REPORT OF THE

Training Course on Age Determination Using Vertebra for Sharks and Rays

29 April – 1 May 2019

SEAFDEC/Training Department
Samut Prakan, Thailand

Course report:	**Training Course on Age Determination Using Vertebra for Sharks and Rays**
Authors:	**SEAFDEC/TD**
Course Date:	**29 April – 1 May 2019**
Implementing Agency:	**Southeast Asian Fisheries Development Center (SEAFDEC)**
Host Agency:	**JTF-project**
Course Location:	**SEAFDEC/TD**
Report Date:	**June 2018**

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REPORT OF THE TRAINING COURSE ON AGE DETERMINATION USING VERTEBRA FOR SHARKS AND RAYS

29 April – 1 May 2019 at SEAFDEC/Training Department, Samut Prakan, Thailand

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I. INTRODUCTION

Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/ TD) has developed an activity, Improving the Data Collection of the Commercially-exploited Aquatic and Threaten Species: Sharks and Rays since year 2013 under Enhancing Compilation and Utilization of Fishery Statistics and Information for Sustainable Development and Management of Fisheries in Southeast Asian Region project. The aim of this activity was to enhance capability of fisheries sectors in compiling and utilizing shark and ray statistics and information in order to support sustainable fishery management in the region.

In year 2013, this project was initiated by organizing technical meeting for combining data and information of sharks and rays in order to understand the situations in the Southeast Asian region. The outputs from meeting revealed that National Statistics in Southeast Asian countries showed the catch of the sharks and rays data by group. It is not classified into the species level and recording of essential information such as biological data is insufficient. Lack of enumerator, who could identify sharks and rays at species level is big challenge in the region. In this connection, SEAFDEC Member Countries had agreed during the meeting that the regional activities on sharks and rays data collection should be initially taken place starting from building national capacity to identify species and establishing national shark landing data collection systems.

In the year 2014, the project activities were emphasized on alleviating problems of sharks and rays data collection in the region by improving capacity of elasmobranch identification at species level through organized regional training for SEAFDEC Member Countries. The aim of the meeting was training the trainer, who is able to convey knowledge from training to their local shark landing enumerators.

In the years 2015-2016, the project activities were the Regional Technical Meeting on Sharks and Rays Data Collection and Project Planning. Outputs of the meetings were: the agreement of participating countries on the format and template of sharks and rays data collection, work plans for year 2015-2016 and Standard Operational Procedure (SOP) of sharks and rays data collection was developed.

With financial support from the Government of Japan through the SEAFDEC/ SEC and SEAFDEC/MFRDMD, and the European Union (EU) through the CITES Secretariat, one-year Regional Project on Sharks and Rays Data Collection was implemented from September 2015 to August 2016 in six (6) SEAFDEC Member Countries, namely: Cambodia, Indonesia, Malaysia, Myanmar, Thailand, and Viet Nam. Major outputs of the activities were: 1) regional sharks and rays data at species in Southeast Asian region 2) improving human resources capacity of SEAFDEC Member Countries on sharks and rays identification and data collection,

3) updating sharks and rays information in Southeast Asian Region 4) national reports of sharks and rays.

In year 2017, the project step forward for fisheries management by organizing the Technical Consultation Meeting on Shark Stock Assessment and Improving Data Collection in Southeast Asian Region aiming to select the most appropriated stock assessment models for converting landing data to scientific sharks and rays stock statuses. The meeting was attended by four (4) resource persons from Malaysia, Japan and Thailand, six (6) representatives from SEAFDEC and eight (8) representatives from four countries including Indonesia, Myanmar, Thailand and Vietnam**.** The main outcome of the meeting was agreement of participants as they accepted Yield per Recruit Model (YPR model) to be the most appropriate method to assess status of sharks and rays based on short term data condition in Southeast Asian region**.**

In year 2018: SEAFDEC organized the "Training on Shark and Ray Stock Assessment using YPR model" in order to 1) Strengthen the human resource development on stock assessment of sharks and rays, of researchers from SEAFDEC Member Countries, 2) Improve the information on stock assessment of sharks and rays by species in the region, and 3) Establish a network of "sharks and rays" stock assessment scientists in the Southeast Asian region.

The important aspect of using the YPR model is to quantify the effect of size selection and fishing mortality on the yield from a fixed number of individuals that enters the fishery, i.e. recruitment, by incorporating the growth parameters as inputs for the model. However, during the 2018 training, it was found that the growth parameters, which were estimated from length frequency data, were biased due to insufficient landing data. To obtain the accurate growth parameters, the ideal number of fish samples should at least 500 each species and the length measurements of samples must cover all lengths of such species from small size to large size. This makes it difficult to estimate the YPR of our targeted shark species based on the existing data in Southeast Asia.

To solve the problem, the stock assessment resource person from the aforementioned training suggested that determining the reliable growth parameters should be conducted by using the length-at- actual age analysis, where the age of individual fish can be obtained by its hard part, i.e. vertebra. However, since the researchers from the SEAFDEC Member Countries still have limited knowledge about this area of research, it was necessary to organize the training course on age determination for human resource capacity building in Southeast Asian region.

The three (3) days training course was organized by SEAFDEC/TD in Samut prakarn, Thailand from 29 April to 1 May 2019. With funding support from Japanese Tryst Fund VI, the training had nineteen (19) participants and observers including officer from Department of fisheries Cambodia, Indonesia, Malaysia, Myanmar, Thailand and Vietnam as well as bachelor and master degree student from Kasetsart University and Hokkaido University. The list of participants, observers, resource persons, and SEAFDEC Officers, appears as **Annex 1**.

II. OBJECTIVE

1. To enhance human resource development on age determination for formulating grow rates of sharks and rays to stock assessment researcher of SEAFDEC Member Countries,
2. To attain the more reliable YPR model, and
3. To strengthen a network of stock assessment scientists in the Southeast Asian

III. REVIEW OF COURSE DELIVERY

In the Opening Ceremony, Mr. Isara Chanrachkij, Research and Development Division Head gave an introductory report to all participants, resource persons and SEAFDEC staff. The opening remark was made by Dr. Kom Silapajarn, Secretary-General and Chief of the Training Department to welcome all participants and resource persons to the training course and to Thailand. His Opening remark appears as **Annex 2**. After the opening ceremony, Mr. Sukchai Arnupapboon, course coordinator briefed on schedule of the training to all participants. The schedule appears in **Annex 3.** On the last day of the training workshop, Mr. Akito Sato, Deputy Secretary-General delivered certificate to all participants and resource persons and gave the Closing Remarks for the closing ceremony. His Closing Remarks appeared as **Annex 4**.

The project leader for improving data collection for sharks and rays, Mr. Sukchai Arnupapboon presented the background information of the project which has already completed since 2013 and now focus on capacity building of stock assessment researcher to make reliable growth rate based on age length analysis.

Mr. Sukchai Arnupapboon also explained that the training course was held in 3 day. It would be conducted through lecture and practical class. The performance of the training participants as well as observers would be rated through practical examination both before and after to ensure that they have gained the skill in determine age of sharks and rays. He added that with the enhanced knowledge and skills of the determine age of sharks and rays be able to up with attaining stock assessment result for the proper management of sharks and rays. The Prospectus of the Training is shown as **Annex 5.**

The training workshop was delivered entirely by resource persons; 1) Prof. Tuantong Jatagate, Fishery Researcher and Lecturer, faculty of agriculture, Ubon Ratchathani University, 2) Assoc. Prof. Thanitha Darbanandana, Fishery Researcher and Lecturer, faculty of fisheries, Kasetsart University, 3) Dr. Sontaya Koolkalya, Fishery Researcher and Lecturer, faculty of agricultural Technology, Rambhai Barni Rajabhat UniversityProf. 4) Dr. Ahmad bin Ali, Head of Fisheries Oceanography and Resource Enhancement Section and 5) Matsuishi Takashi Fritz, Fishery Researcher and Lecturer, faculty of fisheries sciences Hokkaido University.

The training course started with the lecture provided by Dr. Ahmad bin Ali regarding status of elasmobranch fisheries in Southeast Asia countries. He outlines the capture statistic and diversity of chondrichthyans as well as with market

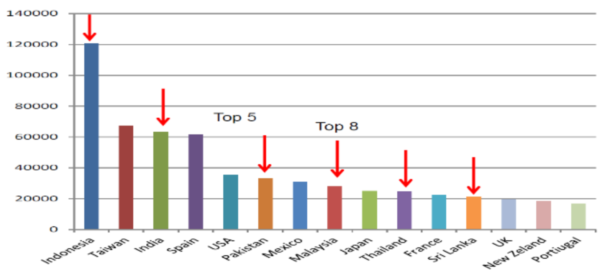


Fig. 1 World capture of chondrichthyans, 2013

value and trade problem in Southeast Asian Countries (Annex 6).

This was followed by the lecture of Prof. MATSUISHI Takashi Fritz on Sensitivity of Yield per Recruit (YPR) Model. The using of YPR method was very useful for data limited stock assessment in case that only length – frequency data (LFD) available. However, YPR was the compounded holistic model which has some important assumption required for "stable fishery condition" and several parameters such as biological and mortality parameters. Major cause of uncertainties were biological parameters estimation (maximum length (L_∞), growth rate (K) which can also provide major effect to theoretical age when length 0 (t_0) as well) in order to be further use for mortality parameters estimation. Therefore, the using of input parameters should be observed carefully the implementation should be based on the reality and sometimes also based on experiences of researchers.

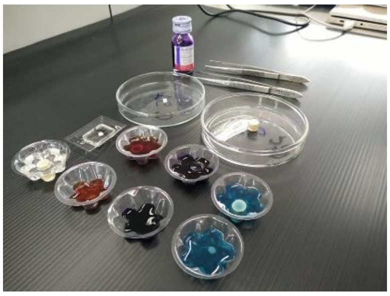
Mr. Supapong Patarapongpan, PhD student from Hokkaido University lectured on Case Study Using YPR. His Presentation focused on the providing of the provisional result of the research using data from SEAFDEC one year data collection project. Catch and CPUE data was observed and extracted from catch statistic of Myanmar and Indonesia. Result show that the most appropriate age at first captured (t_c) for scallop hammerhead should be about 2.5 – 3 years old at fishing mortality (F) about 2 /year. However, all result provided still contained several uncertainties considering to the lack of appropriate frequency of LFD which cannot be used for determining the appropriate biological, catch and mortality parameters. Therefore, the presentation was a good example for extent the data collection project in order to obtain the appropriate data set for further reliable result.

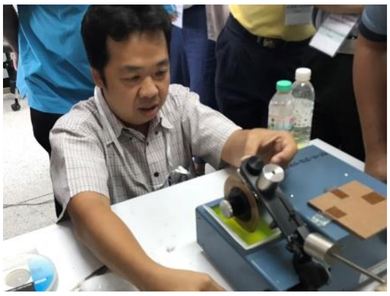
The "Preparation of Shark Sample, Vertebra, Stand and Embedding (in epoxy) and Section Vertebra" was presented by Fishery Researcher and Lecturer from Ubon Ratchathani University, Prof. Tuantong Jutagate. The process of work in laboratories was presented in detail. Additionally, in this session, all participant received handout of Technical Manual Sample Preparation for Age Determination of Elasmobrance produced by Prof. Tuantong Jutagate. Dering the practical session, all participant worked in group and practiced step by step as following;

- Identification (Species and Sex)
- Measure total length, precaudal length, body width and Weight
- Vertebra removing
- Boil and bleach to clean vertebra
- Vertebra stain
- Embedding in epoxy
- Sectioning

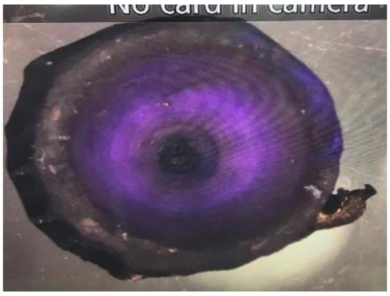


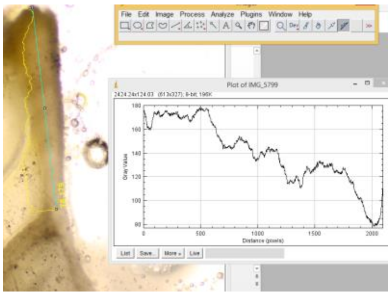


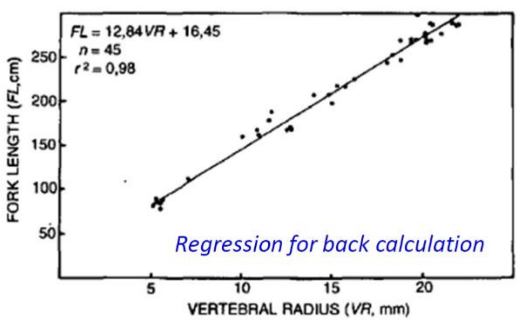



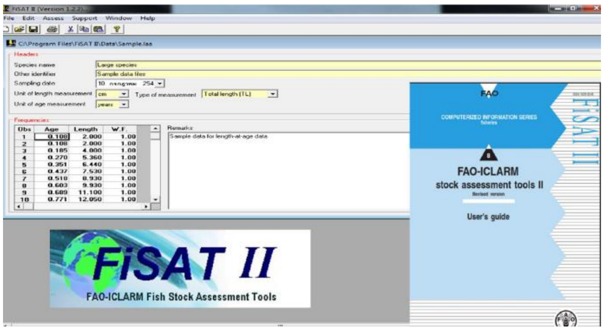
The “Age reading and imaging” was presented by Fishery Researcher and Lecturer from Rambhai Barni Rajabhat University, Dr. Sontaya Koolkalya. He trained participant to count growth ring by using digital image technique through Image-J program. This new technique is huge advantage comparing to directly count under microscope and Image-J is free software program.





Prof. Tuantong Jutagate provided lecture on “validation, estimation of growth parameter and construction of growth model”. There were several methods for insuring aging accuracy and quantifying aging precision introducing during the course. For estimation growth, black calculation method and SPSS program was trained to participants.





On the last day of training course, participants presented the results of their training. From their presentation, all group were good in their practical work. They could determine age of their shark sample. Additionally, participants would receive comments and suggestions from resource persons for better understanding and apply in their work.

IV. COURSE EVALUATION

Course evaluation was conducted by asking participants to examine pre and post-test in regard to knowledge of age determination. The Average score for pre- and post-test of participants were 10.74 and 17.96, respectively. Result showed that the participants score in post-test were significantly higher than the pre-test as 95% confidence interval at p – value = $2*10^{-5}$. Increasing score of participants showed the positive progress from this training course.

V. CONCLUSION

The course coordinator, Mr. Sukchai Arnupapboon reported the results of this training course appear as **Annex 6**. During this training course, participants gained and improved their knowledge and skills to determine age of sharks as observed by the results of their presentation as well as comparing the score between pre- and post-test. In addition, all participants could adapt the knowledge to produce growth curve. this is very important skill when participants assess status of fisheries and resource as well as assess stock biomass. This training course was reached the aims that to enhance knowledge and skills for all participants and to create the network connection of researchers/biologists among the Member Countries to further communicate and cooperate in stock assessment in the Southeast Asian region.

VI. LOGISTICS AND ADMINISTRATIVE SUPPORT

SEAFDEC provided logistical and administrative support. A number of administrative staffs were present throughout the course to liaise with the venue and arrange for the facility during the training. SEAFDEC organized a welcome dinner on the first day of training.

VII. ANNEXES

See annexes as separate documents;

1. List of participants, resource persons and staff
2. Opening Remark
3. Program and Syllabus
4. Closing Remarks
5. Provisional and prospectus
6. Training report
7. Status Elasmobranch Fisheries in the Southeast Asian Region
8. Sensitivity of Yield per Recruit (YPR) Model
9. The Provisional Results of YPR Analysis
10. Age Determination Using Vertebra
11. Handout for Sample Preparation
12. Handout for ImageJ Program

Annex 1

List of participants

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Annex 2

Opening Remark

Dr. Kom Silapajarn

SEAFDEC Secretary-General

Training on Age Determination by Using Vertebra for Sharks and Rays

29 April- 1 May 2019, SEAFDEC Training Department, Samut Prakan, Thailand

Distinguished Representatives from the SEAFDEC Member Countries; Resource persons, Officers from SEAFDEC, Ladies and Gentlemen, Good Morning!

On behalf of SEAFDEC, it is indeed my great pleasure to welcome all of you to SEAFDEC/Training Department, Samut Prakan, Thailand for these 3-days Training on Age Determination by Using Vertebra for Sharks and Rays.

We all recognized that the Southeast Asian region has rich biodiversity of sharks and rays. It is recorded that at least 196 species of sharks and 160 species of rays are found inhabiting in Southeast Asian water. It is obvious that the Southeast Asian water is one of the richest shark and ray area.

Sharks and rays have become one of the valuable fishery resources and commodities of Southeast Asia. It contributes to the livelihood of fishers, traders and exporters. However, since the past decades, Sharks and rays were highly caught. For example, Fishery Statistics recorded those two (2) countries in Southeast Asia, namely: Indonesia and Malaysia are in the top ten (10) fishing countries of sharks and rays in the world.

In this situation, the mobilization to develop sustainable management strategy based on science evidence should be conducted as soon as possible.

In year 2018, SEAFDEC initiated support with SEAFDEC Member Countries (MCs) to assess fisheries and resource status of sharks and rays by using Yield per Recruit (YPR) model. Assessment by this model requires estimated growth rate, maximum age and age of maturity. All of which rely on accurate estimation of age.

In the case of sharks and rays, age can be estimated using counting the growth bands technique at the vertebrae or the fin spine, when present. However, we understand that this technique is quite new for the Southeast Asian researchers and they still lack knowledge on this technique. In this connection, SEAFDEC/TD organized Training on “Age Determination by Using Vertebra for Sharks and Rays.” The objectives are as follows:

To enhance human resource development on age determination for formulating growth rates of sharks and rays; attain the more reliable YPR model, and strengthen a network of stock assessment scientists in the Southeast Asian region.

I sincerely hope that you have active and fruitful discussions in this training. I also hope this training will contribute to better management of Sharks and Rays in the region.

With that, Ladies and Gentlemen, I take great pleasure in declaring this Technical Consultation Meeting open.

Thank you once again and have a good day.

Annex 3

Program and Syllabus

Date/Time	Training Activity/Topic	Resource Person
28 April/Sunday		
	Resource persons and course attendees arrive at SEAFDEC Training Department, Samut Prakan, Thailand	
29 April/Monday		
0830-0900	Registration	SEAFDEC Personnel
0900-0930	Opening Ceremony, Group Photo and Pre-test Examination	SEAFDEC
0930-0945	Refreshment	SEAFDEC
0945-1030	Updating the status elasmobranch fisheries in SEA countries	Dr. Ahmad Ali
1030-1200	Lecture on Sensitivity of Yield per Recruit (YPR) model and Case Study Using YPR Assessment for Shark	Prof. MATSUISHI Takashi Fritz and Mr. Supapong Patarapongpan
1200-1300	Lunch	
1300-1500	Preparation of shark samples	All resource person
1500-1515	Break	
1515-1700	Preparation of vertebra and stain	All resource person
1700-1800	Embedding (in epoxy) and section of vertebra	All resource person
1800-2000	Welcome dinner	
30 April/Tuesday		
0830-1000	Age reading and imaging*	All resource person
1000-1030	Break	
1030-1230	Age reading and imaging (cont.)*	All resource person
1230-1330	Lunch	
1330-1430	Age verification and validation**	All resource person
1430-1500	Break	
1500-1700	The back calculation	All resource person
1 May/Wednesday		
0830-1000	Lecture on estimation of the growth parameters **	All resource person
1000-1030	Break	
1030-1230	Lecture on estimation of the growth parameters (cont.) and construction of growth model**/***	All resource person
1230-1330	Lunch	
1330-1445	Q&A and Post-test Examination	All resource person

Date/Time	Training Activity/Topic	Resource Person
1445-1500	Break	
1500-1515	Closing remark	SEAFDEC
1515-2100	Excursion at MBK shopping mall	SEAFDEC
2 May/Thursday		
	Departures of resource persons and course attendees	

* The course attendees are requested to install the **ImageJ Program** to their laptops (https://imagej.nih.gov/ij/download.html)

** The course attendees are requested to install the **R Program** to their laptops (https://cran.r-project.org/bin/windows/base/)

*** The course attendees are requested to install the **FiSAT Program** to their laptops (http://www.fao.org/fishery/topic/16072/en#4)

Annex 4

Closing Remark

Mr. Akito Sato,

Secretary-General and Chief of the Training Department

Training on Age Determination by Using Vertebra for Sharks and Rays

29 April- 1 May 2019, SEAFDEC Training Department, Samut Prakan, Thailand

Distinguished Representatives from the SEAFDEC Member Countries; Resource persons and Officers from SEAFDEC Training Department (SEAFDEC/TD), Ladies and Gentlemen, Good Afternoon!

On behalf of SEAFDEC, it is my great pleasure to address all of you at the closing of the Training on Age Determination Using Vertebra for Sharks and Rays at SEAFDEC/TD.

As you know, the mobilization to develop sustainable management strategy based on science evidence, particularly stock and fisheries status assessment should be conducted as soon as possible in our region.

One of the important input data to assessment model is the growth parameters. We all have been known that counting the growth bands technique at the heart part is the highest accurate technique. Therefore, SEAFDEC/TD organized the training to build-up the capacity of researchers who participated in this training.

Ladies and Gentlemen, I am so happy to hear that all of you have learnt a lot from this training. I know this is not an easy task, infact; it is challenging. I encourage all of you to please keep continue to do your best.

On behalf of SEAFDEC, I would specifically wish to express our sincerest appreciation to our resource persons, namely: Prof. Tuantong Jatagate, Assoc. Prof. Thanitha Darbanandana, Dr. Sontaya Koolkalya, and Prof. Matsuishi Takashi Fritz as well as assistant resource person, Mr. Supapong Pattarapongpan with their dedications, knowledge and experiences shared with us during the training. You all have guided our participants and we appreciate that.

We understand that you have taken time out of your very important schedules to contribute to this training and some of you have even traveled long distance. Thank you for your valuable contribution and making this training fulfilling on its objectives.

Let me express my very special thanks to all participants who have actively attended this training. After this training, I believe we can come up with skill to estimate growth parameter and I wish that every participant could be in a position to apply the knowledge. More importantly, it is also my hope that the spirit of friendship that has been nurtured over the last three (3) days will be continued and strengthened.

Furthermore, I would like to say a special thanks to SEAFDEC/TD staff who worked tirelessly both in the foreground and background. Organizing this training is not at all an easy task, you all made it together for running this smoothly. You deserve congratulations for a job well done.

Once again, I wish therefore to congratulate each and everyone of you for having made this training a success that it has been. I thank you all for the work well done.

Ladies and Gentlemen, I now declare this training closed. I wish all of you "Good Luck"

Last but not least, I wish you all have very safe journey back home. See you in June this year.

Thank you and Have a nice day.

Annex 5

Provisional Prospectus

Training on Age Determination Using Vertebra for Sharks and Rays

Introduction

Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/TD) in collaboration with Southeast Asian Fisheries Development Center/Marine Fisheries Resource Development and Management Department (SEAFDEC/MFRDMD) have developed an activity, Improving the Data Collection of the Commercially-exploited Aquatic and Threaten Species: Sharks and Rays since year 2013 under Enhancing Compilation and Utilization of Fishery Statistics and Information for Sustainable Development and Management of Fisheries in Southeast Asian Region project. The aim of this activity was to enhance capability of fisheries sectors in compiling and utilizing shark and ray statistics and information in order to support sustainable fishery management in the region.

In year 2013, this project was initiated by organizing technical meeting for combining data and information of sharks and rays in order to understand the situations in the Southeast Asian region. The outputs from meeting revealed that National Statistics in Southeast Asian countries showed the catch of the sharks and rays data by group. It is not classified into the species level and recording of essential information such as biological data is insufficient. Lack of enumerator, who could identify sharks and rays at species level is big challenge in the region. In this connection, SEAFDEC Member Countries had agreed during the meeting that the regional activities on sharks and rays data collection should be initially taken place starting from building national capacity to identify species and establishing national shark landing data collection systems.

In the year 2014, the project activities were emphasized on alleviating problems of sharks and rays data collection in the region by improving capacity of elasmobranch identification at species level through organized regional training for SEAFDEC Member Countries. The aim of the meeting was training the trainer, who is able to convey knowledge from training to their local shark landing enumerators.

In the years 2015-2016, the project activities were the Regional Technical Meeting on Sharks and Rays Data Collection and Project Planning. Outputs of the meetings were: the agreement of participating countries on the format and template of sharks and rays data collection, work plans for year 2015-2016 and Standard Operational Procedure (SOP) of sharks and rays data collection was developed.

With financial support from the Government of Japan through the SEAFDEC/SEC and SEAFDEC/MFRDMD, and the European Union (EU) through the CITES Secretariat, one-year Regional Project on Sharks and Rays Data Collection was implemented from September 2015 to August 2016 in six (6) SEAFDEC Member Countries, namely: Cambodia, Indonesia, Malaysia, Myanmar, Thailand, and Viet Nam. Major outputs of the activities were: 1) regional sharks and rays data at species in Southeast Asian region 2) improving human resources capacity of SEAFDEC Member Countries on sharks and rays identification and data collection,

3) updating sharks and rays information in Southeast Asian Region 4) national reports of sharks and rays.

In year 2017, the project step forward for fisheries management by organizing the Technical Consultation Meeting on Shark Stock Assessment and Improving Data Collection in Southeast Asian Region aiming to select the most appropriated stock assessment models for converting landing data to scientific sharks and rays stock statuses. The meeting was attended by four (4) resource persons from Malaysia, Japan and Thailand, six (6) representatives from SEAFDEC and eight (8) representatives from four countries including Indonesia, Myanmar, Thailand and Vietnam**.** The main outcome of the meeting was agreement of participants as they accepted Yield per Recruit Model (YPR model) to be the most appropriate method to assess status of sharks and rays based on short term data condition in Southeast Asian region**.**

In year 2018: SEAFDEC organized the “Training on Shark and Ray Stock Assessment using YPR model” in order to 1) Strengthen the human resource development on stock assessment of sharks and rays, of researchers from SEAFDEC Member Countries, 2) Improve the information on stock assessment of sharks and rays by species in the region, and 3) Establish a network of “sharks and rays” stock assessment scientists in the Southeast Asian region.

The important aspect of using the YPR model is to quantify the effect of size selection and fishing mortality on the yield from a fixed number of individuals that enters the fishery, i.e. recruitment, by incorporating the growth parameters as inputs for the model. However, during the 2018 training, it was found that the growth parameters, which were estimated from length frequency data, were biased due to insufficient landing data. To obtain the accurate growth parameters, the ideal number of fish samples should at least 500 each species and the length measurements of samples must cover all lengths of such species from small size to large size. This makes it difficult to estimate the YPR of our targeted shark species based on the existing data in Southeast Asia.

To solve the problem, the stock assessment resource person from the aforementioned training suggested that determining the reliable growth parameters should be conducted by using the length-at- actual age analysis, where the age of individual fish can be obtained by its hard part, i.e. vertebra. However, since the researchers from the SEAFDEC Member Countries still have limited knowledge about this area of research, it has become necessary that the training on aging determination for human resource capacity building in Southeast Asian region should be convened by SEAFDEC.

Objectives

1. To enhance human resource development on age determination for formulating grow rates of sharks and rays to stock assessment researcher of SEAFDEC Member Countries,

2. To attain the more reliable YPR model, and

3. To strengthen a network of stock assessment scientists in the Southeast Asian region

Expected Outputs

1. Enhancing the knowledge of fishery officers on age determination by annual ring technique
2. Increasing the number of growth rate information of shark and rays by species,
3. Network of stock assessment researchers,

Date and Venue

Training on “Age determination using vertebra for sharks and rays” will convened on 29 / 30 April to 1 May 2019 at SEAFDEC/TD (3 days), Samut prakan, Thailand.

Annex 6.

Closing Report

SEAFDEC Secretary-General, our Resource persons, Participants, Guests, Ladies and Gentlemen, Good Afternoon!

My name is Sukchai Arnupapboon, Fishing Ground and Oceanographic Section Head. Currently, I am also the project leader for shark and ray of SEAFDEC/TD.

The training on "Age Determination Using Vertebra for Sharks and Rays" has been conducted on 29 April 2019 until today, Ladies and Gentlemen, time flies so fast, we all have gone through these three (3) days together, you all have worked hard from day to night, and every single day you learned new things.

Ladies and gentlemen, I would like to report on the training activities and how the training course became successful to all the participants. This training course was specifically designed for Asian stock assessment researchers to learn the technique for determining age of sharks and rays focusing the vertebra using the heart part which there were various sessions, including theoretical and practical. The course syllabus consists of the following:

1. Updating the status of elasmobranch fisheries in SEA countries;
2. The sensitivity of Yield per Recruit;
3. Sample preparation;
4. Age reading and back calculation; and
5. The estimation of the growth parameter

During the training course, I observed that all participants improve their skills and they knew how to determine age of sharks and rays. Not only that, but they also shared their experiences with regards to shark and ray among the resource persons and participants. In this condition, I would like to say and strongly believed that our training course is successful.

However, our task is not end yet. I hope that when you go back to your countries, you will be able to carry out shark and ray ageing research. Ultimately, I hope that you could be able to apply this knowledge for sharks and rays fisheries management in your respective countries.

Ladies and Gentlemen, finally, we are very happy to see that all participants gained the knowledge from our resource persons. I hope the success on sustainable sharks and rays fisheries management to be yours and in your countries.

With this note, Sir, Thank you very much.

Annex 7.

Status Elasmobranch Fisheries in the Southeast Asian Region

STATUS ELASMOBRANCH FISHERIES IN THE SOUTHEAST ASIAN REGION

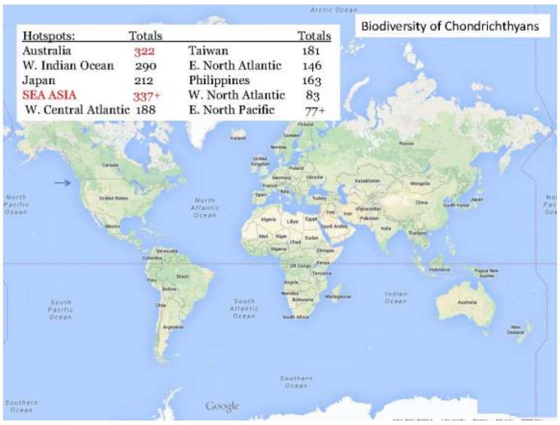
AHMAD ALI (PhD)
Senior Researcher
Southeast Asian Fisheries Development Center (SEAFDEC)
Regional Vice Chair, IUCN Shark Specialist Group Southeast Asia Region

Presented at
Training on Age Determination Using Vertebra for Sharks and Rays

29 April-1 May 2019 , Bangkok Thailand

Contents

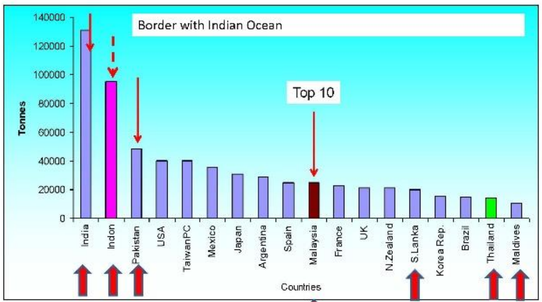
- Introduction
- Sharks and Ray Fisheries



Biodiversity of Sharks Species in SEA Region/world (Ali *et al.* 2018) : 196/509= 38.5%

Order/Family/ Common Name	No of Species	B	C	I	MY	MN	T	Philippines	V
HEXANCHIFORMES (Cow And Frilled Sharks)	3	0	0	3	3	1	2	3	3
ECHINORHINIFORMES (Bramble Sharks)	2	0	0	0	0	1	1	1	0
SQUALIFORMES (Dogfishes)	44	3	1	24	4	6	4	23	10
(Pending confirmation)		1	1		1	1	2	2	
PRISTIOPHORIFORMES (Saw Shark)	1	0	0	0	0	0	0	1	0
SQUATINIFORMES (Angelsharks)	8	2	0	3	1	1	2	2	2
HETERODONTIFORMES (Bullhead Sharks)	1	1	1	1	1	0	1	1	1
ORECTOLOBIFORMES (Carpet Sharks)	20	8	8	16	9	9	10	8	10
LAMNIFORMES (Mackerel Sharks)	11	1	0	10	2	4	7	8	5
(Pending confirmation)						1		1	2
CARCHARHINIFORMES (Ground Sharks)	107	30	16	57	48	42	49	49	39
(Pending confirmation)				3		1	2	4	2
Total Species	196	45	26	114	68	64	76	96	70
Pending confirmation		1	1	3	1	3	4	7	4

World captures of Chondrichthyans in 1997



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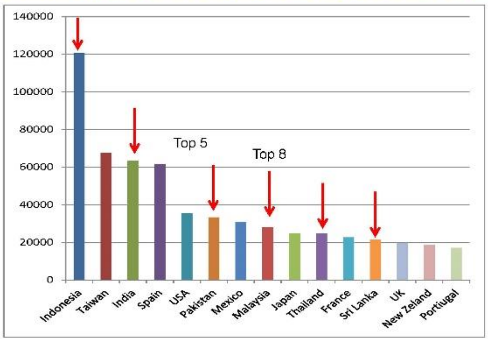
World captures of chondrochthyans in 2003



Where is China?

Table 1

Capture production by top 20 catching countries 1950-2003 and 1990-2003 (tonnes). Individual year totals and a total for 1950-2003

Country	1950	1960	1970	1980	1990	2000	2001	2002	2003	TOTAL 1950-2003
Top 20 1950-2003										
1. Japan	100 700	83 900	61 544	54 298	32 103	31 873	27 696	32 879	24 906	3 035 820
2. India	30 000	35 600	44 100	49 656	51 230	76 057	67 971	66 923	63 266	2 677 213
3. Indonesia	1000	6100	10 100	42 855	73 272	113 626	110 311	106 398	120 670	2 267 523
4. Taiwan Province of China	9000	17 100	36 300	52 260	75 731	45 923	42 355	44 412	67 432	2 030 447
5. Pakistan	4800	6600	34 300	64 975	40 043	51 170	49 269	49 904	33 248	1 866 822
6. France	17 600	26 300	28 017	35 267	26 310	24 952	25 799	23 136	22 547	1 480 088
7. UK	29 400	29 340	22 400	21 355	21 776	17 389	19 346	16 832	19 581	1 332 363
8. Mexico		4700	9100	26 551	44 880	35 260	32 718	30 888	30 872	1 089 646
9. Norway	12 000	30 000	43546	15 572	11 117	2857	2921	1901	2020	1 033 527
10. Spain	10 800	14 100	7500	2052	14 163	82 349	77 103	62 996	61 613	1 023 565
11. Korea, Republic of	11 500	10 900	16 300	18 029	15 721	15 394	11 131	11 961	12 567	830 862
12. Sri Lanka	500	8100	12 500	14 170	15 263	23 890	24 110	25 340	21 290	787 766
13. USA	2613	2795	1700	11 221	34 576	30 935	22 072	24 076	35 372	750 990
14. Peru	1300	7200	19 000	13 277	12 266	15 405	11 870	16 633	8613	643 689
15. Malaysia	2500	3000	6600	10 855	17 360	24 521	25 209	24 167	27 948	619 672
16. USSR		100	26 376	12 648						588 017
17. Thailand	2000	4300	11 400	9456	10 950	24 689	24 278	30 208	24 724	580 727
18. Nigeria	1300	2000	8300	21 476	8402	13 238	14 626	13 449	15 179	457 656
19. New Zealand	1000	2000	2600	6590	10 108	17 718	19 796	21 238	18 459	383 979
20. Portugal	3100	2200	1900	4095	26 563	12 783	13 854	14 016	16 999	380 556
TOTAL	241 113	296 335	403 583	486 659	541 834	660 029	622 435	617 357	627 306	

Source: *Capture production 1950-2003*. FAO Fisheries Department 2000

TABLE 1

World captures of chondrichthyan fishes, 2000–2011

Country	2000	2001
Indonesia	113 626	110 311
India	76 057	67 971
Spain	80 357	69 986
Taiwan Province of China	45 923	42 355
Argentina	25 750	31 784
Mexico	35 260	32 718
United States of America	30 935	22 072
Pakistan	51 170	49 863
Malaysia	24 521	25 209
Japan	31 873	27 696
Brazil	21 585	20 408
France	24 952	25 799
Thailand	24 689	24 278
New Zealand	17 718	19 796
Sri Lanka	34 380	29 400
Portugal	12 783	13 855
Nigeria	13 238	14 626
Iran (Islamic Republic of)	12 155	11 635
Republic of Korea	15 394	14 011
United Kingdom	17 389	19 346
Peru	15 405	11 870
Canada	12 899	13 718
Yemen	5 000	7 100
Australia	7 543	9 238
Senegal	10 757	10 058
Venezuela (Bolivarian Republic of)	5 491	4 718
Libya	-	-
Costa Rica	12 901	9 659
Madagascar	5 736	5 735
Oman	3 891	3 830
Philippines	4 319	5 303
Morocco	[illegible]	[illegible]
Chile	5 751	5 636
Maldives	13 523	11 935

2011	AVERAGE	%	Rank
103 245	106 034	0.13	1
73 572	73 842	0.09	2
89 212	61 293	0.08	3
43 073	43 869	0.05	4
36 065	35 983	0.04	5
31 589	33 815	0.04	6
39 331	32 483	0.04	7
11 752	27 222	0.03	8
18 995	23 412	0.03	9
10 238	21 914	0.03	10
25 960	20 992	0.03	11
16 363	20 861	0.03	12
8 220	18 532	0.02	13
16 171	17 749	0.02	14
6 455	16 613	0.02	15
19 084	16 592	0.02	16
18 491	15 574	0.02	17
12 032	13 750	0.02	18
14 126	12 399	0.02	19
5 435	11 294	0.01	20
10 641	10 002	0.01	21
5 235	9 732	0.01	22
9 548	9 528	0.01	23
6 737	9 017	0.01	24
5 525	8 428	0.01	25

GENERAL OVERVIEW OF SHARKS AND RAYS FISHERIES IN CAMBODIA

1. 435 km coastlines in the Gulf of Thailand, stretched between Vietnamese borders in the south to Thai border in the west.
2. Four provinces located along these coastlines namely, Koh Kong (237 Km), Preah Sihanouk (105 Km), Kampot (67 Km) and Kep (26 Km).
3. Using EU-CITES budget SEAFDEC supported Sharks/Rays data collection and data analysis for one yearfrom September 2015 to August 2016 and in 2018-2019

Source: Sambo and Seyha, 2018

Landings of Shark and Ray by Species at Sihanoukville Landing Site (Jetty 66) from 2015- 2016

	2015				2016								Total
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
Ray	178.46	215,47	528.45	482,00	612.00	963,00	577,00	370.00	367,00	361,00	388,00	332,00	5374,38
Aetobatus ocellatus	41,05		48,38					73,45		14,16	40,70	21,66	239,40
Dasyatis parvonigra	15,01	26,20	99,35	81,64	97,67	286,42	160,09	21,95	44,34	28,69		51,39	912,76
Dasyatis zugei	48,84	33,99	119,63	100,77	191,14	80,14	99,71	106,79	142,23	68,44	18,04	49,23	1058,96
Himantura imbricata	20,30	74,91	149,69	91,97	117,22	353,19	207,21	59,57	41,98	14,50	63,28	53,70	1247,51
Himantura walga	53,26	78,67	111,40	207,62	205,96	243,26	109,99	108,24	138,44	235,22	265,98	142,71	1900,75
Taeniura lymma		1,70										13,30	15,00
Shark	164.06	301,75	647.00	1146,00	841.62	1309,00	934,00	704.00	621.00	714,54	559,46	585,00	8527,43
Atelomycterus marmoratus	14,76	17,92	75,65	62,65	281,12	137,08	136,92	2,41	15,08	31,13	16,99	87,07	878,77
Carcharhinus leucas	3,40							23,10	15,68			23,46	65,64
Carcharhinus melanopterus								31,00				32,64	63,64
Carcharhinus sorrah									52,20	66,87	28,71	89,44	237,22
Chiloscyllium punctatum	145,90	283,83	571,35	1083,35	560,50	1171,92	797,08	647,49	538,04	616,55	513,77	352,39	7282,17
Grand Total	342.52	517.22	1175.45	1628.00	1453.62	2272.00	1511.00	1074.00	988.00	1075.54	947.46	917.00	13901.81

Source: Sambo and Seyha, 2018

Landings of shark and ray by gear at at Sihanoukville Landing Site (Jetty 66) from 2015-2016

Type of Gear	2015				2016								Grand Total
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
Trawl Net Comercial Scale	60	72.3	453.4	444	536	720	267	335	285	271	305	196	3944.7
Trawl Net Midium Scale	74.3	96.7				71	266	16	24	26	83	123	780
Trawl Net Small Scale	43.8	46.5	75	38	76	172	44	19	58	64		13	649.3
Total catch ray	**178.1**	**215.5**	**528.4**	**482**	**612**	**963**	**577**	**370**	**367**	**361**	**388**	**332**	**5374**
Trawl Net Comercial Scale	14.8	56.4	590	1108	743.3	1048.1	426	605	556	544.5	486.5	355	6533.6
Trawl Net Midium Scale	124.2	209.1				173	442	99	43	43	73	180	1386.3
Trawl Net Small Scale	25	36.2	57	38	98.3	87.9	66		22	127		50	607.5
Total catch shark	**164.1**	**301.8**	**647**	**1146**	**841.6**	**1309**	**934**	**704**	**621**	**714.5**	**559.5**	**585**	**8527**
Grand total	**342.2**	**517.2**	**1175.4**	**1628**	**1454**	**2272**	**1511**	**1074**	**988**	**1075.5**	**947.5**	**917**	**13902**

Source: Sambo and Seyha, 2018

List of 10 Most Common Sharks and 10 Rays Species at Sihanoukville Landing Site (Jetty 66) from 2015-2016

	2015				2016								Total
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
Ray	178.46	215.47	528.45	482.00	612.00	963.00	577.00	370.00	367.00	361.00	388.00	332.00	5374.38
Aetobatus ocellatus	41.05		48.38					73.45		14.16	40.70	21.66	239.40
Dasyatis parvonigra	15.01	26.20	99.35	81.64	97.67	286.42	160.09	21.95	44.34	28.69		51.39	912.76
Dasyatis zugei	48.84	33.99	119.63	100.77	191.14	80.14	99.71	106.79	142.23	68.44	18.04	49.23	1058.96
Himantura imbricata	20.30	74.91	149.69	91.97	117.22	353.19	207.21	59.57	41.98	14.50	63.28	53.70	1247.51
Himantura walga	53.26	78.67	111.40	207.62	205.96	243.26	109.99	108.24	138.44	235.22	265.98	142.71	1900.75
Taeniura lymma		1.70										13.30	15.00
Shark	164.06	301.75	647.00	1146.00	841.62	1309.00	934.00	704.00	621.00	714.54	559.46	585.00	8527.43
Atelomycterus marmoratus	14.76	17.92	75.65	62.65	281.12	137.08	136.92	2.41	15.08	31.13	16.99	87.07	878.77
Carcharhinus leucas	3.40							23.10	15.68			23.46	65.64
Carcharhinus melanopterus								31.00				32.64	63.64
Carcharhinus sorrah									52.20	66.87	28.71	89.44	237.22
Chiloscyllium punctatum	145.90	283.83	571.35	1083.35	560.50	1171.92	797.08	647.49	538.04	616.55	513.77	352.39	7282.17
Grand Total	342.52	517.22	1175.45	1628.00	1453.62	2272.00	1511.00	1074.00	988.00	1075.54	947.46	917.00	13901.81

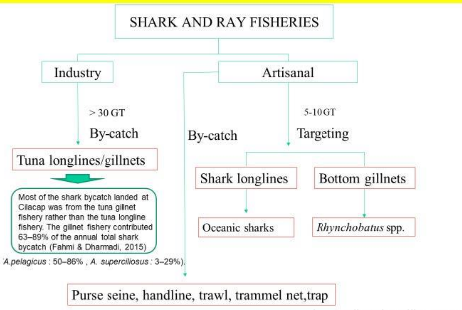
Source: Sambo and Seyha, 2018

Landings of Shark and Ray by Species at Study Site Sihanoukville Landing Site (Jetty 66) from 2017-2018

	2017	2018
Ray	**566.05**	**820.51**
Aetobatus flagellum		76.34
Aetobatus ocellatus		15.71
Brevitrygon heterura	84.44	167.8
Brevitrygon imbricata	211.37	232.35
Hemitrygon akajei	58.97	7.95
Himantura uarnak		
Maculabatis gerrardi	9.09	9.61
Narcine lingula	0.3	40.85
Narcine maculata		21.09
Neotrygon cf varidens	18.65	42.2
Rhinoptera javanica		27.48
Rhynchobatus australiae		
Taeniura lymma	22	34.79
Telatrygon zugei	161.23	144.34
Shark	**961.76**	**1135.68**
Atelomycterus marmoratus	87.69	167.59
Carcharhinus leucas		41.6
Carcharhinus melanopterus		8.1
Chiloscyllium punctatum	874.07	918.39
	961.76	1135.68

Source: Sambo and Seyha, 2018

GENERAL OVERVIEW OF SHARKS AND RAYS FISHERIES IN INDONESIA



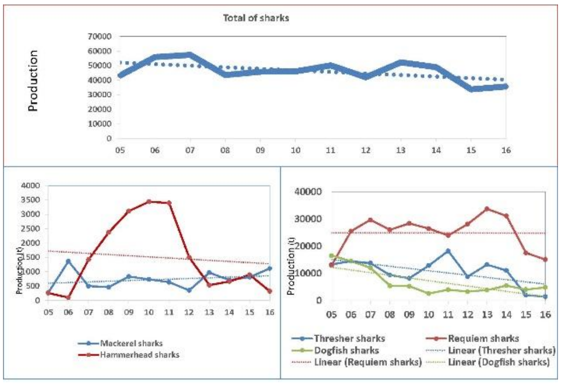
Source: Dharmadi and Andika, 2018

Main landing sites of shark and ray in Indonesia

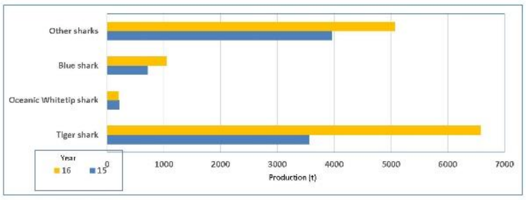
LOCATION	FISHING GEAR TYPE	REMARKS
JAVA		
Cilacap (Central Java)	Shark LL, Tuna LL	Targeted & Bycatch
Muncar (East Java)	Shark LL,	Targeted
Perigi (East Java)	Shark LL	Targeted
Muara Angke (Jakarta)	Bottom GN	Targeted
Cirebon (West Java)	Bottom GN	Targeted
Palabuhanratu (West Java)	Tuna LL	
BALI		
Benoa	Tuna LL	Bycath
SUMATERA		
Sibolga	Shark LL	Bycatch
Lampulo	Shark LL	Targeted
KALIMANTAN		
Pontianak	Bottom LL	Targeted
SULAWESI		
Paotere-Makasar	Longline, Gillnet,	Target & Bycatch
P.Ambo-Sul.Bar	Shark LL	Targeted
NTB		
Tanjungluar	Shark LL (Bottom, Surface LL)	Targeted
NTT		
Kupang	Shark LL (Bottom, Surface LL)	Targeted
Osi	Shark LL	Targeted
Dobo	Shark LL	Targeted
Papela	Shark LL	Targeted

Jaiteh et al., 2016

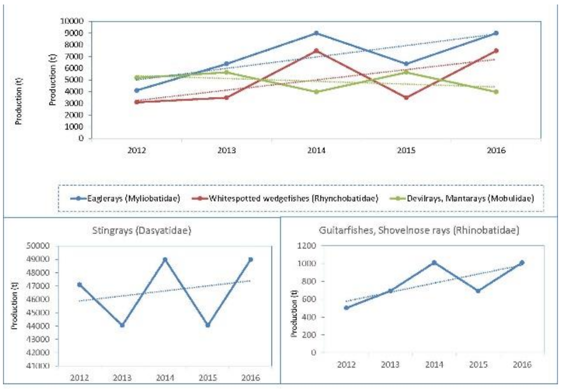
Source: Dharmadi and Andika, 2018



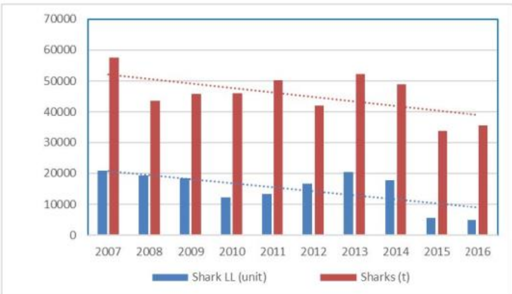
Sharks landing in Indonesia Source: Dharmadi and Andika, 2018 (DGCF, 2017)



Source: Dharmadi and Andika, 2018



Rays landing in Indonesia Source: Dharmadi and Andika, 2018 (DGCF, 2017)

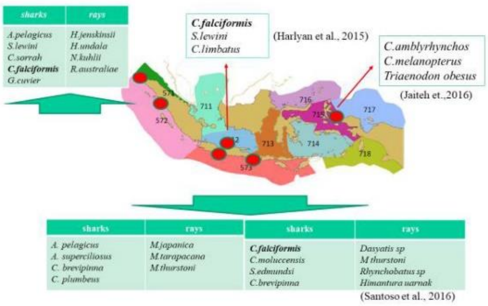


Source: Dharmadi and Andika, 2018

List of 10 Most Common Sharks and 10 Rays Species

No	Sharks	No	Rays
	Carcharhinidae :		**Dasyatidae :**
1	*Carcharhinus falciformis*	1	*Neotrygon orientalis*
2	*Carcharhinus brevipinna*	2	*Pateobatis jenkinsii (H.jenkinsii)*
3	*Galeocerdo cuvier*	3	*Dasyatis ushiei*
4	*Prionace glauca*	4	*Himantura uarnak*
	Alopiidae :	5	*Himantura undulata*
5	*Alopias pelagicus*	6	*Taeniurops meyeni*
6	*A;opias superciliosus*		**Mobulidae :**
	Sphyrnidae :	7	*Mobula japanica*
7	*Sphyrna lewini*	8	*Mobula thurstoni*
	Centrophoridae :		**Rhynchobatidae :**
8	*Centrophorus moluccensis*	9	*Rhynchobatus australiae*
	Squalidae :	10	*Rhynchobatus springeri*
9	*Squalus edmundsi*		
	Triakidae :		
10	*Mustelus manazo*		

Source: Dharmadi and Andika, 2018



Dominant species of sharks & rays

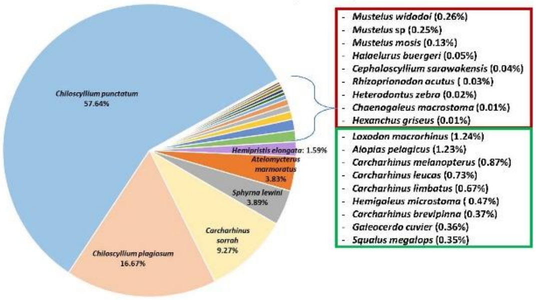
Source: Dharmadi and Andika, 2018

GENERAL OVERVIEW OF SHARKS AND RAYS FISHERIES IN MALAYSIA

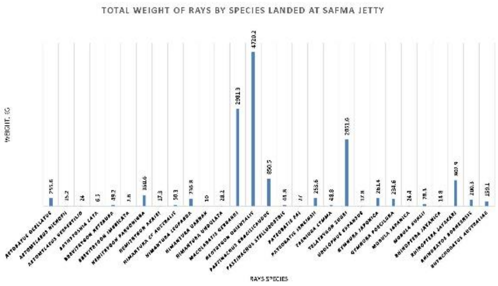
- The fishing area for marine capture fisheries covers a total of 547,200 km^2. Malaysian marine capture fisheries are categorized into coastal and deep-sea fisheries.
- In 2017, coastal fisheries contributed 1,170,270 tonnes (79.9%) while deep-sea fisheries contributed 294,842 tonnes (20.1%) to the total marine landings.
- Sharks and rays, that constitute part of the demersal fishery landings, are caught in Malaysian waters from the coast to the edge of the EEZ. The landings from 2008 - 2017 contributed between 1.2 – 1.7 %, with an average of 1.5%, of the total marine landings.
- Sharks are not targeted by fishers but are caught together with other commercially important species. They are brought back whole to the port.

Source: Abdul Haris *et al* 2018

Total Weight of Sharks by Species at Kota Kinabalu (2017)

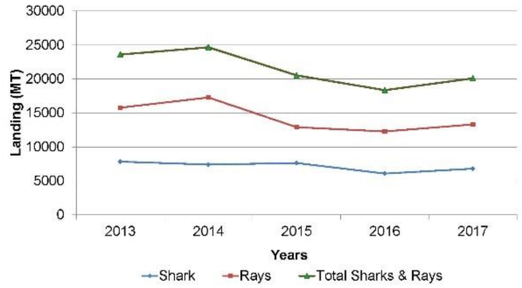


Total Weight of Rays by Species at Kota Kinabalau (2017)



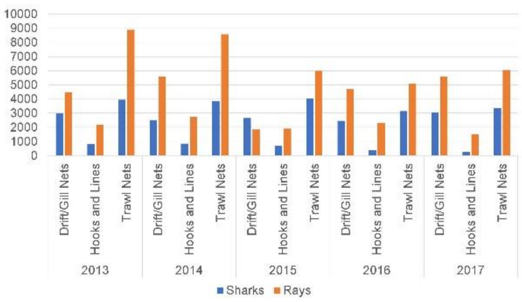
Source: Abdul Haris *et al* 2018

Shark and Ray landings
Landing trend in tonnes (2013- 2017)



Average catches of sharks and rays in marine total landing is 1.4 %
(Ranged between 1.2 % – 1.7 %)

Landings of sharks and rays by gears (2013-2017)



Data source: Annual Fisheries Statistics, 2013-2017

Source: Abdul Haris *et al* 2018

List of 10 Most Common Sharks and 10 Rays Species at Four Different Locations

Sharks Species

No	Larut Matang	Manjung Utara	Kota Kinabalu	Sandakan
1	*Chiloscyllium hasseltii*	*Chiloscyllium hasseltii*	*Chiloscyllium punctatum*	*Chiloscyllium punctatum*
2	*Chiloscyllium punctatum*	*Chiloscyllium punctatum*	*Chiloscyllium plagiosum*	*Carcharhinus sorrah*
3	*Atelomycterus marmoratus*	*Atelomycterus marmoratus*	*Atelomycterus marmoratus*	*Chiloscyllium plagiosum*
4	*Carcharhinus sorrah*	*Carcharhinus sorrah*	*Carcharhinus sorrah*	*Atelomycterus marmoratus*
5	*Atelomycterus cf erdmanni*	*Chiloscyllium indicum*	*Sphyrna lewini*	*Rhizoprionodon acutus*
6	*Atelomycterus cf baliensis*	*Stegostoma fasciatum*	*Hemipristis elongata*	*Hemigaleus microstoma*
7	*Chiloscyllium indicum*		*Loxodon macrorhinus*	*Sphyrna lewini*
8	*Carcharhinus brevipinna*		*Mustelus manazo*	*Carcharhinus sealei*
9	*Carcharhinus leucas*		*Carcharhinus brevipinna*	*Hemipristis elongata*
10	*Chiloscyllium cf hasseltii*		*Heterodontus zebra*	*Stegostoma fasciatum*

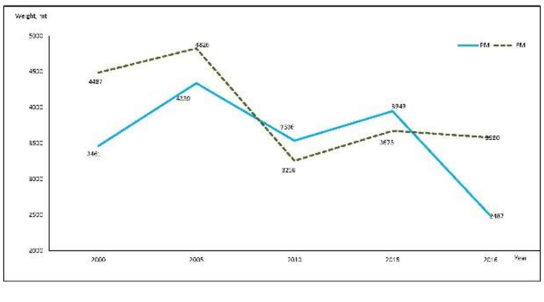
Rays Species

No	Larut Matang	Manjung Utara	Kota Kinabalu	Sandakan
1	*Neotrygon orientalis*	*Brevitrygon heterura*	*Neotrygon orientalis*	*Neotrygon orientalis*
2	*Maculabatis gerrardi*	*Maculabatis gerrardi*	*Maculabatis gerrardi*	*Maculabatis gerrardi*
3	*Brevitrygon heterura*	*Neotrygon orientalis*	*Telatrygon zugei*	*Taeniura lymma*
4	*Telatrygon zugei*	*Telatrygon zugei*	*Rhinobatos borneensis*	*Telatrygon zugei*
5	*Rhynchobatus australiae*	*Maculabatis pastinacoides*	*Rhynchobatus australiae*	*Pateobatis fai*
6	*Hemitrygon akajei*	*Gymnura poecilura*	*Gymnura poecilura*	*Pateobatis uarnacoides*
7	*Maculabatis pastinacoides*	*Hemitrygon fluviorum*	*Hemitrygon parvonigra*	*Rhynchobatus australiae*
8	*Narcine sp*	*Rhynchobatus australiae*	*Pastinachus gracilicaudus*	*Pateobatis jenkinsii*
9	*Pateobatis jenkinsii*	*Pateobatis fai*	*Gymnura japonica*	*Himantura leoparda*
10	*Rhinobatos cf borneensis*	*Pateobatis uarnacoides*	*Pateobatis jenkinsii*	*Himantura uarnak*

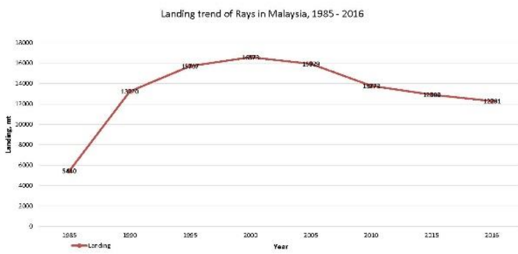
Data source: Data Collection Project 2015-2016 under EU-CITES

Source: Abdul Haris *et al* 2018

HISTORICAL LANDING TREND OF SHARKS IN MALAYSIA FROM 2000 TO 2016



Historical Landing Trend of Rays in Malaysia 1985-2016



GENERAL OVERVIEW OF SHARKS AND RAYS FISHERIES IN MYANMAR

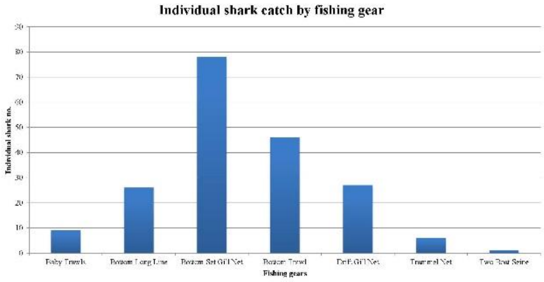
1. Marine fishing industries are offshore and inshore.
2. Most of the shark landing are by-catch.
3. Most shark species were caught by several type of gears such as bottom trawl, drift gillnet and bottom long line.
4. Many fishers are small scale, using wooden boats with engine not more than 25 horse power.
5. No fishing license targeted for catching shark fishing.

Source: Soe Win , 2018

Results (Market and Landing Survey)

WCS

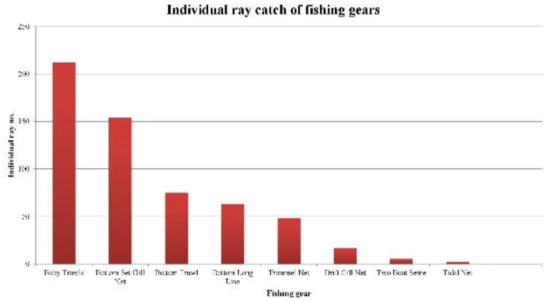
- The most individual shark catch fishing gear was bottom set gill net and the rest were bottom trawl and drift gill net and bottom long line.



Results (Market and Landing Survey)

WCS

- The most individual ray catch fishing gear was baby trawl and the rest were bottom set gill net, bottom trawl and bottom long line.



Data and Informaton Collection

Information Gathering on Shark and Ray Fisheries(2015-2016)

Data Collection Site

Yangon Region
(Yangon)
9 - Times (22 – Species)Shark
(40-species) Ray
(2-Species)Skate

Mon State
(Mawlamyine)
9 - Times (6 – Species)Shark
(11-species)Ray

Source: Soe Win , 2018

Current Activities and Initiative on Recording Landings Data at Species Level(2015-16)

Source: Soe Win , 2018

Sharks: 20 Species under 4 Families

Rays: 41 Species under 12 Families

Skates: 2 Species under 1 Families

No	Region/ State	Sharks Weight kg	%	Rays Weight kg	%	Total	Fishing Gear
1.	Yangon	8427.93	76.18	2635.42	23.82	11063.35	Trawl, GSBN
2.	Mawlamyine	444.09	49.57	451.73	50.43	895.82	Longlines, Gill net
Total		8872.02		3087.15		11959.17	Trawl, GSBN

Survey Sites in Rakhine Coastal Area (2017-2018)

Source: Soe Win , 2018

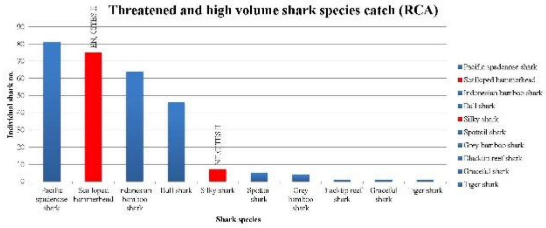
- Gwa
- Kyeintali
- Thandwe
- Manaung
- Kyaukphyu
- Sittway

Result(Current Activities Landing Survey) Inshore

- 77shark species (including Critically Endangered (2), Endangered (3) and Vulnerable (11)

Shark

- 286 of individual sharks were recorded.
- 13 species of shark (5 family) (including Sanpya Fish market survey)
- 1 EN, 3 CITES appendix II (S.lewini.R.typus,C.falciformes)

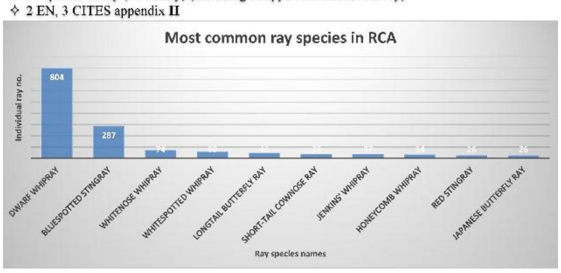


Results (Current Activities Landing Survey)

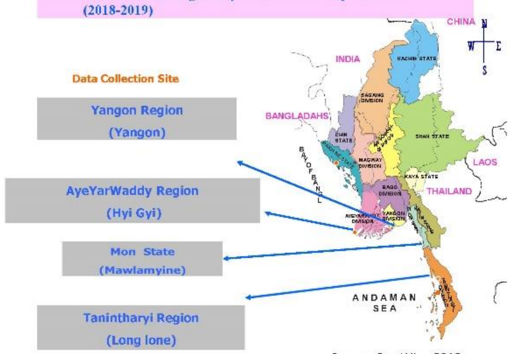
- 84 ray species (including Critically Endangered (3), Endangered (7) and Vulnerable (24)

Ray

- 1594 of individual rays were recorded.
- 37 species of ray (10 family) (including Sanpya Fish market survey)
- 2 EN, 3 CITES appendix II



Current Activies landing survey on Shark and Ray Fisheries (2018-2019)



Source: Soe Win , 2018

Myeik Landing Site

Myeik Landing Site

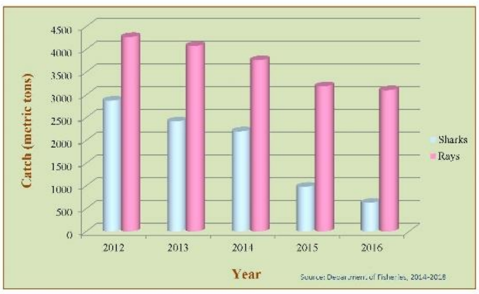
THAILAND

- Sharks and rays are caught as by-catch
- Annual landings less than 0.5% of total marine fishes
- Mostly catch from trawls (otter-board and paired trawls)
- Trend of shark and ray landings slightly decrease

Source: Somchai and Tassapon, 2018

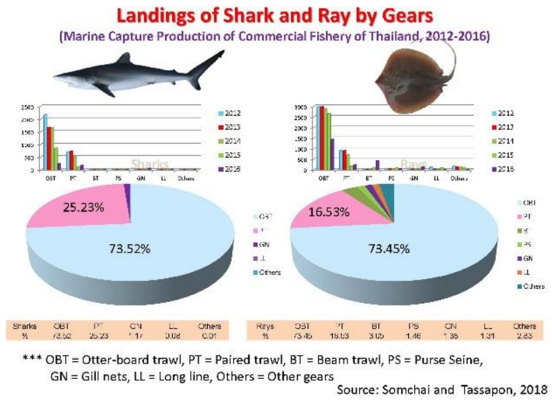
Shark and Ray Landings

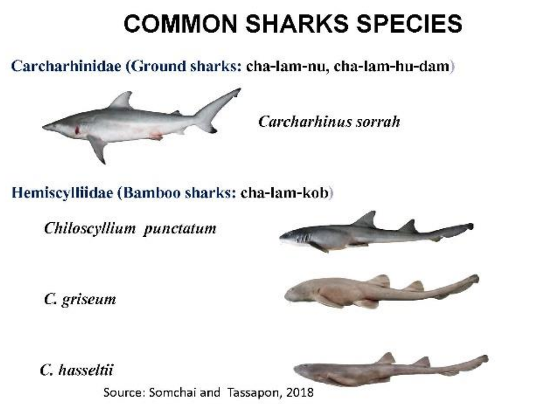
(Annual Fisheries Statistics of Thailand, 2012-2016)

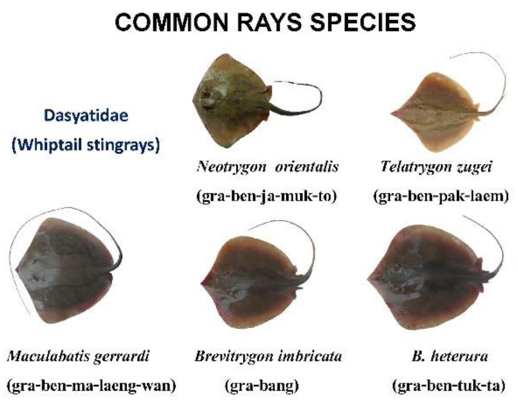


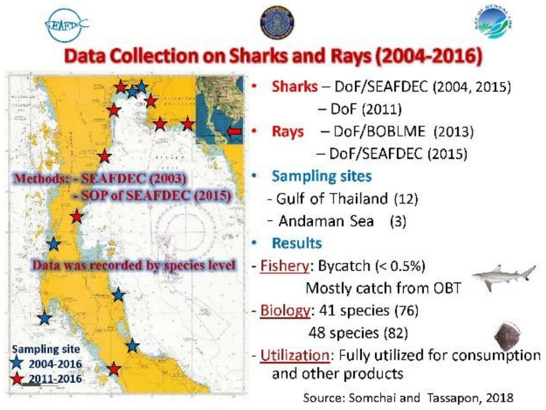
Gulf of Thailand = 83 %, Andaman Sea = 17%

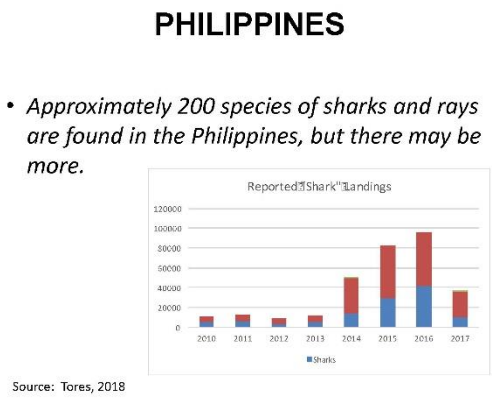
Source: Somchai and Tassapon, 2018

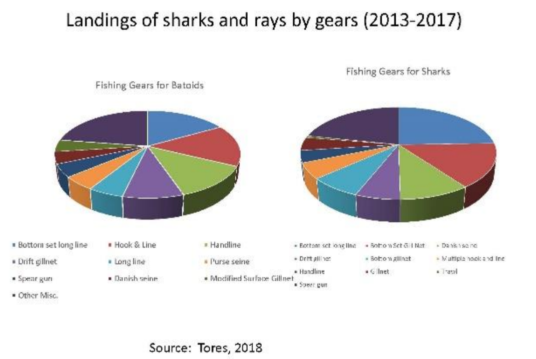

Landings of Shark and Ray by Gears
(Marine Capture Production of Commercial Fishery of Thailand, 2012-2016)
25.23%
73.52%
16.53%
73.45%
*** OBT = Otter-board trawl, PT = Paired trawl, BT = Beam trawl, PS = Purse Seine,
GN = Gill nets, LL = Long line, Others = Other gears
Source: Somchai and Tassapon, 2018

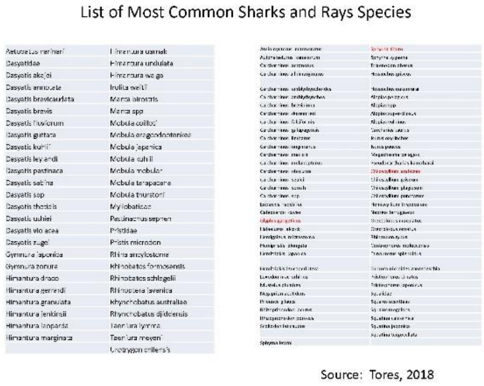

COMMON SHARKS SPECIES
Carcharhinidae (Ground sharks: cha-lam-nu, cha-lam-hu-dam)
Carcharhinus sorrah
Hemiscylliidae (Bamboo sharks: cha-lam-kob)
Chiloscyllium punctatum
C. griseum
C. hasseltii
Source: Somchai and Tassapon, 2018

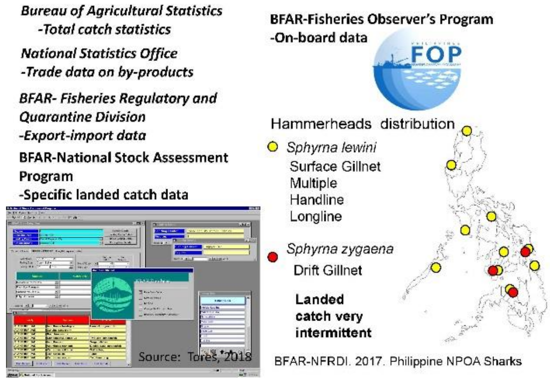

COMMON RAYS SPECIES
Dasyatidae
(Whiptail stingrays)
Neotrygon orientalis
(gra-ben-ja-muk-to)
Telatrygon zugei
(gra-ben-pak-laem)
Maculabatis gerrardi
(gra-ben-ma-laeng-wan)
Brevitrygon imbricata
(gra-bang)
B. heterura
(gra-ben-tuk-ta)


Data Collection on Sharks and Rays (2004-2016)
Methods: - SEAFDEC (2003)
- SOP of SEAFDEC (2015)
Data was recorded by species level
Sampling site
2004-2016
2011-2016
Sharks – DoF/SEAFDEC (2004, 2015)
– DoF (2011)
Rays – DoF/BOBLME (2013)
– DoF/SEAFDEC (2015)
Sampling sites
- Gulf of Thailand (12)
- Andaman Sea (3)
Results
- Fishery: Bycatch (< 0.5%)
Mostly catch from OBT
- Biology: 41 species (76)
48 species (82)
- Utilization: Fully utilized for consumption and other products
Source: Somchai and Tassapon, 2018


PHILIPPINES
Approximately 200 species of sharks and rays are found in the Philippines, but there may be more.
Sharks
Source: Tores, 2018


Landings of sharks and rays by gears (2013-2017)
Fishing Gears for Batoids
Fishing Gears for Sharks
Bottom set long line
Hook & Line
Handline
Drift gillnet
Long line
Purse seine
Spear gun
Danish seine
Modified Surface Gillnet
Other Misc.
Source: Tores, 2018


List of Most Common Sharks and Rays Species
Dasyatidae
Dasyatis akajei
Dasyatis brevicaudata
Dasyatis brevis
Dasyatis guttata
Dasyatis kuhlii
Dasyatis pastinaca
Dasyatis spp
Dasyatis ushiei
Dasyatis zugei
Gymnura japonica
Gymnura zonura
Himantura draco
Himantura granulata
Himantura jenkinsii
Himantura marginata
Himantura undulata
Manta birostris
Manta spp
Mobula japanica
Mobula kuhlii
Mobula tarapacana
Pastinachus sephen
Pristidae
Pristis microdon
Rhina ancylostoma
Rhinobatos schlegelii
Rhinoptera javanica
Rhynchobatus australiae
Rhynchobatus djiddensis
Taeniura lymma
Taeniura meyeni
Source: Tores, 2018


Current Activities and Initiative on Recording Landings Data at Species Level
Bureau of Agricultural Statistics
-Total catch statistics
National Statistics Office
-Trade data on by-products
BFAR- Fisheries Regulatory and Quarantine Division
-Export-import data
BFAR-National Stock Assessment Program
-Specific landed catch data
BFAR-Fisheries Observer's Program
-On-board data
FOP
Hammerheads distribution
Sphyrna lewini
Surface Gillnet
Multiple
Handline
Longline
Sphyrna zygaena
Drift Gillnet
Landed catch very intermittent
Source: Tores, 2018
BFAR-NFRDI. 2017. Philippine NPOA Sharks

GENERAL OVERVIEW OF SHARKS AND RAYS FISHERIES IN VIETNAM

Shark and ray fishery was developed strongly in Vietnam from the end of 80's to 90's. Shark and ray fishery is being developed in the central provinces. Fishing boat used popularly has hull length of 14-17m with engine of 45-60 hp. Season for shark catching lasts from January to September. The highest catch of shark can be reached from March to June.

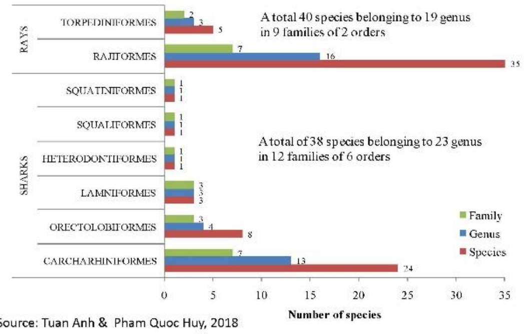
In Vietnam, research about the shark and ray is still limited, species' basic information have not been collected into major reports. Its stop at the lists of species in the topics synthesis and different projects. Therefore, collection of data on sharks and ray in Vietnam are scattered and incomplete data.

Source: Tuan Anh & Pham Quoc Huy, 2018

From 2015 – 2017, data collection shark and rays in 2 landing sites (Binh Thuan and Vung Tau) supported by SEAFDEC.

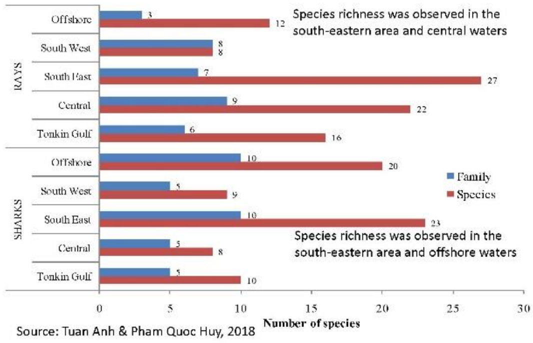
Source: Tuan Anh & Pham Quoc Huy, 2018

Composition of sharks and rays species in Vietnam



Source: Tuan Anh & Pham Quoc Huy, 2018

Distribution of Sharks and Rays Species in Vietnam



Source: Tuan Anh & Pham Quoc Huy, 2018

Data collection from 2015 - 2017

	Binh Thuan (Species)	Vung Tau (Species)
Shark	12	24
Rays	29	25
Skates	3	3
Total	**44 species**	**52**

Source: Tuan Anh & Pham Quoc Huy, 2018

Shark and ray landings

- Landing trend in tones (2010- 2015)

1. Trawl and Gill nets:

: average catch: 1kg/h.

: catch composition less than 1% of the total catches in each trip.

2. Long line fishery:

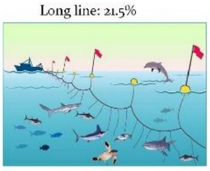
: average catch: 3-41kg/1000 hooks.

: catch composition 15-36 % of the total catch in each trip.

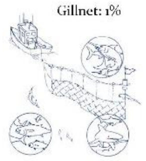
Source: Tuan Anh & Pham Quoc Huy, 2018

Landings of Sharks and Rays by Gears (2008-2012)

Long line: 21.5%



Gillnet: 1%



Trawl: 0.72%

Source: Tuan Anh & Pham Quoc Huy, 2018

Landings of sharks and rays by gears (2010 - 2015)

Gear	Sharks			Rays		
	% catch	CPUE	Standing biomass (ton)	% catch	CPUE	Standing biomass (ton)
Bottom trawl (i)	0.3-1.3	0.2-1.1	7,702	2.2-5.2	1.1-5.4	36,960
Gillnet (ii)	0.7-1.6	0.3-0.6	15,375	8.0-9.0	3.2-3.9	64,500
Longlines (iii)	19.5-24.6	1.5-1.9	-	10.2-12.9	0.6-0.7	-
Total			**23,077**			**101,460**

CPUE: (i) - kg/hour; (ii) - kg/km net; (iii) - kg/100 hooks

Source: Tuan Anh & Pham Quoc Huy, 2018

List of 10 Most Common Sharks and Rays Species in Vietnam

Sharks	Rays
1. *Alopias vulpinus*	1. *Neotrygon orientalis*
2. *Alopias pelagicus*	2. *Hemitrygon akajei*
3. *Carcharhinus sorrah*	3. *Telatrygon zugei*
4. *Sphyrna lewini*	4. *Dasyatis thetidis*
5. *Carcharhinus longimanus*	5. *Brevitrygon imbricata*
6. *Scoliodon laticaudus*	6. *Maculabatis gerrardi*
7. *Heterodontus zebra*	7. *Okamejei cairae*
8. *Chiloscyllium punctatum*	8. *Okamejei hollandi*
9. *Atelomycterus marmoratus*	9. *Brevitrygon heterura*
10. *Isurus oxyrinchus*	10. *Gymnura japonica*

Source: Tuan Anh & Pham Quoc Huy, 2018

Annex 8.

Sensitivity of Yield per Recruit (YPR) Model

Sensitivity of Yield per Recruit (YPR) model

MATSUISHI Takashi Fritz
Faculty of Fisheries Sciences
Hokkaido University

1

Graphical Understanding of YPR model

2

Quick assessment for data poor stock

- Difficult to get age composition
- Short data series
- Intensive data collection

- Utilize current length composition data to the stock assessment

- YPR is a method to assess the growth overfishing.
- Good tool for quick assessment of data poor stock, combining YPR/F, SPR and related methods.

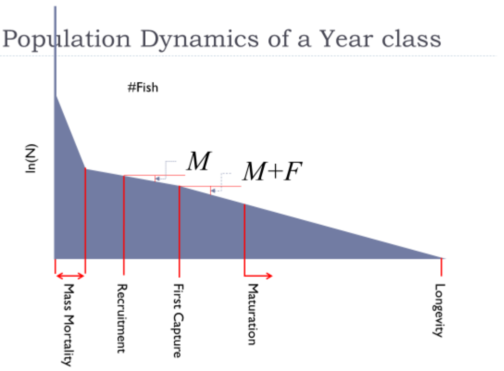
3

Parameters used for YPR

Name	Estimation	Notation	Default Value for this trial
Natural Mortality	Empirical Equations	M	0.2
Fishing Mortality	Age composition (Length composition, Growth Curve or ALK)	F	0.2
Age at Recruitment	Age composition	t_r	1
Age at First Capture	Age composition	t_c	2
Longevity	Maximum age	t_λ	10
vBGC Parameter	GC estimation / L-W relationship	W_∞	1
vBCG Parameter	GC estimation	K	0.3
vBCG Parameter	GC estimation	t_0	0

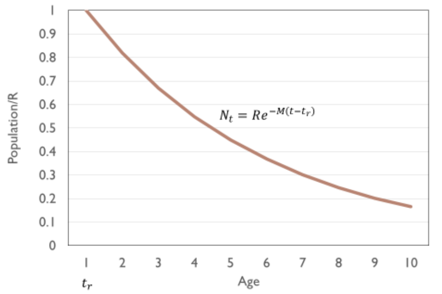
4

Population Dynamics of a Year class



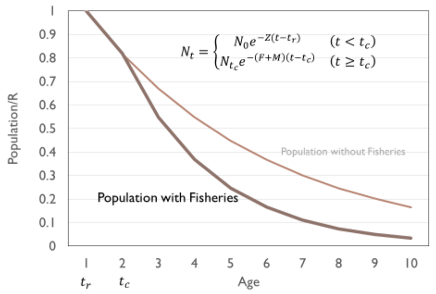
5

Population without Fisheries after recruit



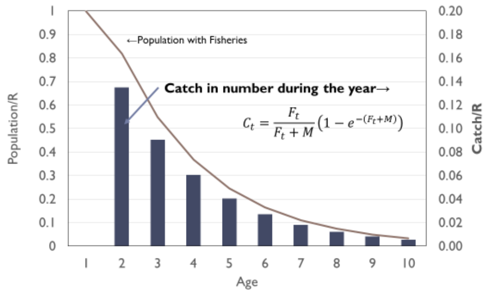
6

Population with Fisheries



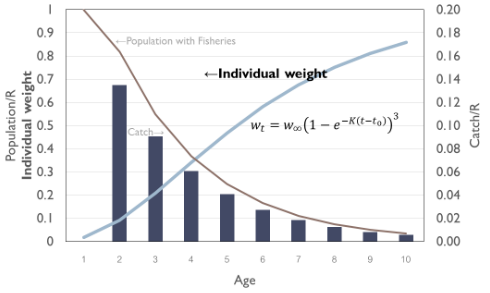
7

Catch in Number



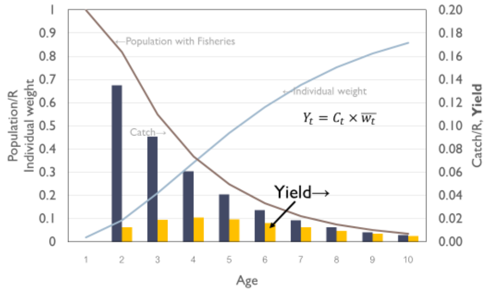
8

Individual weight estimated by vBGC



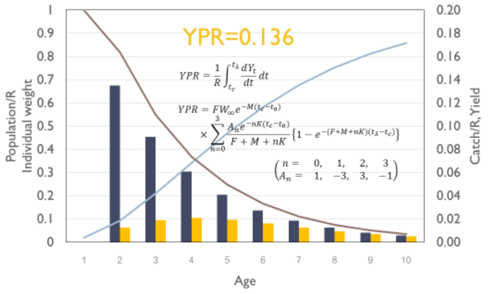
9

Yield in weight



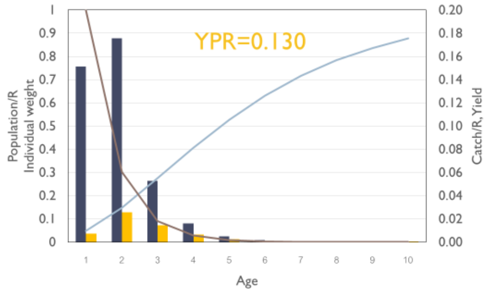
10

Total weight of Yield standardized to recruit



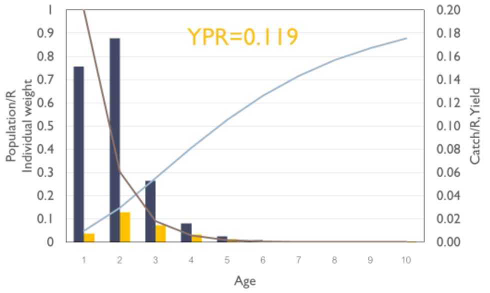
11

Heavy Fisheries ($F = 1.0$)



12

Small fish fisheries ($t_c = 1$)



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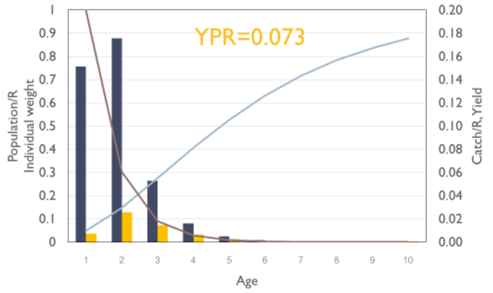
Small and Heavy Fisheries ($F = 1.0, t_r = 1$)



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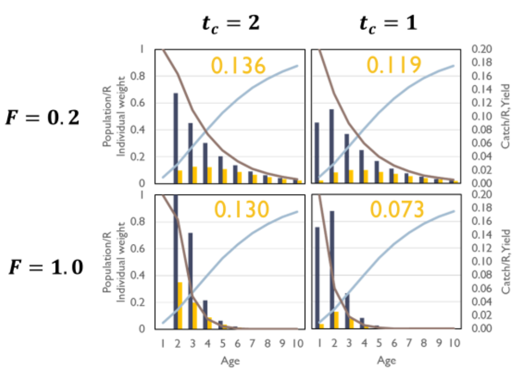

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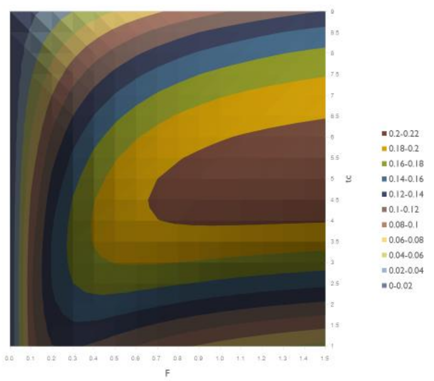

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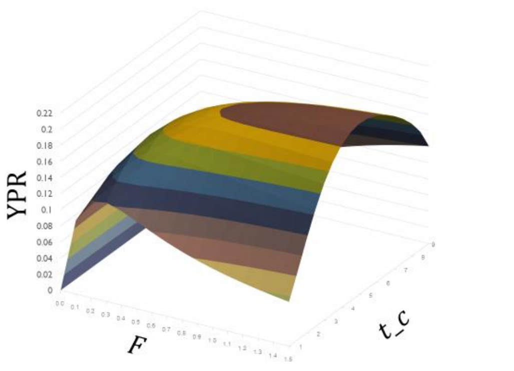

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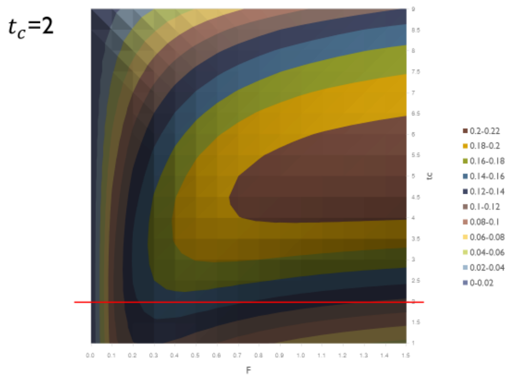

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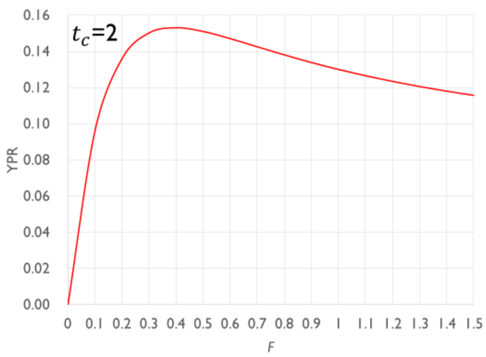

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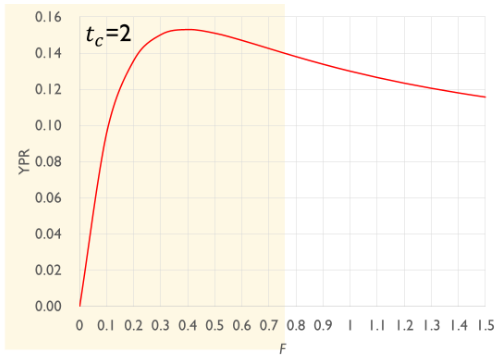

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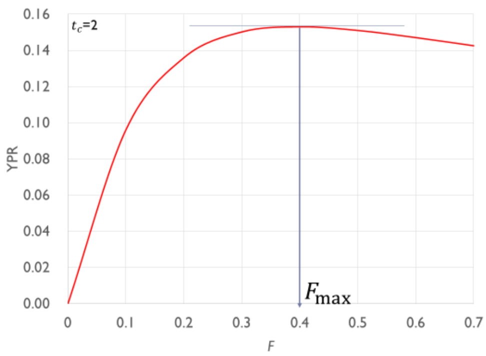

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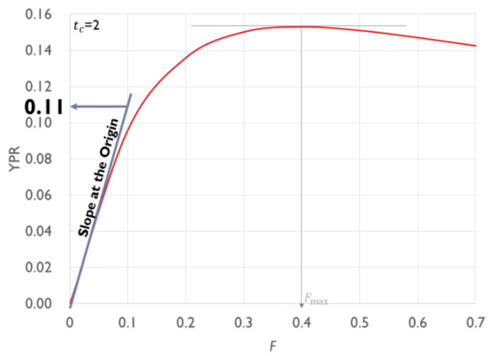

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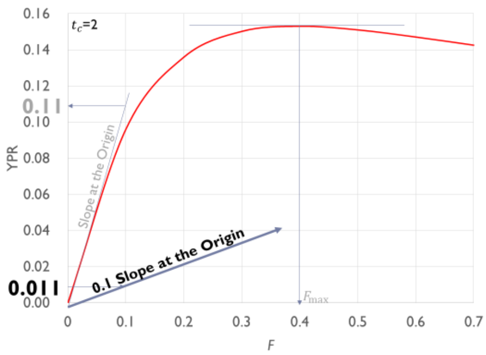

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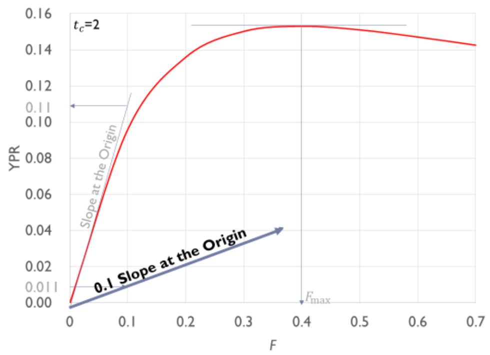

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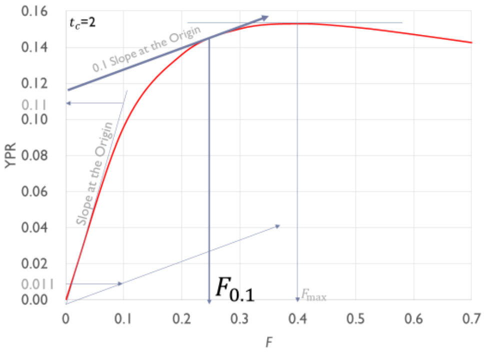

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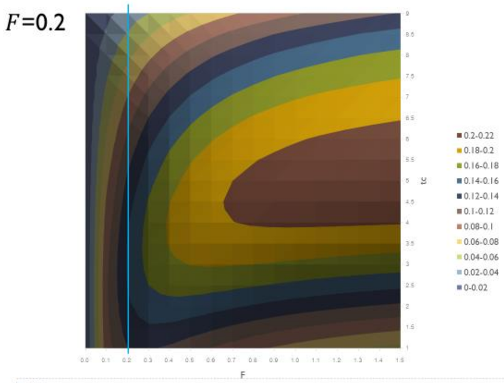

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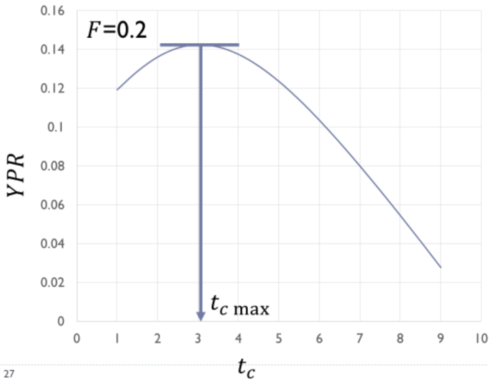

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Sensitivity of Growth Curve Parameter

28

Parameters used for YPR

Name	Estimation	Notation	Default Value for this trial
Natural Mortality	Empirical Equations	M	0.2
Fishing Mortality	Age composition (Length composition, Growth Curve or ALK)	F	0.2
Age at Recruitment	Age composition	t_r	1
Age at First Capture	Age composition	t_c	2
Longevity	Maximum age	t_λ	10
vBGC Parameter	GC estimation / L-W relationship	W_∞	1
vBCG Parameter	GC estimation	K	0.3
vBCG Parameter	GC estimation	t_0	0

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von Bertalanffy growth curve

- von Bertalanffy growth curve (VBGC) is most popular.

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right)$$

- L_t: length at age t
  L_∞: asymptotic average maximum body size
  K : growth rate coefficient
  t_0: hypothetical age which the species has zero length

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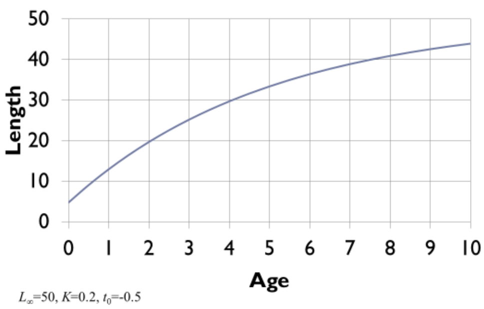
von Bertalanffy Growth Curve



L_∞=50, K=0.2, t_0=-0.5

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Length – Weight relationship

- Usually the relationship between weight and length follow the allometric equation

$$w_t = aL_t^b$$

- w_t: weight at age t
  L_t: length at age t
  a: scaling constant
  b: allometric growth parameter (close to 3)

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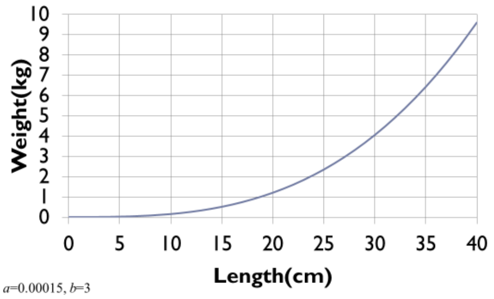
Example



a=0.00015, b=3

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von Bertalanffy growth equation for body weight

- Combined with VBGC and allometric equation
  VBGC for body weight ;

$$w_t = w_\infty\left(1 - e^{-K(t-t_0)}\right)^b$$

- w_t: weight at age t
  w_∞: asymptotic average maximum body weight
  K : growth rate coefficient
  t_0: hypothetical age which the species has zero length
  b: allometric growth parameter (often set to 3)

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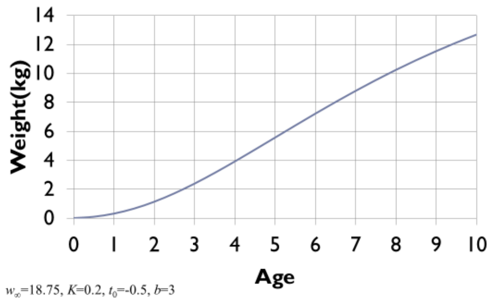
Example of VBGC for body weight



w_∞=18.75, K=0.2, t_0=-0.5, b=3

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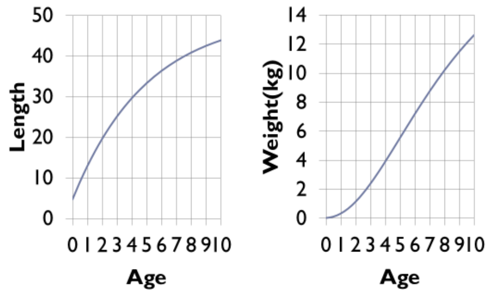
VBGC for Length vs. Weight



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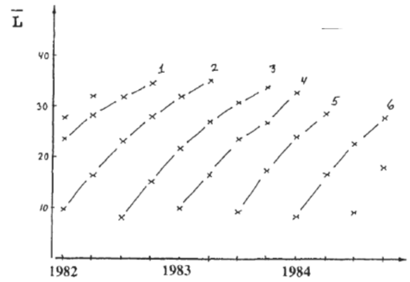
Growth curve estimated from peaks transition



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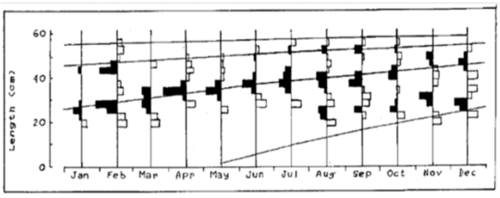
Example



Growth curve of *Tenualosa ilisha* from Bangladesh by ELEFAN I superimposed on the restructured length-frequency diagram (Linf=61.50 cm and K=0.83/yr)

Rahman, M. A., Amin, S. N., Haldar, G. C., & Mazid, M. A. (2000). Population dynamics of *Tenualosa ilisha* of Bangladesh water. Pakistan Journal of Biological Science, 3(4), 564-567.

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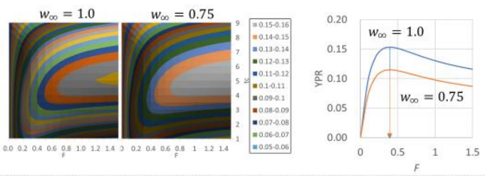
Sensitivity of w_∞

- $$YPR = Fw_\infty e^{-M(t_c-t_0)} \times \sum_{n=0}^{3} \frac{A_n e^{-nK(t_c-t_0)}}{F+M+nK}\left\{1 - e^{-(F+M+nK)(t_\lambda - t_c)}\right\}$$
- Misestimation of w_∞ affect only level of YPR
- F_{max}, $F_{0.1}$ does not affected by the estimation of w_∞



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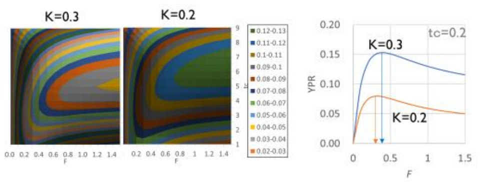
Sensitivity of K

- Misestimation of K affect Fmax and level of YPR



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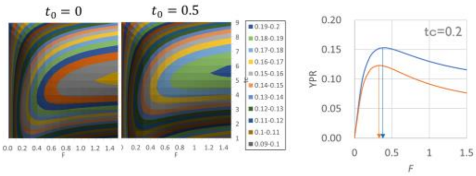
Sensitivity of t_0

- Misestimation of t_0 affect *F*max and level of YPR



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Other effect of GC mis-estimation

Name	Estimation	Notation	Default Value for this trial
Natural Mortality	Empirical Equations	M	0.2
Fishing Mortality	Age composition (Length composition, Growth Curve or ALK)	F	0.2
Age at Recruitment	Age composition	t_r	1
Age at First Capture	Age composition	t_c	2
Longevity	Maximum age	t_λ	10
vBGC Parameter	GC estimation / L-W relationship	w_∞	1
vBCG Parameter	GC estimation	K	0.3
vBCG Parameter	GC estimation	t_0	0

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Other effect (2)

- Natural Mortality
  - $\ln M = -0.0066 - 0.279 \ln L_\infty + 0.6543 \ln K + 0.4634 \ln T$ (Pauly 1980)
  - Overestimation of *K* leads *M* underestimation
- Fishing mortality estimation is affected by the GC if age composition is estimated from GC
  - Overestimation of *K* leads *F* underestimation
- t_r and t_c may be mis-estimated by the mis-estimation of GC

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Conclusion

- To make a reliable YPR analysis, Growth Curve Parameter estimation is very important.
- Growth curve estimation from length frequency is sometimes unreliable.
- Age-determination is very important for YPR analysis.

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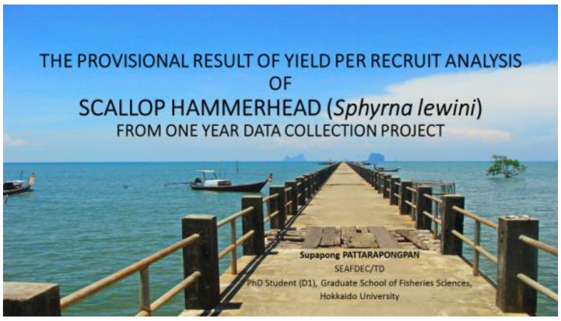
Annex.9

The Provisional Results of YPR Analysis

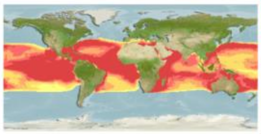


Introduction

- Hammerhead is a shark in family Carcharhinidae
- 2 genera with 10 spp.
- 3 spp. were listed in CITES appendix II and two of them distributed in SEA
  - *Sphyrna lewini*
  - *S. mokarran*
  - *S. zygaena*
- The study of stock status of Hammerhead still limited in SEA

Introduction

- Scallop hammerhead (*Sphyrna lewini*)



Introduction

- Most of study were conducted in Atlantic Ocean
  - Western North Atlantic
  - Gulf of Mexico
- Some from Northeast Pacific

Introduction


Global Phylogeography with Mixed-Marker Analysis Reveals Male-Mediated Dispersal in the Endangered Scalloped Hammerhead Shark (*Sphyrna lewini*)

- "*S. lewini* is a endangered large pelagic shark with wide range distribution. The genetic study show that they sharing the same gene from Western Central Pacific until North Western Atlantic Ocean"
- Coastal line is the key point of genetic dispersion through the reproductive and Juvenile hatchery area

Objectives

- To observe the migratory pattern of scallop hammerhead shark in one year from catch trend
- To observe and comparing the growth parameter of hammerhead in regional level and each area
- To simulate stock status of hammerhead in regional level

Study Site

- 3 major study sites from 2 countries
- Myanmar
  - Yangon
  - Ye (Mawlamyin)
- Indonesia
  - Lampulo

Myanmar
- GN: Gill Net
- SBN: Set Bag Net
- TN: Trawl Net

Indonesia
- BGN: Bottom Gill Net
- HL: Hand Line
- PS: Purse Seine
- SLL: Surface Longline
- BLL: Bottom Longline

Materials and methods

- CPUE standardization using Generalized Linear Model and measuring the appropriate of the model using Akaike's Information Criteria (AIC)
  - Gaussian with Identification Link
  - Gaussian with logarithm link
  - Poisson with logarithm link
- Length – weight relationship
- Biological parameters and Catch selectivity using FiSAT II
- Age determination using von Bertalanffy growth's equation
- Stock status determined using Yield per Recruit Analysis

Materials and Methods

Area\Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
MYA: Ygn	1.04(103)	1.27(112)	1.75(92)	0.16(71)	1.78(27)	1.34(3)	2.67(3)	1.34(15)	8.67(3)	-	0.90(21)	1.2(10)
MYA: Ye	-	-	0.5(2)	-	-	-	-	-	-	-	0.34(3)	0.43(7)
IND: Lpl	-	35(1)	27.5(2)	65(1)	32(1)	40.25(4)	-	53.5(6)	-	-	38.34(3)	29(7)
Sub – Region	1.04(103)	1.57(113)	2.25(96)	2.5(72)	2.82(28)	23.57(7)	2.67(3)	16.24(21)	8.67(3)	-	5(27)	9.13(24)

*average weight (sample size)

Size range:
- Ye (Myanmar): 45 – 80 cm. TL
- Yangon (Myammar): 45 – 137 cm. TL
- Lampulo (Indonesia): 94 – 273 cm. TL

Materials and Methods

- Considering to catch data deficient,
- Longevity (t_λ) will be assumed as 15 years for sub – regional level
- Size at first captured (L_C) and fishing mortality (F) will be simulated
- Natural mortality (Paully, 1980) at surface temperature 29°C was 0.45

Category	L_C	F
Low	66.86	0.3
Medium	133.43	7
High	200	13

*low from the lowest calculation result, high from the highest calculation result and medium from the average between both

Materials and methods

$$L_t = L_\infty\left(1 - e^{-(K(t_L - t_0))}\right)$$

$$t_L = t_0 - \left(\frac{1}{K}\right)\ln\left(1 - \left(\frac{L_t}{L_\infty}\right)\right)$$

L_t = Length at age t (cm.)
L_∞ = Maximum Length (cm.)
K = Growth Rate (/year)
t_L = Age at particular length (Year)
t_0 = Theoretical age at length 0 (Year)

Materials and methods

$$\frac{Y}{R} = FW_\infty e^{-M(t_C - t_r)} \times \sum_{n=0}^{3} \frac{A_n e^{-nK(t_C - t_0)}}{F + M + nK}\left\{1 - e^{-(F+M+nK)(t_\lambda - t_C)}\right\}$$

$$\begin{cases} n = 0, \ 1, \ 2, \ 3 \\ A_n = 1, \ -3, \ 3, \ -1 \end{cases}$$

F Fishing Mortality (/year)
M Natural Mortality (/year)
K Growth Rate (/year)
W_∞ Maximum weight (kg.)
t_C Age at first captured (Year)
t_r Age at recruitment (Year)
t_λ Longevity (year)

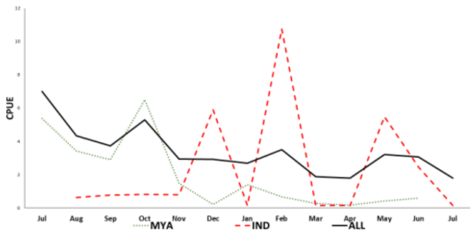
Result: CPUE STD

$$CPUE + \text{mean}(CPUE * 0.1) \sim Year + Month + Fishing\ Ground + Gear + GRT$$

Area	Appropriate Model	AIC		Remarks
		Full	Adjusted	
Indonesia	Gaussian + ID	458.9	486.9	No sig. diff
Myanmar	Poisson + log	1022.2	1020.2	No sig. diff
IND+MYA	Poisson + log	651.57	647.57	

- Parameter Country and Area (Province) were added for IND+MYA
- Parameter Area was added for Myanmar
- Effort unit: day of operation

Result: CPUE STD IND+MYA



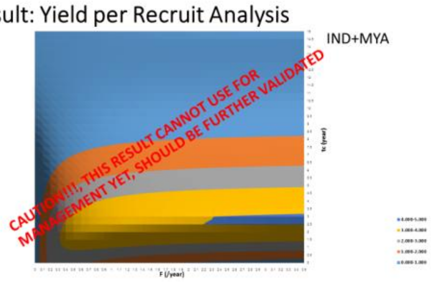
Result: Biological Parameters

Parameters	Value			Remarks
	MYA	IND	IND+MYA	
L_∞ (cm.)	152.69	262.10	262.68	ELEFAN
W_∞ (kg.)	11.53	71.34	71.72	L – W Relationship
Ø'	4.409	4.199	4.316	FiSAT
K (/year)	1.1	0.23	0.30	ELEFAN
t_0 (year)	-0.27615	-0.71999	-0.55067	vBGF

$W = 7 \times 10^{-6} L^{2.898}$
b range: 2.846 – 2.950

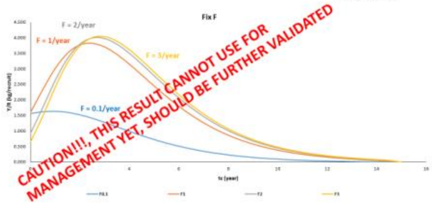
Result: Yield per Recruit Analysis

IND+MYA



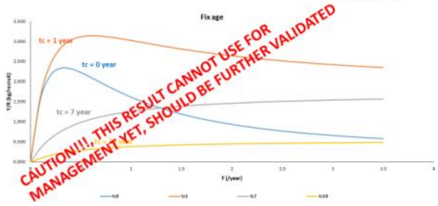
Result: Yield per Recruit Analysis

IND+MYA



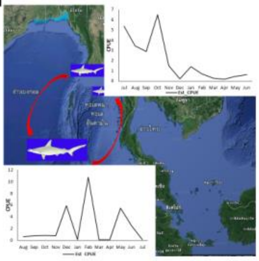
Result: Yield per Recruit Analysis

IND+MYA



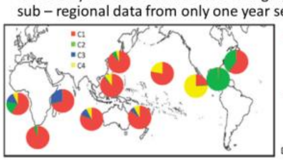
Summary and Discussion

- Scallop hammerhead will migrate from shoreline to offshore at length 115 cm. TL, approximately (Hoyos – Padilla *et al.*, 2014)
- Myanmar's CPUE standardization result show that the fishing ground may the feeding area for small size shark
- Meanwhile, Indonesia seems to be the feeding ground or migratory rout for the large size shark



Summary and Discussion

- YPR result, even though it can provide the maximum Y/R at F and tc but result still needed to be study more
- Since they has the characteristic of highly migratory species, only in sub – regional data from only one year seems to be deficient

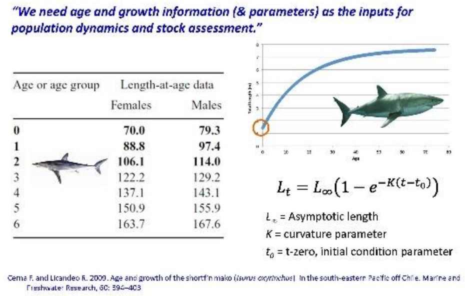


- **Therefore, the use of these result should be observe with caution**
- **Result may contained many uncertainties regarding to data limited issue**

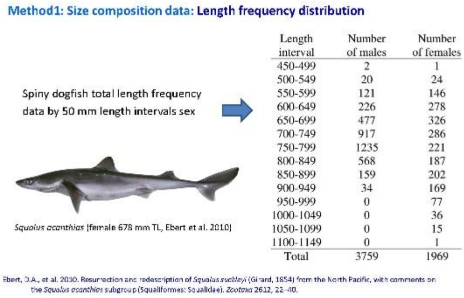
Darly – Engel et al. (2012)

Annex. 10

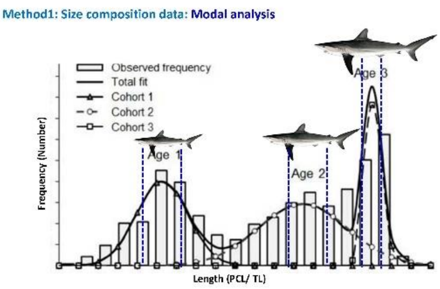
Age Determination Using Vertebra

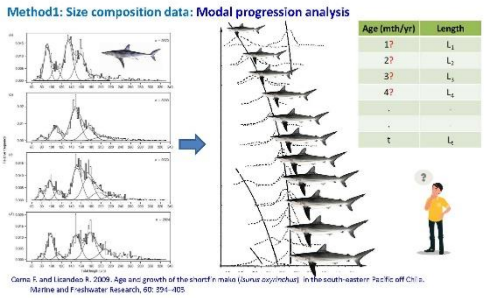


Age or age group	Length-at-age data	
	Females	Males
0	**70.0**	**79.3**
1	**88.8**	**97.4**
2	**106.1**	**114.0**
3	122.2	129.2
4	137.1	143.1
5	150.9	155.9
6	163.7	167.6

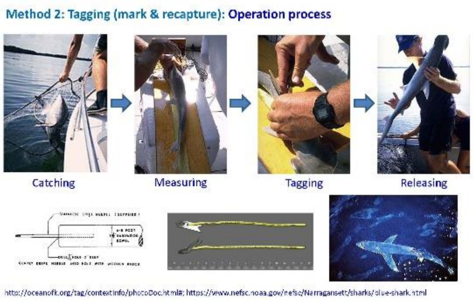


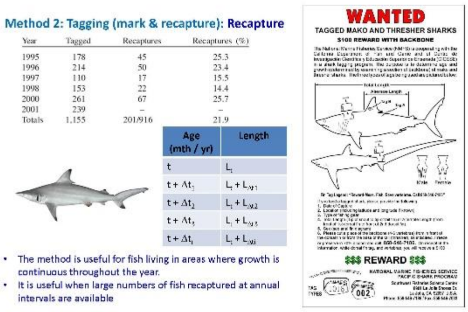
Length interval	Number of males	Number of females
450-499	2	1
500-549	20	24
550-599	121	146
600-649	226	278
650-699	477	326
700-749	917	286
750-799	1235	221
800-849	568	187
850-899	159	202
900-949	34	169
950-999	0	77
1000-1049	0	36
1050-1099	0	15
1100-1149	0	1
Total	3759	1969





Age (mth/yr)	Length
1?	L_1
2?	L_2
3?	L_3
4?	L_4
.	.
.	.
t	L_t



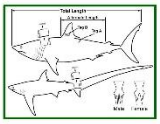


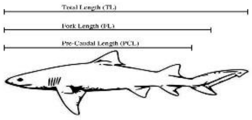
Year	Tagged	Recaptures	Recaptures (%)
1995	178	45	25.3
1996	214	50	23.4
1997	110	17	15.5
1998	153	22	14.4
2000	261	67	25.7
2001	239	–	–
Totals	1,155	201/916	21.9

Age (mth / yr)	Length
t	L_t
$t + \Delta t_1$	$L_t + L_{\Delta t1}$
$t + \Delta t_2$	$L_t + L_{\Delta t2}$
$t + \Delta t_3$	$L_t + L_{\Delta t3}$
$t + \Delta t_i$	$L_t + L_{\Delta ti}$

✓ **Method 3: Hard parts study (Most popular)**

Larger, more anterior vetebral centra should be used, but depend on species, e.g. thresher shark from the base of the tail.





Highly recommended manuals (please please download)

Steps for preparing the vertebra(e): https://www.youtube.com/watch?v=JhD8_7mc8N4

Cleaning the vertebra(e)

Wash the vertebral columns

↓

Remove connective tissue and muscle

↓

OR

Soak in 5% Sodium-hypochorite

for 30 - 60 minutes

then rinse in distilled water

↓

Air-drying, and then cut

In most cases, the annual growth bands of elasmobranches can be seen quite easily and clearly........

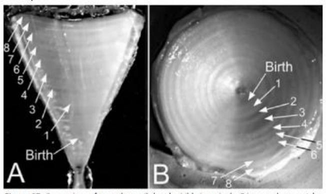


Figure 17. Comparison of annual growth bands visible in a single *Prionace glauca* vertebra after sectioning (A) and as viewed whole (B); annual growth bands are indicated.

Campana S.E. 2014 . Age determination of elasmobranchs, with special reference to Mediterranean species: a technical manual. Studies and Reviews. General Fisheries Commission for the Mediterranean. No. 94. Rome, FAO . 38 p.

Staining methods

- **Silver Nitrate:** Vertebral sections were placed in a 1% silver nitrate solution for 1–3 minutes and simultaneously illuminated with an ultraviolet light source for anywhere between 2 and 4 minutes.
- **Crystal Violet:** Vertebral sections were soaked in a 0.01% solution of crystal violet. The staining interval was 10 minutes.
- **Alcian Blue:** Vertebral sections were soaked in Alcian Blue solution (16 ml 100% ethanol, 2 mg Alcian Blue and 4 ml glacial acetic acid in 0.8 ml distilled water) for 12 hrs.
- **Alizarin red-S:** soaked for ~15 h and then rinsed in running tap water.
- **Others:** cobalt nitrate, ammonium sulfide, haemotoxylin, cedar wood oil, Safranin O etc.

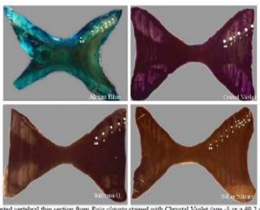
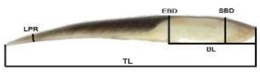


Figure 2. Mounted vertebral thin section from *Raja clavata* stained with Chrystal Violet (age -5 yr a 49.2 cm TL female), Silver Nitrate (age-10 yr a 74.2 cm TL male), Safranin O (age-4 yr a 45.9 cm TL male) and Alcian Blue (age-6 yr a 56.2 cm TL female). BB: Birth Band.

Bagusta N. et al. (2017) Comparison of Staining Techniques for Age Determination of Some Chondrichthyan Species . Turkish Journal of Fisheries and Aquatic Sciences 17: 41-49.

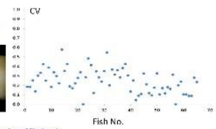
The spine

Short-spine spurdog (*Squalus mitsukurii*)



LRP: Last readable point,
EBD: Enamel base diameter,
SBD: Spine base diameter,
BL: Base length (BL), and
(S)TL: Spine total length

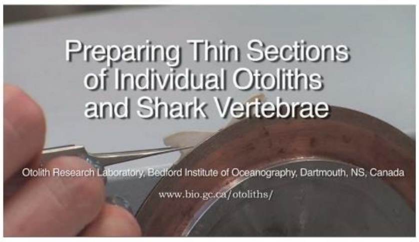
Growth band of the dorsal spine of *S. mitsukurii*



Paiboonleeskul K. et al. 2013. Ageing of shortspine spurdog in the Andaman Sea of Thailand. Maejo Int. J. Sci. Technol. 7(Special Issue), 14-21

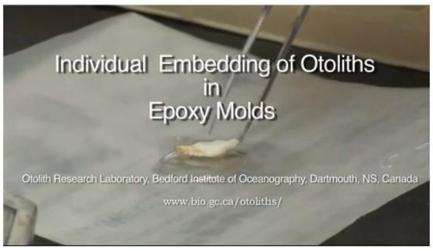
Preparing the low-speed diamond saw:

https://www.youtube.com/watch?v=YEw9UQDsT1I



Embedding the vertebra for sectioning (small vertebra)

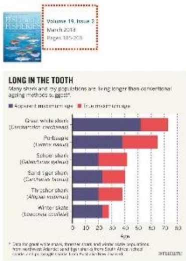
https://www.youtube.com/watch?v=yNrq5A194bc



Ageing of sharks & rays: Concern - 1

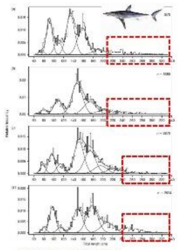
"Sometimes, when sharks stop growing, so do their vertebrae, which means that counting the rings can make an animal seem younger than it is "

"If age information is wrong, models that guide fisheries' decisions about how many animals can safely be caught will also be wrong"

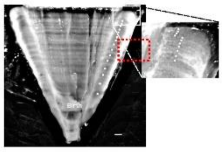


http://sharkyear.com/2017/sharks-and-rays-live-a-lot-longer-than-we-thought.html

Ageing of sharks & rays: Concern - 2



(Cerna F. and Licandeo R. 2009)



Lee's phenomenon:

The common finding that in older fish populations, forms with more narrow annual rings or more narrow growth zones are more frequent than in younger populations (FishBase.org)

Campana, S.E., Natanson, L.J. and Myklevoll, S. 2002. Bomb dating and age determination of large pelagic sharks. Can. J. Fish. Aquat. Sci. 59:450–455.

Ageing of sharks & rays: Concern - 3

- Species that are success in growth zones validation, and accurate growth parameters are achieved.
- Species that growth zones are not represent time or age.
- Species that age validation varied and often conflict

Deep-water elasmobranchs
- deep-sea catsharks
- skates
- squaliform elasmobranchs

- Other lamniform sharks
- Other carcharhinids

Cailliet G.M. 2015. Perspectives on elasmobranch life history studies: a focus on age validation and relevance to fishery management. Journal of Fish Biology 87, 1271–1292

Validation

Methods for insuring ageing accuracy and quantifying ageing precision

- Marginal increment analysis***
- Release of known age and marked fish into wild
- Mark-recapture of chemically-tagged wild fish
- Ageing of discrete length modes
- Rearing in captivity (hatchery-reared?)
- Details and other methods in **Table 1** of Campana 2001

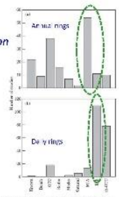
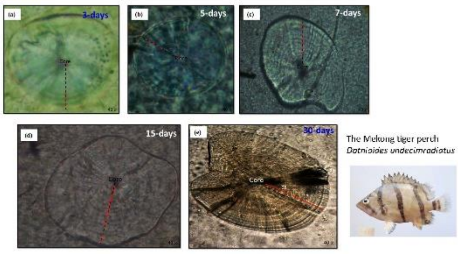


TABLE I. Features, advantages and disadvantages of methods used to confirm or support the accuracy of age interpretations. Methods are listed in descending order of scientific value. Growth structure refers to either annulus (A) or daily growth increment (D), depending on application

	Age validation							
Method	Annual/ daily	Applicable age range	Advantages	Limitations	Precision	Sample size required	Time required	Cost

Campana, S. E. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. Journal of Fish Biology 59:197–242..

Validation



The Mekong tiger perch *Datnioides undecimradiatus*

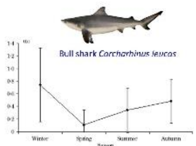
Kwanghwang W. 2016. Estimating Age and Growth of the Mekong Tiger Perch, *Datnioides undecimradiatus* (Roberts and Kottelat, 1994) by Using Hard Structures . Kasetsart University Fisheries Research Bulletin 40(2): 29-38.

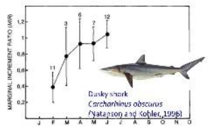
Validation

Relative marginal increment (RMI) by MIR

$$MIR = \frac{(VR - R_n)}{(R_n - R_{n-1})}$$

where; MIR = marginal increment ratio
VR = vetebral radius
R_n = distance from center to outer edge of last complete band
R_{n-1} = distance from center to outer edge of next-to-last complete band





Neer, J.A., et al. 2005. Age and growth of the *Carcharhinus leucas* in the northern Gulf of Mexico: incorporating variability in size at birth. J. Fish. Biol. 67:370-383.

Verification

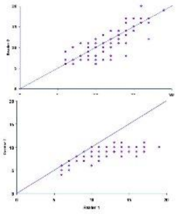
Serve as good relative indicator of precision within and between readers

- Varies among species and ages within a species
- Test for bias (or test of symmetry) can also be done, using Bowker's Test of Symmetry
- Can be simply as calculate percent reader agreement (=[No. agreed/No. read] x 100) within and between readers for all samples
- Two methods are commonly applied

1. Coefficient of variation (CV)

$$CV_j = 100\,\% \times \frac{\sqrt{\sum_{i=1}^{R}\frac{(X_{ij}-X_j)^2}{R-1}}}{X_j}$$

where ; X_{ij} is the i^{th} age determination of the j^{th} fish,
X_j is the mean age estimate of the j^{th} fish, and
R is the number of times each fish is aged.



Baca K. and Homer-Drummond S. 2010. Age Determination and Validation in Chondrichthyan Fishes. *PowerPoint presentation*

Verification

2. Average percent error (APE)

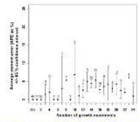
$$APE = \frac{\sum_{j=1}^{n} APE_j}{n}$$

where;

$$APE_j = 100 \times \frac{\sum_{i=1}^{r}\frac{|x_{ij}-\bar{x}_j|}{\bar{x}_j}}{n}$$

where; APE_j = the average percent error for the j^{th} fish;
x_{ij} = the i^{th} age estimate on the j^{th} fish;
x_j = the mean age estimate for the j^{th} fish;
R = the number of times that each fish was aged
n = the number of aged fish in the sample

Pig eye shark *Carcharhinus amboinensis*



Tillett B.J. 2011. Similar life history traits in bull (Carcharhinus leucas) and pig-eye (C. amboinensis) sharks. Marine & Freshwater Research, 62(7), 850–860.

Data analysis

Package 'FSA'

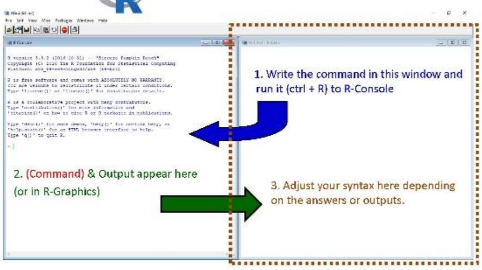
November 22, 2018

Version 0.8.22
Date 2018-11-22
Title Simple Fisheries Stock Assessment Methods
Description A variety of simple fish stock assessment methods. Detailed vignettes are available on the fishR website <http://derekogle.com/fishR/>.
URL https://github.com/droglenc/FSA
BugReports https://github.com/droglenc/FSA/issues
License GPL (>= 2)
LazyData true
Depends R (>= 3.2.0)
Imports graphics, grDevices, stats, tools, utils, car, dplyr, dunn.test, epitools, gplots, lmtest, plotrix, plyr, sciplot, withr
Suggests asbio, DescTools, fishmethods, FSAdata, knitr, marked, nlme, nlstools, pkgdown, psych, Rcapture, testthat, rmarkdown
Encoding UTF-8
RoxygenNote 6.1.1
NeedsCompilation no
Author Derek Ogle [aut, cre] (<https://orcid.org/0000-0002-0370-9299>), Powell Wheeler [aut] (Added method='Burnham' to removal()), Alexis Dinno [aut] (Provided base functionality of dunnTest())
Maintainer Derek Ogle <derek@derekogle.com>
Repository CRAN
Date/Publication 2018-11-22 16:30:06 UTC

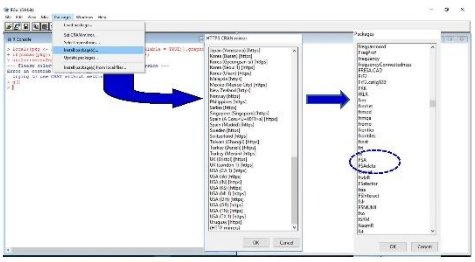
Prof. Derek Ogle

http://derekogle.com/

Quick glance to R



Install FSA-package

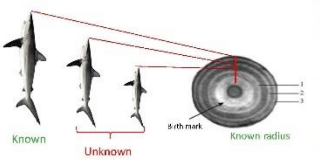


FSA-Package: Tests of *Symmetry* and *Precision* (file: shark1.xls")

```
## The FSA-package (for bias and precision test)##

library(FSA) ## working with the package "FSA"
library(FSAdata) ## the data file for working with package "FSA", just if you want to play with the package
####################################

## Importing the data ##

dat=read.table("shark1.txt", header=T, row.names=1) ## working on the "shark1" data file by making object "dat"
attach(dat) ## attach object "dat"
####################################

### Symmetry (or Bias) test ##

ab1 <- ageBias(reader1~reader2,data=dat,ref.lab="reader2",nref.lab="reader1") ## Testing on symmetry (or bias)
ab1 ## showing the systematic differences in assigned ages between the two readers
summary(ab1,what="Bowker") ## showing the Chi-square tests of symmetry by "Bowker" method
summary(ab1,what="EvansHoenig") ## showing the Chi-square tests of symmetry by "EvansHoenig" method
plot(ab1) ## showing the result in graphic
####################################

### Precision test ##

ap1 <- agePrecision(~reader1+reader2,data=dat) ## Testing the precision on age reading among readers
summary(ap1,what="precision") ## showing the results
###################################

#########################################################################################
```

Back calculation-1

- Method for describing the growth history of each individual sample
- Proportional relationship between animal length or disk width and radius of vertebral centrum or distance from focus to each annulus within a given centrum



Age (yr)	Length
1	L_1
2	L_2
3	L_3
4	L_4
t	L_t

Back calculation-2

1. The Dahl-Lea direct proportions method

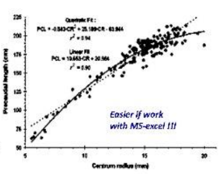
$$L_i = CR_i\left({}^{L_c}/_{CR_c}\right)$$

where; L_i = length at ring (age) *i*;
CR_i = centrum radius at ring (age) *i*;
L_c = length at capture; and
CR_c = centrum radius at capture.

2. Linear-modified Dahl-Lea method

$$L_i = L_c[(a + bCR_i)/(a + bCR_c)]$$

where *a* and *b* are the linear fit coefficient estimates



3. Quadratic-modified Dahl-Lea method

$$L_i = L_c\left[\left(a + b_1CR_i + b_2CR_i^{\,2}\right)/\left(a + b_1CR_c + b_2CR_c^{\,2}\right)\right]$$

where *a*, b_1 and b_2 are the quadratic fit coefficient estimates

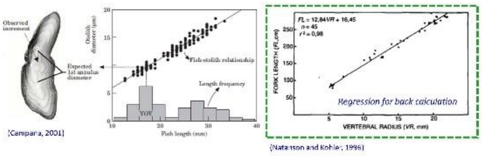
Goldman K.J. 2005. Age and growth of elasmobranch fishes , pp. 76-102 In: Management techniques for elasmobranch fisheries. FAO FISHERIES TECHNICAL PAPER 474

Back calculation-3

4. Size-at-birth modified Fraser-Lee method

$$L_i = L_c + [(CR_i - CR_i)(L_c - L_{Birth})/(CR_c - CR_{Birth})]$$

where L_{Birth} = length at birth and CR_{Birth} = centrum radius at birth



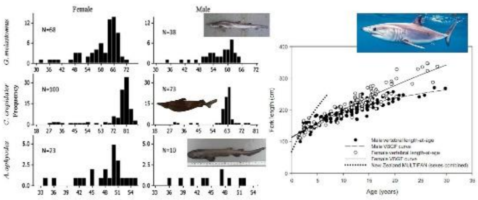
Natanson L.J. and Kohler N.E. 1996. A preliminary estimate of age and growth of the dusky shark *Carcharhinus obscurus* from the south-west Indian ocean, with comparisons to the western north Atlantic population. S. Afr. J. mar. Sci. 17: 217-224

Converting radius to length in MS-Excel (file: "shark2. xls")

Sample No.	TL (cm)	Centrum radius (μm)	Number of annuli	Centrum radius at ring i-th							
				1	2	3	4	5	6	7	8
1											
2											
3											
4											
5											
			Average ± SD								

Sample No.	TL (cm)	Centrum radius (μm)	Number of annuli	Size at age (ring) i-th							
				1	2	3	4	5	6	7	8
1											
2											
3											
4											
5											
			Average ± SD	✓	✓	✓	✓	✓	✓	✓	✓

Difference in growth between sex



Bishop, S.D.; Francis, M.P.; Duffy, C. (2004). Age, growth, maturity, longevity and natural mortality of the shortfin mako shark (Isurus oxyrinchus) in New Zealand waters. New Zealand Fisheries Assessment Report. National Institute of Water and Atmospheric Research, New Zealand. 35 p

Moore et al. (2013) Population biology and ageing of the deep water sharks Galeus melastomus, Centroselachus crepidater and Apristurus aphyodes from the Rockall Trough, north-east Atlantic. Journal of the Marine Biological Association of the UK, 1-10

ANalysis of COVAriance (file: "shark3. xls")

```
## Determining difference in growth between sexes ##

## Importing the data ##

dat3=read.table("shark3.txt", header=T, row.names=1) ## working on the "shark3"
names(dat3) ## viewing the name of variables
attach(dat3) ## attach object "dat3"
##################################

## ANCOVA analysis ##

md1 <- aov(TL~Age*Sex,data = dat3)## Model with interaction between categorical variables and predictor variable
print(summary(md1))## viewing the results of object "md1"


md2 <- aov(TL~Age+Sex,data = dat3)## Model without interaction between categorical variables and predictor variable
print(summary(md2)) ## viewing the results of object "md1"

## Comparing Two Models ##
md1 <- aov(TL~Age*Sex,data = dat3)
md2 <- aov(TL~Age+Sex,data = dat3)
print(anova(md1,md2)) ## viewing the ANCOVA results
##################################
```

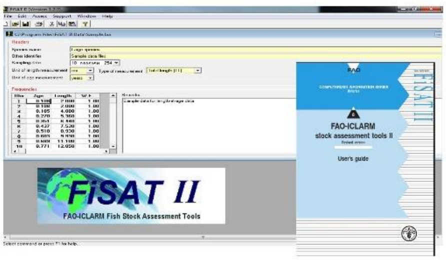
FSA: Estimation of the growth parameters (L_∞, K and t_0) -1 (file: "shark4. xls")

```
## Estimation of the parameters of the Von Bertalanffy Growth Function (VBGF)###

library(FSA) ## working with the package "FSA"
library(FSAdata) ## the data file for working with package "FSA", just if you want to play with the package
##################################

## Importing the data ##

dat4=read.table("shark4.txt", header=T, row.names=1) ## working on the "shark4" data file (TRY also "shark5")
attach(dat4) ## attach object "dat4"
##################################


## Simple examples of each parameterization

vbStarts(tl~age,data=dat4)
vbStarts(tl~age,data=dat4,type="Original")
##################################


## Examples with a Plot

vbStarts(tl~age,data=dat4,plot=TRUE)
vbStarts(tl~age,data=dat4,type="original",plot=TRUE)
##################################
```

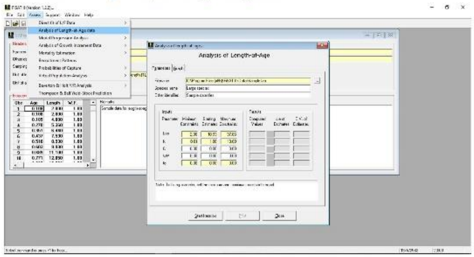
FSA: Estimation of the growth parameters (L_∞, K and t_0) -2

```
##################################


## Reparameterize

( vb1 <- vbFuns() ) ## Creating a function for a specific parameterizations
ages <- 0:20 ## determine age from ? to ? years
plot(vb1(ages,Linf=?,K=?,t0=?)~ages,type="b",pch=19)## Inputting results from 1st round, type = line-type, pch = dot-type
x11() ## new graphich window
plot(tl~age,data=dat4,pch=19)
fit1 <- nls(tl~vb1(age,Linf,K,t0),data=dat4,
            start=vbStarts(tl~age,data=dat4)) ## Fitting the line
summary(fit1,correlation=TRUE) ## Obtaining the new estimated parameters
##################################

###################################################################################################
```

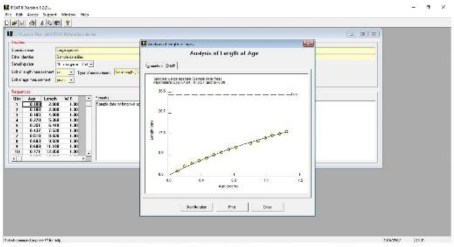
FiSAT: Estimation of growth parameters by "length-at-age (*.laa)" data



FiSAT: Assess → Analysis of Length-at-Age data

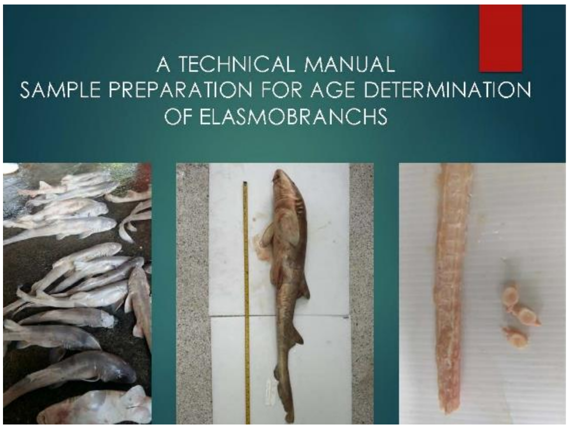


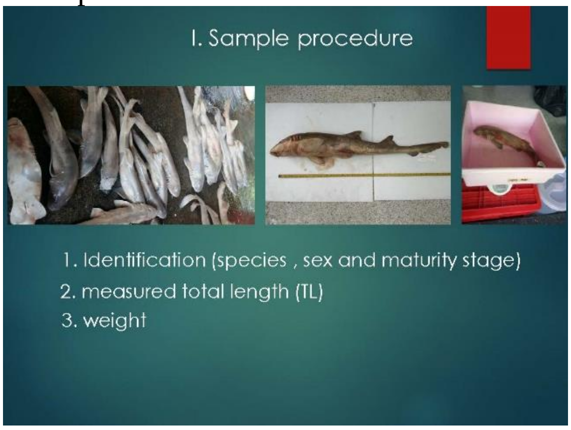
FISAT: The graphical result

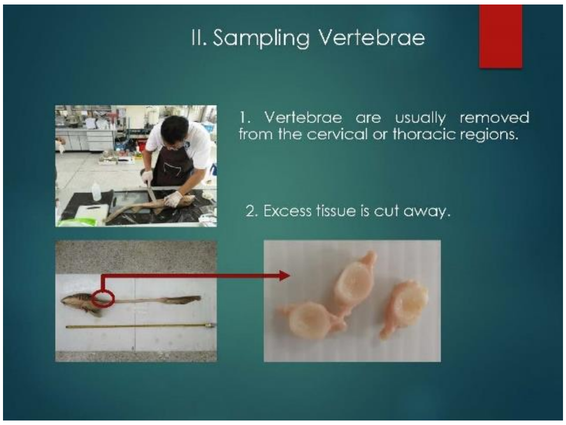


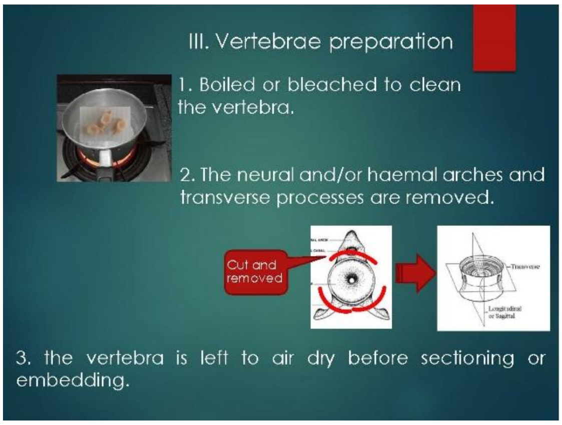
Annex. 11

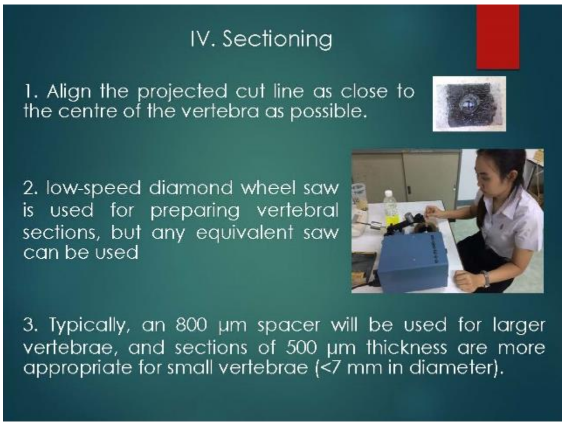
Handout for Sample Preparation

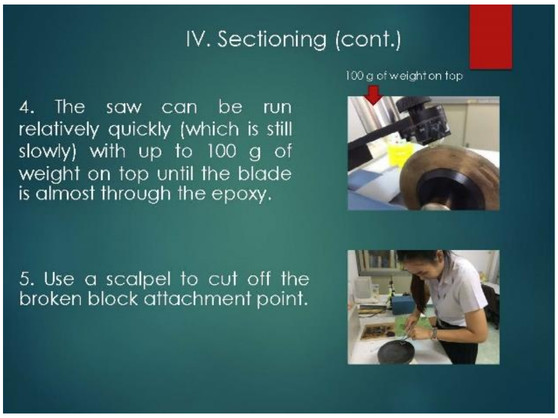


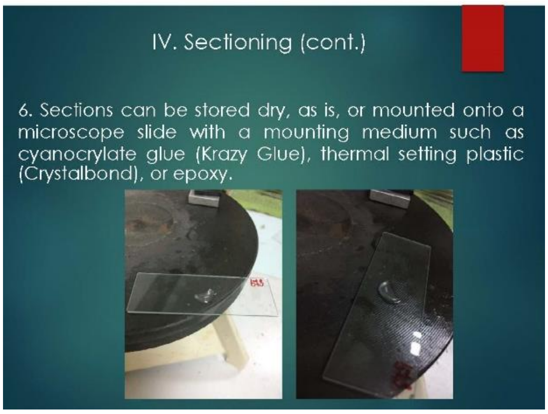


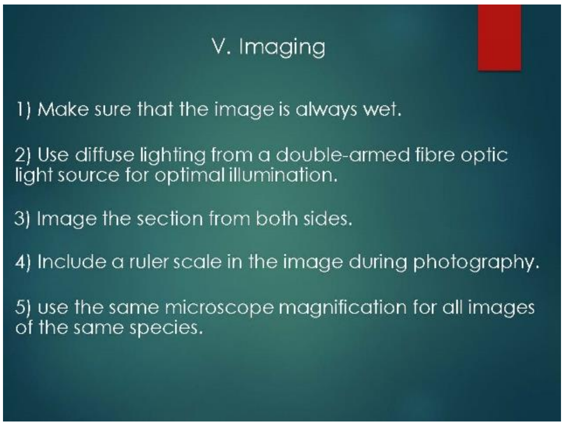











V. Imaging
1) Make sure that the image is always wet.
2) Use diffuse lighting from a double-armed fibre optic light source for optimal illumination.
3) Image the section from both sides.
4) Include a ruler scale in the image during photography.
5) use the same microscope magnification for all images of the same species.

Annex. 12

Handout for ImageJ Program