi-process data

Example of semi-process data:

Country:	Malaysia		Malaysia	
Fishing ground:				
Fishing Area:				
Name of sampling port:				
Date:				
Time:	1800		1900	
Type of fishing boat:	PS		PS	
Name of Species:				
Total catch of species (kg):	1200		100	
Total weight of species (kg):				
Sample weight of species (kg):	80		30	
Name of enumerators	N.Rahman		N.Rahman	
Raising factor	1200/80	15	1000/30	3

Lower limit MM	Upper limit MM	Mid-length MM	Lt-Freq	Raising Freq.	Lt-Freq	Raising Freq.	Pool Freq.
100	104	102.5		0		0	0
105	109	107.5	1	15		0	15
110	114	112.5	3	45		0	45
115	119	117.5	7	105		0	105
120	124	122.5	12	180		0	180
125	129	127.5	23	345	2	6	351
130	134	132.5	46	690	4	12	702
135	139	137.5	30	450	5	15	465
140	144	142.5	26	390	9	27	417
145	149	147.5	19	285	10	30	315
150	154	152.5	12	180	13	39	219
155	159	157.5	6	90	20	60	150
160	164	162.5	4	60	12	36	96
165	169	167.5	1	15	9	27	42
170	174	172.5	4	60	7	21	81
175	179	177.5	7	105	4	12	117
180	184	182.5	9	135	2	6	141
185	189	187.5	5	75	1	3	78
190	194	192.5	7	105	3	9	114
195	199	197.5	12	180	6	18	198
200	204	202.5	24	360	9	27	387
205	209	207.5	19	285	10	30	315
210	214	212.5	13	195	17	51	246
215	219	217.5	16	240	25	75	315
220	224	222.5	13	195	9	27	222
225	229	227.5	9	135	8	24	159
230	234	232.5	3	45	1	3	48
Total			331	4965	186	558	5523

This format is easy for raising and pooling the length frequency in that particular month and sampling site

Appendix VI

Example of semi-process data of Gonad Maturity

Example of semi-process data:

Country: Malaysia Fishing Ground: Kelantan
Fishing Area: off Kelantan waters
Name of sampling port: Tok Baali Date: 2-Nov'02 Time: 0600
Type of fishing gear (PS/HL/LL/PL/Gill net): PS
Total catch of boat: 12000 kg
Sample Weight: 80 kg
Name of Enumerators: N.Rahman
Species name: *Rastrelliger kanagurta*

Sample no.	TL (cm)	BL (cm)	FL (cm)	SL (cm)	BW (g)	Sex & Stages	GW (g)	GSI
1	205	167	184		112	F1	0.3	0.27
2	210	173	187		114.9	F1	0.2	0.17
3	228	209	227		211.7	F3	8.3	3.92
4	244	193	213		163.2	F3	3.4	2.08
5	252	280	220		193.1	F3	7.8	4.04
6	248	193	212		176.2	F3	5.8	3.29
7	215	176	195		137.3	F3	3.1	2.26
8	216	179	195		125.6	F3	3.3	2.63
9	258	217	225		218.7	F4	8.5	3.89
10	222	181	196		145.4	F4	7.2	4.95
11	265	212	232		226.6	F5	6.6	2.91
12	255	211	225		185.6	M3	7	3.77
13	242	295	213		176.1	M3	10.2	5.79
14	252	214	223		193.2	M3	8.9	4.61
15	254	203	222		198.7	M3	7.2	3.62
16	216	179	195		127.9	M3	4.3	3.36
17	222	184	203		139.6	M4	3.2	2.29
18	226	183	204		131.8	M4	2.8	2.12
19	215	174	193		124.4	M4	0.6	0.48
20	230	167	183		102	M4	1	0.98
21	215	175	192		114.8	M4	5.9	5.14
22	225	185	202		143.7	M5	7.6	5.29
23	214	175	191		119.7	M5	2.7	2.26
24	212	174	188		109.6	M5	1.4	1.28

Total GSI Males 41.00
Average GSI Males 3.15
S.D. of males 1.7370
Total GSI Females 30.41
Average GSI Females 0.29
S.D. of females 1.5162

Note: GSI=GW/BW*100
Average GSI Males=SumGSI/number of males
Average GSI Females=SumGSI/number of females

Appendix VII

Maturity parameters of Yellowfin Tuna, Bigeye Tuna and Skipjack Tuna

Scientific name	Age	Size at maturity	
		FAO	Sulu Sulawesi Seas
Yellowfin Tuna *Thunnus albacares*	2.5-3.0 years	100 cm	100 cm
Bigeye Tuna *Thunnus obesus*	3.0-3.5 years	100 cm	100 cm
Skipjack Tuna *Katsuwonus pelamis*	2.0 years	42 to 45 cm	38 cm

Source:
FAO: http://www.fao.org/fishery/topic/16082/en#Reproduction
Sulu Sulawesi Seas: Sub-regional Technical Meeting for Finalizing Workplan of Activiies for SEAFDEC Joint Program on Tuna Research in Sulu Sulawesi Sea, 18-21 August 2014 at Tawau-Sabah Malaysia

Appendix VIII

Five-point maturity tuna scale for partial spawners

Identify sex and gonad stage of fish through visual censes. As for the characteristic of gonad stages, refer to the standard maturity scale as Five-point maturity scale for partial spawners.

Stage	State	Description	Picture*
I	Immature	Ovary and testis about 1/3 of the length of body cavity. Ovaries pinkish, translucent; testis whitish. Ova not visible to naked eye.	
II	Maturing virgin and recovering spent	Ovary and testis about 1/2 of the length of body cavity. Ovary pinkish, translucent; testis whitish, more or less symmetrical. Ova not visible to naked eye.	
III	Ripening	Ovary and testis is about 2/3 of the length of body cavity. Ovary pinkish-yellow colour with granular appearance, testis whitish to creamy. No transparent or translucent ova visible.	
IV	Ripe	Ovary and testis from 2/3 to full length of body cavity. Ovary orange-pink in colour with conspicuous superficial blood vessels. Large transparent, ripe ova visible. Testis whitish-creamy, soft.	
V	Spent	Ovary and testis shrunken to about 1/2 length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe ova, darkened or translucent. Testis blood shot and fl abby.	

Source: FAO: http://www.fao.org/docrep/003/f0752e/f0752e05.htm

For picture of Tuna Gonad Stage will be add-on later.

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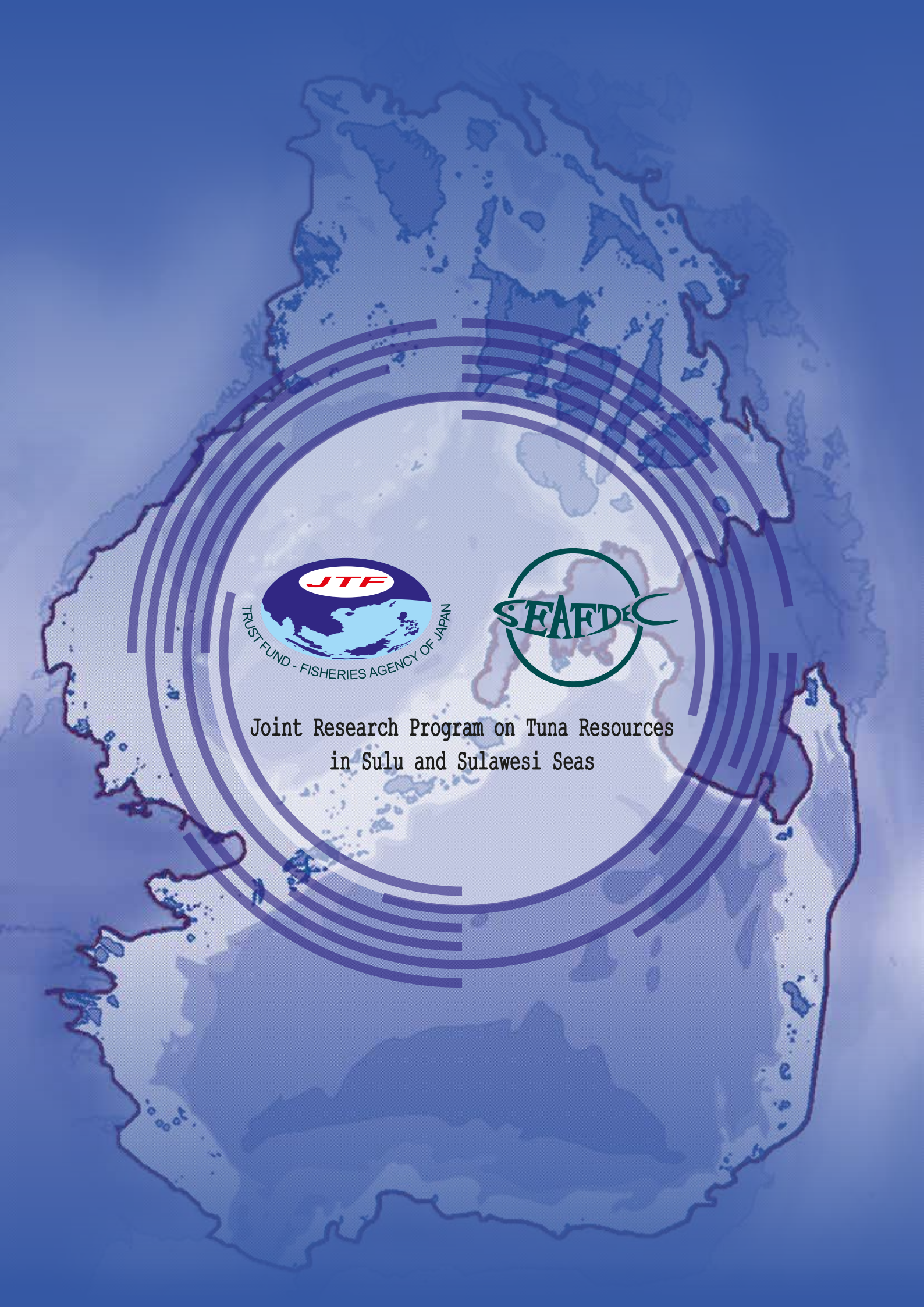
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