ACTIVITY REPORT: USAID SEA PARTICIPATION IN THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM

Iloilo City, Philippines | 8-12 April 2019

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ACRONYMS & ABBREVIATIONS

AFAF Asian Fisheries and Aquaculture Forum
AFS Asian Fisheries Society
BDM biomass dynamics model
\( B_{\text{MSY}} \) biomass at MSY
cm centimeter
Dir. PSDI Direktorat Pengelolaan Sumber Daya Ikan (Directorate of Fish Resource Management)
E exploitation rate
EAF ecosystem approach to fisheries
F fishing mortality
FMA Fisheries Management Area (Wilayah Pengelolaan Perikanan - WPP)
\( F_{\text{MSY}} \) fishing mortality at MSY
GOI Government of Indonesia
K individual growth coefficient
KomnasKajiskan Komisi Nasional Pengkajian Sumber Daya Ikan (National Commission on Fish Resource Assessment)
LB length-based
\( L_c \) current length at first capture
\( L_c\text{-opt} \) optimum length at first capture
LOA length overall
M natural mortality
MMAF Ministry of Marine Affairs and Fisheries
MSY maximum sustainable yield
ne-BDM non-equilibrium biomass dynamics model
PURISKAN Pusat Riset Perikanan (Fisheries Research Center)
Rp Indonesian rupiah
SPR spawning potential ratio
USAID United States Agency for International Development
USAID SEA United States Agency for International Development Sustainable Ecosystems Advanced Project
USAID Oceans United States Agency for International Development Oceans and Fisheries Partnership
WCS Wildlife Conservation Society
WIB Western Indonesia Time
WWF World Wildlife Fund for Nature
EXECUTIVE SUMMARY

Six scientific papers on fish stock assessments that were conducted with support from the United States Agency for International Development Sustainable Ecosystems Advanced Project (USAID) were presented at a special scientific session during the 12th Asian Fisheries and Aquaculture Forum (12th AF) held in Iloilo City in April 2019. USAID SEA provided participation assistance to four researchers from the Ministry of Marine Affairs and Fisheries (MMAF) who presented the papers alongside fisheries experts from USAID SEA and implementing partner Wildlife Conservation Society (WCS). The assistance was part of a bigger initiative by USAID SEA to help strengthen fisheries management in Indonesia, such as through stock assessments and the development of harvest strategies for three target species groups, namely, red snapper, grouper and small pelagic fish. Specifically, it was aimed at sharing the stock assessment findings and obtaining scientific and technical inputs from international experts, as well as building the capacity of the MMAF researcher-presenters to share and promote their work with the international community of fish stock assessment experts.

AFAF is a triennial event organized by the Asian Fisheries Society to provide an international platform for scientists from all over the world to discuss issues pertaining to sustainable fisheries and aquaculture in the Asia-Pacific Region.

To follow up their participation in 12th AFAF, the researchers said they would incorporate relevant feedback and comments from the forum to improve their papers before these are finalized and submitted to USAID SEA for review.

USAID SEA also took part in a parallel exhibition where it had the opportunity to disseminate and promote project results through an exhibit on “USAID Marine Resource Management Programs” that it produced and presented with the USAID Oceans and Fisheries Partnership.

INTRODUCTION

The United States Agency for International Development Indonesia Sustainable Ecosystems Advanced Project (USAID SEA) supports Indonesia in its effort to strengthen fisheries management, particularly in Fisheries Management Area (FMA 715) in the eastern part of the country that includes Maluku, North Maluku and West Papua. To do this, the Project has embarked on several fisheries strategies, including stock assessment and the development of harvest strategies for three target species groups, namely the red snapper, grouper, and small-pelagic fish. Work in the first and second years of implementation included one-year monitoring of fish landings and stock assessment analyses. Working hand-in-hand with researchers from the Ministry of Marine Affairs and Fisheries (MMAF), USAID SEA has completed the analysis of 10 years’ worth of available fisheries statistics (2005-15) using a non-equilibrium biomass dynamics model. It has also started to analyze the one-year fish landing data it has collected using length-based frequency analysis.

The stock assessment results are intended to be disseminated and advocated to build awareness, among local fisheries managers and a wider national and international audience, of the need to manage the assessed fisheries, thereby creating demand for developing harvest strategies and promoting buy-in and leadership from fisheries managers. Socialization and dissemination have already been conducted to key government agencies at the national level, including the MMAF’s Directorate for Fish Resources
Management (Dir. PSDI) and the National Committee for Fisheries Policy (Komnaskajiskan). In addition, USAID SEA supported MMAF researchers to present six scientific papers at the 12th Asian Fisheries and Aquaculture Forum (12th AFAF) conducted by the Asian Fisheries Society (AFS) in Iloilo City, Philippines on 8-12 April 2019.

USAID SEA’s participation support at the 12th AFAF was part of the Project’s capacity building assistance to MMAF. It provided MMAF with the opportunity not only to present their stock assessment findings to an international audience, but also to obtain feedback from international scientists about improving the assessments, and to learn about fisheries research development, including the approaches and methodologies used, in other Asian countries.

Additionally, USAID SEA took the opportunity to promote and disseminate project results by participating at a four-day exhibition that was held parallel to the 12th AFAF.

This report covers USAID SEA’s participation in both the 12th AFAF and its parallel exhibition.

ABOUT AFAF & AFS

Formerly known as the Asian Fisheries Forum, AFAF is a triennial event organized by AFS. To date, the forum has been convened 12 times around the Asian region, providing an international platform for scientists from all over the world to discuss issues pertaining to sustainable fisheries and aquaculture in the Asia-Pacific Region. The 12th AFAF, which was organized in partnership with the University of the Philippines Visayas and the University of the Philippines Visayas Foundation, consisted of four plenary sessions, 10 regular scientific sessions, seven special scientific sessions, a student research competition, and three special events. It was carried out with 14 partners, nine sponsors, two associates, and 13 exhibitors, including USAID SEA and the USAID Oceans and Fisheries Partnership (USAID Oceans).

AFS is a non-profit scientific society founded in 1984 by fisheries professionals in Asia to promote networking and cooperation among fisheries scientists, technicians and other stakeholders involved in fisheries and aquaculture production, research and development in the region. It aims to enhance food security and income-generating opportunities for fisheries workers through sound management practices, environmentally sustainable development and efficient utilization of aquatic resources.1

OBJECTIVES OF THE ACTIVITY

As noted, USAID SEA’s participation in the 12th AFAF was intended to:

1. Share findings of USAID SEA-supported stock assessments undertaken by researchers from MMAF
2. Obtain scientific and technical inputs from international experts
3. Help build the capacity of the MMAF researchers and fisheries team to share and promote their work with the international community of fish stock assessment experts
4. Promote USAID SEA and disseminate project results to an international audience

IMPLEMENTATION

USAID SEA organized a “USAID SEA Special Scientific Session” at the 12th AFAF, where the MMAF researchers presented their stock assessment findings. Its participation in the parallel exhibition was through an exhibit called “USAID Marine Resource Management Programs” that was put up as a collaboration with USAID Oceans.

The scientific session’s agenda is included in this report as Annex 1. Event dates and venues are shown below (Table 1).

Table 1. Dates and venues of 12th AFAF activities that USAID SEA participated in

<table>
<thead>
<tr>
<th>DATE &amp; VENUE</th>
<th>USAID SEA SPECIAL SCIENTIFIC SESSION</th>
<th>EXHIBIT ON USAID’S MARINE RESOURCE MANAGEMENT PROGRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>11 April 2019 (Thursday)</td>
<td>9-12 April 2019 (Tuesday – Friday)</td>
</tr>
<tr>
<td>Time</td>
<td>10:30-12:20 Western Indonesian Time (WIB)</td>
<td>08.30 – 16.30 WIB</td>
</tr>
<tr>
<td>Venue</td>
<td>Function Room 4, Iloilo Convention Center, Megaworld Blvd, Mandurriao, Iloilo city, 5000 Philippines</td>
<td>Main lobby, Iloilo Convention Center, Megaworld Blvd, Mandurriao, Iloilo city, 5000 Philippines</td>
</tr>
</tbody>
</table>

SUMMARY OF PARTICIPANTS

USAID SEA supported the participation of four MMAF researchers, namely, Dr. Wijopriono Yamin Sastro, Tri Ernawati, Duranta D. Kembaran, and Anthony Sisco Panggabean. They were joined by USAID SEA Senior Fisheries Advisor Dr. Purwanto, USAID SEA Sustainable Fisheries Specialist Ses Rini Mardiani, and Dr. Irfan Yulianto, Marine Program Manager of the Wildlife Conservation Society (WCS), one of 13 USAID SEA implementing NGO partners.

Dr. Wijopriono, Principal Researcher at the Fisheries Research Center (PURISKAN) of MMAF, chaired the USAID SEA Special Scientific Session, with the rest of the group serving as presenters. The session was attended by scientists, academics, researchers and government representatives from Asia and the U.S., including Professor Wilfredo Campos, who chaired the 12th AFAF Scientific Session on Sustainable Fisheries, and Dr. Michael D. Pido, Dean of the Graduate School of Palawan University, Philippines.

Table 2 summarizes the USAID SEA group’s composition by organization and gender.

Table 2. Composition by organization and gender of the USAID SEA delegation to the 12th AFAF

<table>
<thead>
<tr>
<th>ORGANIZATION</th>
<th>FEMALE</th>
<th>MALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMAF</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>WCS</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>USAID SEA (Core Staff)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total No. of Participants (Persons) by Gender</strong></td>
<td><strong>2</strong></td>
<td><strong>5</strong></td>
</tr>
<tr>
<td><strong>Total No. of Participants (Persons)</strong></td>
<td><strong>7</strong></td>
<td></td>
</tr>
</tbody>
</table>
KEY OUTPUTS, OUTCOMES & ACHIEVEMENTS

The main results of USAID SEA’s participation in the 12th AFAF and its parallel exhibition are presented below under four broad headings based on the objectives of the activity: (i) Sharing of findings from USAID SEA-supported stock assessments; (ii) scientific and technical inputs from international experts; (iii) capacity building for MMAF participants; and (iv) promotion of USAID SEA and dissemination of project results.

SHARING OF FINDINGS FROM USAID SEA-SUPPORTED STOCK ASSESSMENTS

Findings from USAID-SEA supported stock assessments were shared primarily through the USAID SEA Special Scientific Session entitled “Toward Sustainable Fisheries in Eastern Indonesia: Assessment of Fish Stocks and Fisheries in a Data-Limited Context.” This session featured findings from stock assessments conducted as part of a series of trainings and workshops supported by USAID SEA to improve data collection and stock assessment methodologies and catch data analysis in Indonesia. The six scientific papers that were presented were prepared by 10 MMAF researchers in collaboration with the USAID SEA Fisheries Team and two project-implementers, namely, WCS and the World Wide Fund for Nature (WWF). (See Session Agenda in Annex 1 for the full list, Annex 4 for Handout Copies of the Presentations, and Annex 5 for the Abstracts and Session Synthesis).

Some questions raised during the session and the presenters’ responses are shown in Table 3.

Table 3. Audience questions and responses by presenters at the USAID SEA Special Scientific Session

<table>
<thead>
<tr>
<th>AUDIENCE QUESTIONS</th>
<th>PRESENTERS’ RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Could small-size fish commanding higher prices than bigger ones be the main reason small-size fish dominated the catch composition in the fisheries studied?</td>
<td>The size of fish caught was generally smaller because of the depth of the fishing area and the hook size or net mesh size used by fishers.</td>
</tr>
<tr>
<td>What technical recommendations could be made from the results of the length-based assessment presented with regard to optimum length and exploitation rate?</td>
<td>At least two technical recommendations can be made: (i) control of fishing pressure, determined on the basis of exploitation level, i.e., E=F/(F+M), where F=fishing mortality and M=natural mortality; and (ii) hook size or mesh size regulation based on optimum length.</td>
</tr>
<tr>
<td>What strategy is proposed to minimize the proportion of undersized fish caught?</td>
<td>Two possible interrelated types of measures can be implemented: (i) technical measures, such as regulating hook size or mesh size and setting limits on allowable fish size in the catch; and (ii) trade measures, including implementing technical measures in collaboration with fish collectors/traders and fish processors.</td>
</tr>
<tr>
<td>What alternative reference points resulted from the stock and risk assessment using the biomass dynamics model?</td>
<td>Two kinds of reference points could be proposed from the stock and risk assessment, namely, input reference points and output reference points, with the corresponding risks of exceeding them.</td>
</tr>
<tr>
<td>Were the indicators used specific for a certain species/group of crustaceans, or can they be applied generically to other species?</td>
<td>Parameters and thresholds for spawning potential ratio (SPR) vary for the different groups of fish (e.g. crustacean, demersal fish) because productivity varies for each fish group.</td>
</tr>
<tr>
<td>Did the bioeconomic model for estimating the best compromise solution to conflicting objectives take into account the social aspects of the fisheries and did it accommodate different priorities?</td>
<td>The model accommodated social considerations (e.g., employment opportunities for fishing vessel crews), and the different priorities of the different objectives.</td>
</tr>
</tbody>
</table>
Scientific & Technical Inputs from Other Experts

The MMAF researchers participated in several plenary sessions, regular scientific sessions and special scientific sessions, where they picked up useful information on developments in scientific approaches and methodological research in fisheries in Asia. In addition to the formal sessions, they also engaged in conversations on the forum’s sidelines, through which they received expert advice to improve their research, as well as sharing their research findings. Some key takeaways include:

1. The forum included at least two studies on length-based assessment of a fishery: one study was presented during the session on Sustainable Fisheries, and the other during the session on Fisheries Biology, Toxicology and Environment. Both studies used length at first maturity (from FishBase) to calculate the SPR value for estimating optimum fish length, and suggested the estimated optimum length as a reference point for managing the fishery. In comparison, using a newer method from Froese et al (2016), the MMAF researchers did not only estimate SPR and optimum length based on SPR, but also global optimum fish length.

2. Poor data availability was a common constraint among the scientists at the 12th AFAF, yet most of the studies that were presented used equilibrium surplus production or biomass dynamics models (BDM), suggesting that few of the scientists, if at all, used the non-equilibrium models (ne-BDM) employed by MMAF researchers for data-poor fisheries. The MMAF researchers regard ne-BDM as a better approach, especially in data-poor or data-limited environments, because it is able to address issues related to the overestimation of model parameters.

3. Based on a presentation during the session on Fisheries Policy and Governance, Indonesia’s rights-based fisheries management system appears to be very similar to that found in the People’s Republic of China, where the right to fish is granted by the government through a licensing system.

4. Overall, the fish stock assessment methods introduced by USAID SEA to MMAF are more advanced than those used in other countries. USAID SEA introduced catch-effort assessment (using ne-BDM) and length-based assessment to improve the stock assessment method used by MMAF researchers.

Capacity Building for MMAF Participants

The results in terms of capacity development for MMAF related largely to scientific presentation skills and skills in chairing scientific sessions, as described below:

Scientific Presentation Skills

The MMAF researchers said they felt that they were upskilled to participate in an international setting, able to contribute not only as presenters sharing their research findings, but also as discussants providing feedback to others, or seeking feedback to improve their research strategies.

Skills in Sharing/Managing Scientific Sessions

The MMAF researchers learned two key lessons from their experience managing the USAID SEA Special Scientific Session:

1. Be flexible – The original plan to have two question-and-answer discussions over the course of the six presentations (meaning, one discussion after every three presentations) was quickly
adjusted when the researchers realized that the forum had parallel sessions, and that many participants would be moving between sessions. Instead, the session chair opened the floor for discussion after every presentation to give all participants as much opportunity as possible to ask questions or offer their comments should they decide to transfer to a parallel session.

2. *Stay on time* – The amount of material covered in the session was quite extensive, so it was important to keep the presentations and discussions within the allotted time, not only to avoid presentations being truncated or cancelled, but also to ensure positive participant experience.

**PROMOTION OF USAID SEA & DISSEMINATION OF PROJECT RESULTS**

With representation from 22 countries, 12th AFAF proved to be an effective venue for promoting USAID SEA and disseminating results from project implementation. Visitors to the “USAID Resource Management Programs” exhibit were each given copies of USAID SEA’s fisheries publications. There was great visitor interest in the print version of the three-volume publication “State of the Sea: Indonesia” but the team only had one copy for display, which was given at the end of the exhibit to Dean Encarnacion Emilia S. Yap of the College of Fisheries and Oceans Sciences of the University of Philippines Visayas. Thirty-three other exhibit visitors from the Philippines, India and China were provided with the electronic version (Annex 6).

**RECOMMENDATIONS**

From their participation in the 12th AFAF, the USAID SEA-supported participants identified the following three recommendations that could apply to their work:

1. Explore the possibility of improving the technical recommendations from stock assessments through other methods of data processing and analysis, e.g. sensitivity analysis to measure the impacts of each technical recommendation on the fisheries system;
2. Conduct more comprehensive studies, including field studies; and
3. Address data limitations and uncertainty in the estimation of SPR

**FOLLOW-UP ACTIVITIES**

In addition to considering the above recommendations, the MMAF researchers will also take steps to:

1. Improve their papers by incorporating feedback and comments from the 12th AFAF; and
2. Finalize the papers and submit to USAID SEA for review.
## ANNEXES

### ANNEX I. AGENDA OF THE USAID SEA SPECIAL SESSION HELD ON 11 APRIL 2019 AT THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM

<table>
<thead>
<tr>
<th>TIME</th>
<th>TITLE</th>
<th>AUTHOR</th>
<th>PRESENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30-10:40</td>
<td>Introduction</td>
<td>Wijopriono</td>
<td></td>
</tr>
<tr>
<td>10:40-10:55</td>
<td>Life history parameters and spawning potential ratio of species <em>Fenneropenaeus merguiensis</em> and <em>Scylla tranquebarica</em> in Fisheries Management Area 715 of Indonesia</td>
<td>D.D. Kembaren, I Inayah, and T. Ernawati</td>
<td>D.D. Kembaren</td>
</tr>
<tr>
<td>10:55-11:10</td>
<td>Life history parameters and spawning potential ratio of some reef fish species in Fisheries Management Area 715 of Indonesia</td>
<td>T. Ernawati, F. Satria, I. Yulianto, S. Agustina, and Sasi</td>
<td>T. Ernawati</td>
</tr>
<tr>
<td>11:10-11:25</td>
<td>Life history parameters and spawning potential ratio of some demersal fish stocks in Fisheries Management Area 715 of Indonesia</td>
<td>T. Ernawati, F. Satria, I. Yulianto, S. Agustina, and A.K. Dhani</td>
<td>I. Yulianto</td>
</tr>
<tr>
<td>11:40-11:55</td>
<td>Stock and exploitation risk of small pelagic fish in Fisheries Management Area 715 of Indonesia</td>
<td>Purwanto, F. Satria, S.R. Mardiani, and Mahiswara</td>
<td>S.R. Mardiani</td>
</tr>
<tr>
<td>11:55-12:10</td>
<td>A bioeconomic model for determining best-compromise solutions to conflicting objectives of small pelagic fishery management adopting ecosystem approach in Fisheries Management Area 715 of Indonesia</td>
<td>Purwanto, S.R. Mardiani, and T.W. Budiarti</td>
<td>Purwanto</td>
</tr>
<tr>
<td>12:10-12:20</td>
<td>Synthesis and closing</td>
<td>Wijopriono</td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
1 Ministry of Marine Affairs and Fisheries (MMAF)  
2 World Wide Fund for Nature (WWF)  
3 Wildlife Conservation Society (WCS)  
4 United States Agency for International Development Sustainable Ecosystems Advanced Project (USAID SEA)
ANNEX 2. ACCEPTANCE LETTER FROM THE RESEARCH INSTITUTE FOR MARINE FISHERIES (BRPL) TO PARTICIPATE IN THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM

31 January 2019

Fayakun Satria
Research Institute for Marine Fisheries
Ministry of Marine Affairs and Fisheries
Indonesia
Email: fsatria70@gmail.com

Purwanto
USAID Sustainable Ecosystems Advanced (USAID SEA) Project
Indonesia
Email Purwanto@SEA-Indonesia.org

Dear Fayakun Satria and Purwanto,

On behalf of the Scientific Committee of the 12th Asian Fisheries and Aquaculture Forum, I would like to inform that your special session proposal is accepted. Your session titled, "TOWARD SUSTAINABLE FISHERIES IN EASTERN INDONESIA: ASSESSMENT OF FISH STOCK AND FISHERIES IN A DATA LIMITED CONTEXT" will be a special session under the 12AFAF theme, "Sustainable Fisheries". It is scheduled on 11 April 2019 (Thursday), 10:30 am to 12:30 noon.

We have reviewed your submission and we found it complete with needed materials for the 12AFAF Book of Abstract and Program. We will contact you if there are additional things needed.

I can be contacted in these email addresses: agferrer@upv.edu.ph and 12afafo2019@gmail.com and in this mobile phone number 09968657887. Thank you.

We look forward to your participation in the 12AFAF. Thank you.

Truly yours,

[Signature]

ALICE JOAN G. FERRER, PhD
Professor, University of the Philippines Visayas
Vice President, Asian Fisheries Society
Co-chair, 12AFAF Organizing Committee
Chair, 12AFAF Scientific Committee
ANNEX 3. LETTER FROM THE RESEARCH INSTITUTE FOR MARINE FISHERIES (BRPL) NOMINATING PARTICIPANTS TO THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM
ANNEX 4. HANDOUT COPIES OF PRESENTATIONS AT THE USAID SEA SPECIAL SCIENTIFIC SESSION HELD ON 11 APRIL 2019 DURING THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM

SESSION INTRODUCTION (Presented by Wijopriono Yamin Sastro)
ASSESSMENT OF FISH STOCK AND FISHERIES IN A DATA LIMITED CONTEXT

One of the issues in the formulation of fisheries management strategies in Indonesia is the limited availability of data (data poor) for stock assessment.

- length-based and catch-effort based methods were used in FMA 715, applying for two species groups of primary interest: reef fish and small pelagic fish.
- These fisheries operate in a marine ecosystem whereby its function and response to fishing are not well known. Consequently, there are uncertainties in the estimated fish stock parameters.
- It is important not only assess the fish stock but also quantify the risk in the development of a fisheries management strategy.

PAPERS:

1. Duanta D. Kembaren, Imayah and Tri Ernawati, Life history parameters and spawning potential ratio of species Fenneropenaeus merguiensis and Scylla tranquebarica in Fisheries Management Area 715 of Indonesia. Research Institute for Marine Fisheries: Indonesia


ASSESSMENT OF FISH STOCK AND FISHERIES IN A DATA LIMITED CONTEXT

Papers:

4. Anthony Sisco Panggabean, Muhammad Tafik, Dimas Angga Redianto, Yoke Han Reyestangshi, and Masayu Rahma Anwar Putri, Status of reef fish stock and fishery in Fisheries Management Area 715 of Indonesia. Research Institute for Marine Fisheries, Ministry of Marine Affairs and Fisheries – Indonesia, 1 Research Institute for Fish Stock Enhancement: Ministry of Marine Affairs and Fisheries – Indonesia

5. Purwanto, Siregar, Sudi Mardani, and Mahiswara, Stock and exploitation risk of small pelagic fish in Fisheries Management Area 715 of Indonesia. The National Commission of Fishery Resources Assessment, 1 The MMAF Research Institute for Marine Fisheries, 2 The USAID – SEA Project.

6. Purwanto, Mardani, and Tri Wahyu Budianto, A bioeconomic model for compromising conflicting objectives of small pelagic fishery management adopting ecosystem approach in Fisheries Management Area 715 of Indonesia. The National Commission of Fishery Resources Assessment, 1 The MMAF Research Institute for Marine Fisheries, 2 The USAID – SEA Project.
LIFE HISTORY PARAMETERS & SPAWNING POTENTIAL RATIO OF SPECIES *FENNEROPENAEUS MERGUIENSIS* & *SCYLLA TRANQUEBARICA* IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA

(Presented by Duranta D. Kembaren)

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**INTRODUCTION**

- Prawns and Crabs are the main group in crustacean fisheries, they are included in the **five kinds of major export commodity** from Indonesia, along with tuna, cephalopods, and seaweeds.
- Banana prawn and purple mud crab are two of crustacean resources which was **commercially targeted** by coastal fishers.
- They are **continuously exploited** using the trammel net and trap.
- Hence, it is **important to understand** their status as the effects of exploitation.
- This study aims to **assess the life history parameter and spawning potential ratio** of banana prawn and purple mud crab in relation to their exploitation status.

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**MATERIAL AND METHODS**

Data collection:
- Des 2017 - Des 2018 from 6 landing site in Serang Selatan & Teluk Hirisari:
  - Trammel-net (prawn) & Trap (crab)
- Biological info:
  - CL/CL (mm), W (g), sex, gamet maturity:
MATERIAL AND METHODS

**data analysis**

- LF, maturity
- SL\(_{90}\), L\(_{50}\), L\(_{50}\), L\(_{T}\), k, L\(_{T}\), Z, M, F
- E

Logistic expansion (King and Luck, 1990)
ELEFAN (Sparke and Gore, 1996)
T H (Bakshi and Bakshi, 1991)
Length-mortality (Rel. 100)
Length-corrected pattern curve (Pics 1983)

The Bureau for Ecologists (BEC),
http://fishecologist.com.au

RESULT

**LF, SL\(_{50}\), L\(_{50}\)**

- SL\(_{50}\) = 12.49 mm
- L\(_{50}\) = 12.66 mm

*F. megalops*

n = 7722

RESULT

**LF, SL\(_{50}\), L\(_{50}\)**

- L\(_{50}\) = 110.59 mm
- SL\(_{50}\) = 125.86 mm

*S. tranquilani*

n = 4964
RESULT GROWTH

RESULT MORTALITY, ER & SPR

<table>
<thead>
<tr>
<th>Species</th>
<th>Z (year⁻¹)</th>
<th>M (year⁻¹)</th>
<th>F (year⁻¹)</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penaeus japonicus</td>
<td>1.12</td>
<td>1.44</td>
<td>1.68</td>
<td>0.54</td>
</tr>
<tr>
<td>Scylla tranquebarica</td>
<td>2.32</td>
<td>0.73</td>
<td>1.58</td>
<td>0.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>SPR (%)</th>
<th>Limit Reference Point</th>
<th>Target Reference Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. japonicus</td>
<td>27 (25-29)</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>S. tranquebarica</td>
<td>30 (28-32)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSIONS

- The life history and mortality parameters resulted in SPR of the banana prawn and purple mud crab were 27% and 30%.
- This study result indicating that banana prawn and purple mud crab were fully exploited.
- It is suggested to apply the size limitation as minimum as size at maturity, 32 mmCL for banana prawn and 110 mmCW for purple mud crab.
LIFE HISTORY PARAMETERS & SPAWNING POTENTIAL RATIO OF SOME REEF FISH SPECIES IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA (Presented by Tri Ernawari)

INTRODUCTION

Fisheries Characteristic
- Multi-species fisheries, species caught in multiple gear
- Artisanal fisheries (vessel size < 10 GT)
- Mostly drop-lines or hand lines, bottom long-lines
- Restricted information series data on species level of catch, fishing effort & population abundance

Life history information needs
- Beneficial to estimate stock status (exp. SPR)
- Very poor information on LH & stock status in FMA 715

Objectives:
- To understand the stock status according to the life history and SPR as inputs to inform management judgments in a very limited data fisheries.
MATERIAL & METHODS

Sampling Sites

- Data collection in 17 fish landing sites
- Length data recorded for 10-20 days each month in August 2017 to November 2018 in North Maluku and Maluku

Number of samples

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Location</th>
<th>Number of Individuals</th>
<th>Range (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lethrinus koujani</td>
<td>Pink car emperor</td>
<td>Maluku</td>
<td>547</td>
<td>15.7 - 34.6</td>
</tr>
<tr>
<td>Pterocephalus tiline</td>
<td>Dark-banded fusilier</td>
<td>Maluku</td>
<td>687</td>
<td>17.5 - 26.0</td>
</tr>
<tr>
<td>Varunia albinicostata</td>
<td>White-edged lyretail</td>
<td>North</td>
<td>339</td>
<td>34.1 - 44.9</td>
</tr>
<tr>
<td>Cephalopholis houonu</td>
<td>Chocolate hind</td>
<td>North Maluku</td>
<td>461</td>
<td>10.0 - 33.2</td>
</tr>
<tr>
<td>Epinephelus auriga</td>
<td>White-streaked grouper</td>
<td>Maluku</td>
<td>511</td>
<td>16.0 - 36.1</td>
</tr>
<tr>
<td>E棁us radiatus</td>
<td>Pale snapper</td>
<td>North Maluku</td>
<td>447</td>
<td>19.4 - 101.6</td>
</tr>
<tr>
<td>Lutjanus gibbus</td>
<td>Humpback red snapper</td>
<td>North</td>
<td>622</td>
<td>12.5 - 47.22</td>
</tr>
<tr>
<td>Lutjanus vitta</td>
<td>Brownstripe red snapper</td>
<td>Maluku</td>
<td>352</td>
<td>14.6 - 55.9</td>
</tr>
</tbody>
</table>

Analysis Method

1. Growth parameter von bertalanffy (Sparre & Vonema 1999)
3. Length based spawning potential ratio (Hordyk et al. 2014)
Spawning Potential Ratio?

1. SPR is a method to determine stock status especially in poor data fisheries.
2. SPR principal is population in unfished stock which has an SPR of 100% (SPR100%) and F (fishing mortality) reduced SPR100% from the unfished level to SPRx% (Prince et al., 2014)

Spesies

- Variola albimarginata
- Epinephelus ongus
- Cephalopholis boeniak
- Pterocaesio tile
- Lutjanus reynosus
- Lutjanus vetula
- Lutjanus gibbus
- Lutjanus argent"
RESULTS & DISCUSSION

GROWTH & MORTALITY

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Location</th>
<th>L (cm)</th>
<th>3 (year)</th>
<th>0.5 (years)</th>
<th>1 (year)</th>
<th>M</th>
<th>Z</th>
<th>T</th>
<th>S</th>
<th>FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lethrinus aeolus</td>
<td>Back-banded</td>
<td>Maluku</td>
<td>33.7</td>
<td>0.3</td>
<td>0.54</td>
<td>11</td>
<td>0.64</td>
<td>1.11</td>
<td>0.67</td>
<td>0.60</td>
<td>1.52</td>
</tr>
<tr>
<td>Prionurus villosus</td>
<td>White-eyed</td>
<td>Maluku</td>
<td>25.82</td>
<td>0.6</td>
<td>0.28</td>
<td>8</td>
<td>0.67</td>
<td>1.16</td>
<td>0.68</td>
<td>0.60</td>
<td>0.71</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>White-tailed</td>
<td>North Maluku</td>
<td>44.47</td>
<td>0.38</td>
<td>0.39</td>
<td>8</td>
<td>0.54</td>
<td>1.09</td>
<td>0.53</td>
<td>0.56</td>
<td>1.62</td>
</tr>
<tr>
<td>Epinephelus coeruleus</td>
<td>White-tailed</td>
<td>Maluku</td>
<td>32.46</td>
<td>0.36</td>
<td>0.42</td>
<td>8</td>
<td>0.50</td>
<td>1.05</td>
<td>0.50</td>
<td>0.50</td>
<td>1.40</td>
</tr>
<tr>
<td>Epinephelus Lanceolatus</td>
<td>Black-scabbard</td>
<td>North Maluku</td>
<td>51.17</td>
<td>0.57</td>
<td>0.45</td>
<td>8</td>
<td>0.60</td>
<td>0.90</td>
<td>0.51</td>
<td>0.56</td>
<td>1.33</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>White-tailed</td>
<td>Maluku</td>
<td>104.46</td>
<td>0.30</td>
<td>0.46</td>
<td>17</td>
<td>0.52</td>
<td>0.94</td>
<td>0.46</td>
<td>0.46</td>
<td>1.67</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>White-tailed</td>
<td>North Maluku</td>
<td>104.46</td>
<td>0.30</td>
<td>0.46</td>
<td>17</td>
<td>0.52</td>
<td>0.94</td>
<td>0.46</td>
<td>0.46</td>
<td>1.67</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>White-tailed</td>
<td>Maluku</td>
<td>41.32</td>
<td>0.33</td>
<td>0.45</td>
<td>10</td>
<td>0.60</td>
<td>0.90</td>
<td>0.50</td>
<td>0.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>White-tailed</td>
<td>North Maluku</td>
<td>54.08</td>
<td>0.33</td>
<td>0.43</td>
<td>8</td>
<td>0.60</td>
<td>0.90</td>
<td>0.43</td>
<td>0.32</td>
<td>1.08</td>
</tr>
</tbody>
</table>

MATURITY

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>L.50</th>
<th>L.95</th>
<th>% Immature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lethrinus aeolus</td>
<td>Maluku</td>
<td>20.26</td>
<td>23.50</td>
<td>21%</td>
</tr>
<tr>
<td>Prionurus villosus</td>
<td>Maluku</td>
<td>19.01</td>
<td>22.75</td>
<td>15%</td>
</tr>
<tr>
<td>Vargula albovittata</td>
<td>North Maluku</td>
<td>25.82</td>
<td>30.00</td>
<td>15%</td>
</tr>
<tr>
<td>Cephalopholis biocellata</td>
<td>North Maluku</td>
<td>18.36</td>
<td>21.50</td>
<td>32%</td>
</tr>
<tr>
<td>Epinephelus angulus</td>
<td>North Maluku</td>
<td>21.07</td>
<td>23.10</td>
<td>10%</td>
</tr>
<tr>
<td>Ethele radiatus</td>
<td>North Maluku</td>
<td>56.86</td>
<td>66.00</td>
<td>69%</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>North Maluku</td>
<td>25.35</td>
<td>28.30</td>
<td>41%</td>
</tr>
<tr>
<td>Lates calcarifer</td>
<td>North Maluku</td>
<td>20.84</td>
<td>25.50</td>
<td>19%</td>
</tr>
</tbody>
</table>

- regarding 20% immature fish in the catch as an indicator for a fishery at risk.
- fishery highly at risk of over-exploited when more than 50% of the catch are immature (Foose et al, 2016)
SPR & Treshold (SPR0.3)

*Ali et al. 2008: SPR < 0.3 overfished

- Only three species were not overfished
- Two species were optimum
- The others were overfished
- Two species (C. hoanak and F. radikerus) that should be more concerned since their SPR level was very low (below 20%)

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SPawning Potential Ratio

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>SPR</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Lethrinus lentjan</em></td>
<td>Pink ear emperor</td>
<td>0.22</td>
</tr>
<tr>
<td><em>Pterocaesio tile</em></td>
<td>Dark-banded fusilier</td>
<td>0.53</td>
</tr>
<tr>
<td><em>Maluku Utara</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Variola albimarginata</em></td>
<td>White-edged lyretail</td>
<td>0.38</td>
</tr>
<tr>
<td><em>Lepisosteus fossilis</em></td>
<td>Chocolate hind</td>
<td>0.31</td>
</tr>
<tr>
<td><em>Epinephelus orbignyi</em></td>
<td>White-streaked grouper</td>
<td>0.25</td>
</tr>
<tr>
<td><em>Echeneis nadim</em></td>
<td>Pale snapper</td>
<td>0.12</td>
</tr>
<tr>
<td><em>Lutjanus gibbus</em></td>
<td>Humpback red snapper</td>
<td>0.29</td>
</tr>
<tr>
<td><em>Lutjanus vitta</em></td>
<td>Brownstripe red snapper</td>
<td>0.17</td>
</tr>
</tbody>
</table>

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Consideration for Management

- The below SPR points out the ability of spawning stocks has been reduced to sustain their abundance in the environment since their biological capacity decreased for producing adult stocks in the structures of population.

- As noted, the species that are long-lived species (low M) and relatively slow growing (low K) more sensitive to exploitation rates and have the longest time to recovery.

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LENGTH-BASED REFERENCE POINTS FOR MANAGEMENT OF SOME DEMERSAL FISH STOCKS IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA (Presented by Irfan Yulianto)

Introduction
Indonesia waters 11 FMAs Indonesia
- 3 FMAs under major fishing area of Eastern Indian Ocean
- 8 FMAs under Western Central Pacific

General profile – coastal fishery
- Multi-species fisheries, species caught in multiple gear
- Small scale fisheries (may be defined by vessel size < 10 GT)
- Targeted demersal and reef fish, some areas overexploited and some under exploited
- However: no time series data on species level of catch and effort

Objective
It is important to develop reference points according to limited data, i.e. length data

This study aims to calculate and analysis reference points according to length data to provide recommendation for managing demersal and reef fishery in FMA 715

We used the optimal length at first capture ($L_{opt}$) and fishing mortality as ref. points. The $L_{opt}$ was calculated based on asymptotic length, growth parameter, natural mortality, and fishing mortality that were estimated from length frequency data of one year monitoring in North Maluku and Maluku Provinces
Material and Method

Data Collection

- 12 landing sites in North Maluku and Maluku Provinces
- 7 – 15 days data collection per month
- Data collected: trip / effort, total catch, total length per fish

North Maluku
- Variola allimarginata
- Cephalopholis boenak
- Epinephelus ongus

Maluku
- Lutjanus lenteran
- Lutjanus vitta
- E. radious
- L. gibbus
- L. vitta

Material and Method

Data Processing and Analysis

Life history:

1. Growth parameter ($L_{\infty}$ in cm, K, tahun, t0) (Sparre & Venema 1999)

Length based reference point:

1. The optimal length at first capture $L_{c, opt}$ (Froese et al. 2016)
# Material and Method

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Location</th>
<th>Lc (cm)</th>
<th>k</th>
<th>M</th>
<th>Z</th>
<th>F</th>
<th>E</th>
<th>FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lethrinus lotianus</td>
<td>Pink ear-emperor</td>
<td>Maluku</td>
<td>31.7</td>
<td>0.1</td>
<td>0.44</td>
<td>1.11</td>
<td>0.67</td>
<td>0.90</td>
<td>1.52</td>
</tr>
<tr>
<td>Pterocaesio tile</td>
<td>Dust-banded salier</td>
<td>Maluku</td>
<td>25.8</td>
<td>0.5</td>
<td>0.97</td>
<td>1.65</td>
<td>0.68</td>
<td>0.84</td>
<td>0.71</td>
</tr>
<tr>
<td>Variola albaimensis</td>
<td>White-edged lyre</td>
<td>North Maluku</td>
<td>44.4</td>
<td>0.38</td>
<td>0.54</td>
<td>1.60</td>
<td>0.55</td>
<td>0.51</td>
<td>1.62</td>
</tr>
<tr>
<td>Cephalopholis beccari</td>
<td>Chocolate hind</td>
<td>North Maluku</td>
<td>31.2</td>
<td>0.36</td>
<td>0.40</td>
<td>1.15</td>
<td>0.75</td>
<td>0.65</td>
<td>1.18</td>
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<tr>
<td>Epinephelus ongus</td>
<td>White-streaked pr</td>
<td>North Maluku</td>
<td>36.2</td>
<td>0.37</td>
<td>0.40</td>
<td>0.93</td>
<td>0.53</td>
<td>0.57</td>
<td>1.33</td>
</tr>
<tr>
<td>Eleotris radialis</td>
<td>Pale snapper</td>
<td>North Maluku</td>
<td>104.2</td>
<td>0.18</td>
<td>0.24</td>
<td>0.64</td>
<td>0.40</td>
<td>0.62</td>
<td>1.67</td>
</tr>
<tr>
<td>Lutjanus gibbus</td>
<td>Humback red snapper</td>
<td>North Maluku</td>
<td>41.2</td>
<td>0.33</td>
<td>0.40</td>
<td>0.90</td>
<td>0.50</td>
<td>0.60</td>
<td>1.50</td>
</tr>
<tr>
<td>Lutjanus vittos</td>
<td>Brownstripe red snapper</td>
<td>North Maluku</td>
<td>34.0</td>
<td>0.37</td>
<td>0.40</td>
<td>0.83</td>
<td>0.43</td>
<td>0.63</td>
<td>1.68</td>
</tr>
</tbody>
</table>

---

# Results

## Length based reference point:

<table>
<thead>
<tr>
<th>No</th>
<th>Species</th>
<th>Current Lc</th>
<th>Lc-opt (F=Current)</th>
<th>Lc-opt (F=M)</th>
<th>Lc-opt (F=0.5 M)²</th>
<th>F/M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lethrinus lotianus</td>
<td>20.00</td>
<td>18.48</td>
<td>18.37</td>
<td>17.70</td>
<td>1.71</td>
</tr>
<tr>
<td>2</td>
<td>Pterocaesio tile</td>
<td>20.68</td>
<td>13.48</td>
<td>13.98</td>
<td>13.03</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td><strong>Maikh</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Variola albaimensis</td>
<td>26.26</td>
<td>26.17</td>
<td>25.75</td>
<td>24.05</td>
<td>1.02</td>
</tr>
<tr>
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<td>Cephalopholis beccari</td>
<td>16.28</td>
<td>20.07</td>
<td>18.92</td>
<td>17.63</td>
<td>1.88</td>
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<td>Epinephelus ongus</td>
<td>21.34</td>
<td>22.71</td>
<td>22.10</td>
<td>20.65</td>
<td>1.33</td>
</tr>
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<td>Epinephelus radialis</td>
<td>34.78</td>
<td>68.38</td>
<td>63.54</td>
<td>59.23</td>
<td>1.67</td>
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<td></td>
<td>Lutjanus gibbus</td>
<td>22.07</td>
<td>26.23</td>
<td>25.67</td>
<td>23.96</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Lutjanus vittos</td>
<td>21.01</td>
<td>21.01</td>
<td>20.86</td>
<td>19.45</td>
<td>1.08</td>
</tr>
</tbody>
</table>

---

# Results – Under-exploited

**Pterocaesio tile**

The lowest exploitation level
Decrease Lc and increase F to result Lopt

$$\text{SPR} = 55\%$$
Results – Sustainable

Variola albimarginata
At the level sustainable where \( F = 0.5^*M - M \)
Decrease \( L_c \) to increase yield and result \( L_{opt} \)
\( SPR = 38\% \)

Results – Decreasing effort

Lutjanus vitta, Epinephelus ongus, L. lentijan
\( F > M \)
increase \( L_c \) for 2 species and decreasing \( L_c \) for \( L. \ lentijan \) to result \( L_{opt} \)
\( SPR = 37\%, 29\%, 22\% \)

Results – Decreasing effort

Cephalopholis boenak, Lutjanus gibbus and
Etelis radios
\( F >>> M \)
Decrease fishing effort to recover
\( SPR = 17\%, 29\%, \) and \( 15\% \)
STATUS OF CORAL REEF FISH STOCK & FISHERY IN FISHERIES MANAGEMENT AREA 715 (Presented by Anthony Sisco Panggabean)

INTRODUCTION

- Fisheries Management Area 715 covering Tomini Bay, Maluku Sea, Seram Sea, Halmahera Sea and Berau Bay
- Reef fisheries in FMA 715 is one of the important activities, and it’s exploitation is traditional or small scale.
- Dominant fishing gear: hand line and bottom long line.
- The best known reef fishing locations in FMA 715 are Togean Island and Berau Bay.
- To find out the stock status and production development of reef fish resources in the FMA 715 waters
MATERIAL AND METHODS

• Data collection was carried out by collecting fisheries statistics data from Directorate General of Capture Fisheries, Indonesian Ministry of Maritime Affairs and Fisheries in 2005 – 2015.

• The analysis for this paper using two approach: non-equilibrium biomass dynamics model (Haddon, 2011) and the surplus production model with logistical model by Schaefer (1954; 1957) and Fox (1970). The software used in this analysis was ASPIC program, developed by Prager (1994, 2002 & 2016).

RESULT AND DISCUSSION

• Development of Catching Effort, Catch and CPUE

- The catch effort is fluctuated gradually between 2005 - 2013. It reached lowest in 2011 and increased gradually in four years.

- The catches slightly increase from 2006 up to one year then remain stable for five years and raise again until 2015.

- The CPUE gradually increase from 2005 to 2013 then fluctuated until 2015.
• Dominant Catch of Coral Reef Fish in FMA 715

The composition of four dominant coral reef fish species landed in FMA 715 fluctuated. The species are: emperors (Lethrinus sp.) (20.49%), wrasse (Caesio sp) (18.25%), red snappers (14.97%), and parrot fish (14.13%).

• Fisheries Production Model and Optimal Production

Table 1. The estimated values of parameters and determination coefficients of the production model of coral reef fishery in the FMA-715

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Schaefer Model</th>
<th>Fox Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td></td>
<td>0.61</td>
<td>0.29</td>
</tr>
<tr>
<td>q</td>
<td>10^5</td>
<td>3.33</td>
<td>3.33</td>
</tr>
<tr>
<td>K</td>
<td>10^6 tons</td>
<td>2.96</td>
<td>4.08</td>
</tr>
<tr>
<td>R²</td>
<td></td>
<td>0.96</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Note: $r^2 = R_{Schaefer}^2$ for Schaefer model (Prage, 1994) $r^2 = R_{Fox}^2$ for Fox model (Fox, 1970).

Based on the result of analysis, the Schaefer Model was better than the Fox Model because the $R$ value is higher (0.96 > 0.95).

Table 2. The optimum value for coral reef fish biomass and production, and the optimum level of fishing mortality, fishing efforts of the coral reef fishery in FMA 715

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Point Estimate</th>
<th>Bias Corrected</th>
<th>Approximate Confidence Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80% lower</td>
</tr>
<tr>
<td>Maximum sustainable yield</td>
<td>MSY</td>
<td>tons</td>
<td>415.749</td>
<td>415.749</td>
<td>670.08</td>
</tr>
<tr>
<td>Fishing mortality at MSY</td>
<td>$F_{MSY}$</td>
<td></td>
<td>0.11</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Catchability coefficient</td>
<td>$q$</td>
<td></td>
<td>3.0066</td>
<td>1.03405</td>
<td>8.40805</td>
</tr>
<tr>
<td>Fishing Effort at MSY</td>
<td>$F_{MSY}$</td>
<td></td>
<td>5.021</td>
<td>3.543</td>
<td>20.021</td>
</tr>
<tr>
<td>Estimated yield in 2014</td>
<td>$Y_{2014}$</td>
<td>tons</td>
<td>411.390</td>
<td>78.100</td>
<td>54.035</td>
</tr>
<tr>
<td>Biomass at MSY</td>
<td>$B_{MSY}$</td>
<td>tons</td>
<td>131.700</td>
<td>431.500</td>
<td>431.500</td>
</tr>
<tr>
<td>Relative biomass at MSY</td>
<td>$B_{relMSY}$</td>
<td></td>
<td>1.08</td>
<td>0.77</td>
<td>1.81</td>
</tr>
<tr>
<td>Relative fishing mortality at MSY</td>
<td>$F_{relFMSY}$</td>
<td></td>
<td>1.42</td>
<td>0.55</td>
<td>2.05</td>
</tr>
</tbody>
</table>
Observed and estimated catch per unit effort of coral reef in FMA-715 stood at about 6.5 tons then decline to around 5.81 tons after two years.

The development of fishing pressures and affected coral reef fish biomass in WPP-715 was shown from the plot of relative fishing mortality and relative fish biomass.

During 2005-2008, fishery was recovering, then entering the safe zone. The stock was in healthy condition for five years from 2009.

Fishing mortality from 2012 slightly decreases and made the fishery status overfishing, but the stock remained in good condition with Bt/Bmsy > 1.

CONCLUSION

- The status of reef fish biomass in FMA 715 was still in good condition, even though the fisheries showed an overfishing trend.
- The status of reef fish is not overfished how ever overfishing was occurring.
STOCK & EXPLOITATION RISK OF SMALL PELAGIC FISH IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA (Presented by Ses Rini Mardiani)

RECOMMENDATION

- Need to regulate the fishing efforts to prevent the stock from declining in the future
- Precautionary approach such as fishing gear use, fishing operations and restrictions on catches
Purseiners in FMA 715

Data

Source: DGC (2016)

17 groups of small pelagic fish species reported in the statistical yearbook of capture fisheries during 2005 – 2015

<table>
<thead>
<tr>
<th>No.</th>
<th>Indonesian name</th>
<th>Common English name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Belalak</td>
<td>Mangrove/blue-spot/blue-tail mullet</td>
</tr>
<tr>
<td>2</td>
<td>Bintang</td>
<td>Oceanic scad/Orgyos scad</td>
</tr>
<tr>
<td>3</td>
<td>Cendro</td>
<td>Needle fish</td>
</tr>
<tr>
<td>4</td>
<td>Diun bambu/Talang-talang</td>
<td>Queenfish</td>
</tr>
<tr>
<td>5</td>
<td>Ikan terbang</td>
<td>Flying fish</td>
</tr>
<tr>
<td>6</td>
<td>Japuh</td>
<td>Rainbow sardine</td>
</tr>
<tr>
<td>7</td>
<td>Juwing-julung</td>
<td>Garfish and Halibaks</td>
</tr>
<tr>
<td>8</td>
<td>Banyar</td>
<td>Indian mackerel</td>
</tr>
<tr>
<td>9</td>
<td>Kembung</td>
<td>Short-bodied mackerel</td>
</tr>
<tr>
<td>10</td>
<td>Layang</td>
<td>Scad, Round-scad</td>
</tr>
<tr>
<td>11</td>
<td>Siro</td>
<td>Spotted sardinella</td>
</tr>
<tr>
<td>12</td>
<td>Silar</td>
<td>Trevallies</td>
</tr>
<tr>
<td>13</td>
<td>Sungkir</td>
<td>Rainbow runner</td>
</tr>
<tr>
<td>14</td>
<td>Tembang</td>
<td>Fringuesca/Deepbody/Goldstriped sardnella</td>
</tr>
<tr>
<td>15</td>
<td>Selangan</td>
<td>Chacunia gizzard shad</td>
</tr>
<tr>
<td>16</td>
<td>Terubuk</td>
<td>Hilsa shad</td>
</tr>
<tr>
<td>17</td>
<td>Tetengker</td>
<td>Torpedo scad</td>
</tr>
</tbody>
</table>

Source: DGC (2016)
Four dominant species

Dominant species contribute small pelagic fishery product (70.3\%):
- round-scads (40.9\%)
- trevallies (14.0\%)
- mackerels (8.4\%)
- sardines (6.9\%).

Data used in the analysis

Source of data:
- Statistical data recorded by Directorate General of Capture Fisheries, MMAF
- Monitoring data consist of fishing activities, catches, fishing vessels and gears collected by Research Institute for Marine Fisheries and/or the Fishing Port Authority
- The fishing effort was standardized into the number of the 20 meter length overall (LOA) vessels operating purse seine.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL CATCH (TONS)</th>
<th>CPUE (TONS/VESSEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>81060</td>
<td>117</td>
</tr>
<tr>
<td>2004</td>
<td>91189</td>
<td>133</td>
</tr>
<tr>
<td>2005</td>
<td>91152</td>
<td>188</td>
</tr>
<tr>
<td>2006</td>
<td>102231</td>
<td>171</td>
</tr>
<tr>
<td>2007</td>
<td>109622</td>
<td>197</td>
</tr>
<tr>
<td>2008</td>
<td>118720</td>
<td>193</td>
</tr>
<tr>
<td>2009</td>
<td>120696</td>
<td>221</td>
</tr>
<tr>
<td>2010</td>
<td>117215</td>
<td>211</td>
</tr>
<tr>
<td>2011</td>
<td>122676</td>
<td>176</td>
</tr>
<tr>
<td>2012</td>
<td>130741</td>
<td>180</td>
</tr>
<tr>
<td>2013</td>
<td>111748</td>
<td>129</td>
</tr>
<tr>
<td>2014</td>
<td>121882</td>
<td>122</td>
</tr>
<tr>
<td>2015</td>
<td>135832</td>
<td>161</td>
</tr>
</tbody>
</table>

Methodology to estimate stock and fishery status

- Biomass dynamics models with Non-equilibrium methods.
- Estimation of the production parameters used least square method with 20000 trials of Monte Carlo simulation and 1500 trials of bootstrapping.
- The analysis to fit non-equilibrium stock-production models to fisheries data was undertaken by using "ASPiC (A Stock–Production Model Incorporating Covariates) Suite", developed by Prager (1994, 2002 & 2016).
- The trajectory of fish biomass and fishing mortality and confidence surfaces, created from the result of bootstrap, were presented by using "KobePlot" software (Nishida et al., 2015).
Methodology to assess risk of over-exploitation

- Risk assessment was conducted to explore the impact of uncertainty (Watson & Sumner, 1999).
- The risk assessment objectives were to estimate probabilities of overexploitation, i.e. violating total biomass at the MSY level ($B_{MSY}$) and fishing mortality at the MSY level ($F_{MSY}$), in three and 10 years later using 10 different catch scenarios.
- The bootstrap method was used to provide estimates of uncertainty using the residuals from the original best fit of biomass dynamic models (Prager, 1994; Haddon, 2011; Kell et al., 2014). This assessment used a non-equilibrium biomass dynamic model (Haddon, 2011).
- The “Risk Assessment” software, developed by Odaira, et al. (2017), was used to perform risk assessments using the residuals from fitting a biomass dynamic model using ASPIC Program version 5.05 (Prager, 1994; 2013).
The estimated values of parameters and determination coefficients of the production model of small pelagic fishery in the FMA 715

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Schafer Model</th>
<th>Fox Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>-</td>
<td>2.186</td>
<td>1.198</td>
</tr>
<tr>
<td>q</td>
<td>$10^{-4}$</td>
<td>3.365</td>
<td>1.426</td>
</tr>
<tr>
<td>X</td>
<td>10^5 tons</td>
<td>2.207</td>
<td>2.701</td>
</tr>
<tr>
<td>$R^2$</td>
<td></td>
<td>0.742</td>
<td>0.752</td>
</tr>
</tbody>
</table>

Note: $r = 2*F_{MSY}$ for Schafer model (Prager, 1994); $r = F_{MSY}$ for Fox model (Fox, 1970).

The optimum value of small pelagic fish biomass and production, and the optimum level of fishing mortality and fishing efforts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Point estimate</th>
<th>Bias-corrected approximate confidence limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum sustainable yield (MSY)</td>
<td>MSY</td>
<td>$10^5$ tons</td>
<td>119.0</td>
<td>111.4 to 128.8</td>
</tr>
<tr>
<td>Fishing Effort at MSY</td>
<td>$F_{MSY}$</td>
<td>No. of purse seiners</td>
<td>840</td>
<td>634 to 1395</td>
</tr>
<tr>
<td>Fishing mortality at MSY</td>
<td>$F_{m}$</td>
<td></td>
<td>1.198</td>
<td>0.75 to 2.19</td>
</tr>
<tr>
<td>Biomass at MSY</td>
<td>$B_{MSY}$</td>
<td>$10^5$ tons</td>
<td>99.6</td>
<td>54.4 to 156.5</td>
</tr>
<tr>
<td>Estimated yield in 2016</td>
<td>$Y_{2016}$</td>
<td>$10^5$ tons</td>
<td>118.9</td>
<td>109.0 to 133.4</td>
</tr>
<tr>
<td>Relative biomass at MSY</td>
<td>$B_{2016}/B_{MSY}$</td>
<td></td>
<td>0.96</td>
<td>0.68 to 1.43</td>
</tr>
<tr>
<td>Relative fishing mortality at MSY</td>
<td>$F_{2016}/F_{MSY}$</td>
<td></td>
<td>1.00</td>
<td>0.61 to 1.33</td>
</tr>
</tbody>
</table>
(A) Estimated trajectory, and (B) trend of the small pelagic fish biomass and fishing mortality

Probabilities (%) of the FMA 715 small pelagic fishery to violate $B_{MSY}$ and $F_{MSY}$ reference levels in three and 10 years

Projections of estimated risk probability of the fishery to violate $B_{MSY}$
Conclusion

• The MSY was about 119 thousand tons per year, resulted by 840 mini purse seiners.
• The probabilities of the fish stock and fishing mortality to violate B_{MSY} and F_{TMR} reference levels decreased with decreases the targeted catch levels.
• In 2015, fishing pressure decreased to the limit of a safe level, but the fish stock was in an overexploited condition and has not recovered to a healthy condition.
• If fishing activities were kept to the current catch level or the MSY level, medium-high risk of biomass or fishing mortality exceeding biomass at MSY (B_{MSY}) or fishing mortality at MSY (F_{TMR}) would occur.

Recommendation

• It is necessary to restore the stock, since the fish stock was in an overexploited condition;
• If B_{MSY} was chosen as the rebuilding target, the stock rebuilding program:
  ▪ Needed strict appropriate management measures, and enhanced monitoring.
  ▪ Should be supported by data collection and a research program.
A BIOECONOMIC MODEL FOR DETERMINING BEST-COMPROMISE SOLUTIONS TO CONFLICTING OBJECTIVES OF SMALL PELAGIC FISHERY MANAGEMENT ADOPTING ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA (Presented by Purwanto)
The high-level policy goals of the utilization of fishery resources

(Act no. 31 of 2004, Act no. 17 of 2007, Presidential Regulation No. 2 of 2015)

- to obtain optimal and sustainable benefits and to ensure sustainability of fishery resources;
- to optimize sustainable use of marine resources;
- to maintain biodiversity and uniqueness of natural resources;
- to maintain the environmental function, carrying capacity, and recoverability.

Operational Objectives of Fisheries Management, and Indicators of achievement

The operational objectives to achieve the broad objectives:
- to optimize sustainable fish production,
- to optimize economic benefit of fishery,
- to increase productivity of fishing vessels,
- to increase employment opportunity for local people to work on fishing vessels.

- Some of those objectives are conflicting and cannot be achieved simultaneously.

<table>
<thead>
<tr>
<th>Operational objectives</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ to optimize sustainable fish production</td>
<td>Total catch</td>
</tr>
<tr>
<td>▪ to optimize economic benefit of fishery</td>
<td>Total economic profit</td>
</tr>
<tr>
<td>▪ to increase productivity of fishing vessels</td>
<td>Catch per unit effort</td>
</tr>
<tr>
<td>▪ to increase employment opportunities for local people to work on fishing vessels</td>
<td>Number of fishers</td>
</tr>
</tbody>
</table>

Measures to achieve management objectives

- Specific controls applied in the fishery to contribute to achieving the management objectives cover:
  - technical measures (gear regulations, closed areas and/or closed seasons),
  - input controls (on fishing effort),
  - output controls (on catches).
- In the case of Indonesia, inputs are more easily monitored than outputs, while catch controls have problems largely associated with monitoring and surveillance.
- In this work, the best solution of conflicting objectives was estimated based on the input control.
**Production and economic profit at different levels of fishing effort**

![Graph showing production and economic profit](image1)

**Trade-off between optimise fishery income and optimise fishery production**

![Graph showing trade-off](image2)

**Trade-off between number of fishers and vessel productivity**

![Graph showing trade-off](image3)

**Fish production, vessel productivity, fishery profits, and employment opportunities in fishing vessels at MSY and MEY management strategies**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Units</th>
<th>Estimated impact of fisheries management</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSY strategy</td>
<td>MEY strategy</td>
</tr>
<tr>
<td>Total catch</td>
<td>1000 tons</td>
<td>119.0</td>
</tr>
<tr>
<td>Catch per unit effort</td>
<td>Tons/Vessel</td>
<td>141.7</td>
</tr>
<tr>
<td>Total economic profit</td>
<td>Rp. billion</td>
<td>467.7</td>
</tr>
<tr>
<td>Number of fishers</td>
<td>People</td>
<td>18480</td>
</tr>
<tr>
<td>Fishing effort</td>
<td>No. of vessels</td>
<td>840</td>
</tr>
</tbody>
</table>

Note: MSY and MEY strategies are management strategies to achieve MSY and MEY, respectively.

5/7/2018

Sustainable Ecosystems Advanced (SEA) Project
Research Institute for Marine Fisheries

usaid.gov
The ideal targets of goals of increasing fish production, vessel productivity, fishery profits, and employment opportunities in fishing vessels

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Units</th>
<th>Estimated impact of fisheries management</th>
<th>Expected value of ideal and anti-ideal targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MSY strategy</td>
<td>MEY strategy</td>
</tr>
<tr>
<td>Total catch</td>
<td>1000 tons</td>
<td>119.0</td>
<td>107.2</td>
</tr>
<tr>
<td>Catch per unit effort</td>
<td>Tons/vessel</td>
<td>141.7</td>
<td>209.5</td>
</tr>
<tr>
<td>Total economic profit</td>
<td>Rp. billion</td>
<td>467.7</td>
<td>607.6</td>
</tr>
<tr>
<td>Number of fishers</td>
<td>People</td>
<td>18480</td>
<td>11264</td>
</tr>
<tr>
<td>Fishing efforts</td>
<td>No. of vessels</td>
<td>840</td>
<td>512</td>
</tr>
</tbody>
</table>

Note: MSY and MEY strategies are management strategies to achieve MSY and MEY, respectively.

A bioeconomic model for mathematical optimisation with multiple goals

Objective of the optimisation is to minimise relative deviation to the targets, weighted by the priority of each fisheries management objective.

Objective function: Minimize $R = w_1 r_1 + w_2 r_2 + w_3 r_3 + w_4 r_4$

Constraint functions:
- Relative deviation to the targets:
  - $r_1 = \eta_1/(G_1 - L_1)$
  - $r_2 = \eta_2/(G_2 - L_2)$
  - $r_3 = \eta_3/(G_3 - L_3)$
  - $r_4 = \eta_4/(G_4 - L_4)$

- Production goal:
  - $G_1 = U_E + \eta_1$

- Fishery profit goal:
  - $G_2 = p_L E + c_E + \eta_2$

- Per vessel profit goal:
  - $G_3 = (p_L - c) + \eta_3$

- Employment opportunity goal:
  - $G_4 = m_E + \eta_4$

- Vessel productivity goal:
  - $U = a_K - (c_K/K) E$

Where:
- $w_1, w_2, w_3,$ and $w_4 =$ Weight that reflect the priorities of each fisheries management objective;
- $G_1, G_2, G_3,$ and $G_4 =$ The ideal goal value of each fisheries management objective;
- $L_1, L_2, L_3,$ and $L_4 =$ Minimum target value or anti-ideal goal of each fisheries management objective;
- $\eta_1, \eta_2, \eta_3,$ and $\eta_4 =$ The negative deviation value of the compromise level of each fisheries management objective against their ideal value;
- $E =$ fishing effort; $n =$ number of crews/vessel; $p =$ fish price; $c =$ cost of fishing/E.

The best-compromise solutions to the conflicting objectives in managing small pelagic fishery in WPP-715

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Units</th>
<th>The best-compromise solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total catch</td>
<td>Thousand tons</td>
<td>116.1</td>
</tr>
<tr>
<td>Catch per unit effort</td>
<td>Tons/vessel</td>
<td>174.4</td>
</tr>
<tr>
<td>Total economic profits</td>
<td>Rp. billion/yr</td>
<td>573.1</td>
</tr>
<tr>
<td>Number of fishers</td>
<td>People</td>
<td>14645</td>
</tr>
<tr>
<td>Effort</td>
<td>No. of vessels</td>
<td>666</td>
</tr>
</tbody>
</table>

Relative fishing mortality: $F/M_{MEY} = 0.79$
Relative biomass: $B_0/B_{M_{MEY}} = 1.23$
INTRODUCTION TO THE USAID SEA SCIENTIFIC SESSION ON “TOWARD SUSTAINABLE FISHERIES IN EASTERN INDONESIA: ASSESSMENT OF FISH STOCKS & FISHERIES IN A DATA-LIMITED CONTEXT”

Abstract: The fish stocks in Fisheries Management Area (FMA) 715 in eastern Indonesia are part of the natural wealth controlled by the state and used to promote prosperity for the people of Indonesia. For the fish stocks of this area to provide sustainable benefits at an optimum level, the government must manage and guide the fisheries utilizing the resource. An ecosystem approach to fisheries (EAF) is being applied by the Government of Indonesia (GOI) in managing fisheries in all its FMAs. Issues in the formulation of fisheries management strategies in Indonesia include the limited availability of data for stock assessment among other constraints. Therefore, assessment methods for fisheries in data-poor/limited situations, i.e. length-based and catch-effort based methods, have been used in FMA 715 for two species groups of primary interest: reef fish and small pelagic fish. These fisheries operate in a marine ecosystem whereby its function and response to fishing are not well known. Consequently, there are uncertainties in the estimated fish stock parameters and it is not only important to assess the fish stock, but also to quantify the risk in the development of a fisheries management strategy. The estimated status of fish stock in FMA 715 and the estimated risk of exceeding the Maximum Sustainable Yield-related reference points of various alternative catch levels are presented in this session. In addition, some operational objectives of EAF are conflicting and cannot be achieved or adopted at once. Thus, a multiple-goal programming model for the small pelagic fisheries of FMA 715 with some conflicting objectives, and the best-compromise solutions are also presented. This session will include six papers that broadly address the fisheries management issues facing FMA 715 in Indonesia and the adoption of an ecosystem approach to fisheries.

LIFE HISTORY PARAMETERS & SPAWNING POTENTIAL RATIO OF *FENNEROPENAEUS MERGUIENSI* & *SCYLLA TRANQUEBARICA* (CRUSTACEAN) IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA

Authors: Duranta D. Kembaren/MMAF-Research Institute for Marine Fisheries; Inayah/WWF-Indonesia; Tri Ernawati/MMAF-Research Institute for Marine Fisheries

Contact: dd.kembaren@gmail.com

Abstract: The banana prawn (*Fenneropenaeus merguiensis*) and purple mud crab (*Scylla tranquebarica*) are two of crustacean resources which are commercially targeted by coastal fishers, especially in Indonesia and South Asian region. They are continuously exploited and, in some areas, indicated to be overfished, hence it is important to understand their status as the effects of exploitation. Life history parameters assessment and spawning potential
ratio (SPR) were applied to evaluate the stock status of these species in Fisheries Management Areas (FMA) 715 of Indonesia. We recorded length and the maturity stages of banana prawn from 6 landing sites and purple mud crab from 2 landing sites in FMA 715. Growth parameters and mortality were analyzed using Rstudio and TropFishR package while SPR was analyzed using LB-SPR method. We found that the growth coefficient of banana prawn was 1.22 per year and the purple mud crab 0.56 per year. The asymptotic lengths of these species were 48.94 mm (carapace length) and 175.08 mm (carapace width), respectively. Based on these life history and natural mortality parameters, the SPR of the banana prawn and purple mud crab were calculated at 27% and 30%, respectively. This study result indicates that banana prawn and purple mud crab are fully exploited.

LIFE HISTORY PARAMETERS & SPAWNING POTENTIAL RATIO OF SOME REEF FISH SPECIES IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA

Authors: Tri Ernowati/MMAF-Research Institute for Marine Fisheries; Fayakun Satria/ MMAF-Research Institute for Marine Fisheries; Irfan Yulianto/WCS-Indonesia; Siska Agustina/WCS Marine-Indonesia Program; Sasi/WWF-Indonesia

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Abstract: Some reef fish such as groupers, snappers, emperors and fusiliers are economically and ecologically important fisheries resources, especially in Indonesia and the Southeast Asian region. They are continuously exploited, and in some areas have collapsed due to high fishing pressure, hence it is important to understand their status. This study aimed to understand their status according to their life history and spawning potential ratio in Fisheries Management Areas (FMA) 715 of Indonesia. We recorded length of Cephalopolis ongus, Cephalopolis boenak, Etelis radiosus, Lethrinus lentjan, Lutjanus gibbus, Lutjanus vitta, Variola alimarginata and Pterocaesio tile from 7 main landing sites in FMA 715, i.e. Ternate, Tidore, Sofifi, Kayoa, Bacan, Gorom, and Grogos. Growth parameters, mortality, length at first capture, were analyzed using Rstudio and TropFishR package while spawning potential ratio was analyzed using LB-SPR method. We found that the growth coefficient of groupers ranged from 0.36– 0.38, snappers ranged from 0.12 – 0.37, emperor around 0.12 and fusilier around 0.6 per year. The lengths asymptotic of these groups were 31.15 – 44.42, 34.03 – 104.20, 31.99 and 25.82 cm (total length), respectively. The natural mortality of all species ranged from 0.16 – 0.97. Based on these life history and natural mortality parameters, spawning potential ratio was estimated to be 17% - 38% for groupers, 15% - 37% for snappers, 20% – 29% for emperors, and 48% - 62% for fusilier. This indicated that snappers and groupers had the highest fishing pressure, followed by emperors and fusiliers; two snapper species and a grouper species were overexploited and the others were fully exploited; the emperor was fully exploited; and the fusilier was underexploited.

LENGTH-BASED REFERENCE POINTS FOR MANAGEMENT OF SOME DEMERSAL FISH STOCKS IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA

Authors: Tri Ernowati/MMAF-Research Institute for Marine Fisheries; Fayakun Satria/MMAF-Research Institute for Marine Fisheries; Irfan Yulianto/WCS-Indonesia; Siska Agustina/WCS Marine-Indonesia Program; Arya Kusuma Dhani/WWF-Indonesia

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Abstract: Groupers, snappers, and emperor are the most important demersal and reef fish in Indonesia, as they have high economic value and significant ecological functions. Consequently, they are under pressure due to simultaneous exploitation. To control the exploitation, it is importance to define and set up reference points to sustain these fisheries. This study aimed to analyze reference points for some important species of demersal fish in Fisheries Management Area (FMA) 715 of Indonesia. We used the optimal length at first capture (L_{c-opt}) as reference points. The L_{c-opt} was calculated based on asymptotic length, natural mortality, and fishing mortality that were estimated from length frequency data from one-year catch monitoring in North Maluku and Maluku Provinces. We calculated L_{L-opt} of Cephalopolis boenak, Epinephelus ongus, Etelis radiosus, Lethrinus lentjan, Lutjanus gibbus, Lutjanus vitta, and Variola alimarginata. We also simulated L_{c-opt} using different fishing mortalities to define target, trigger, and limit reference points and then compared these with current lengths at first capture (L_{c}). We found L_{c-opt} of these species were 20.1, 22.7, 68.4, 18.5, 24.9 - 26.2, 21.0, and 26.2 cm, respectively. The
current length of first capture from all species were higher than $L_{c-\text{opt}}$, except for *Lethrenus lencam*, *Lutjanus vitta* and *V. albimarginata*. It is important to control minimum size of other species, especially *E. radiosus*, which showed a wide difference between $L_{c-\text{opt}}$ and $L_c (> 30 \text{ cm})$.

**STATUS OF CORAL REEF FISH STOCK & FISHERY IN FISHERIES MANAGEMENT AREA 715**

**Authors:** Anthony Sisco Panggabean/MMAF-Research Institute for Marine Fisheries; Muhammad Taufik/MMAF-Research Institute for Marine Fisheries; Dimas Angga Hedianto/ MMAF-Research Institute for Fish Stock Enhancement; Yoke Hany Restiangshi/ MMAF-Research Institute for Marine Fisheries; Masayu Rahmia Anwar Putri/ MMAF-Research Institute for Fish Stock Enhancement

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**Abstract:** Assessment of coral reef fish stock in Fisheries Management Area (FMA) 715 needs to be conducted to update the status of the fish stock and fishery. This study used a fish biomass dynamics model with a non-equilibrium method, which showed that the maximum sustainable yield (MSY) of the coral reef fish stock was about 45,420 tons per year, resulting from fishing effort of 9,221 units equivalent to 7-meter length overall (LOA) vessels operating bottom longline. The fishing effort resulted in a fishing mortality of 0.31. The catch per unit of fishing effort at MSY was about 4.93 ton per vessel. In 2015, the result of the assessment indicated that the fishery experienced overfishing, but the fish stock remained in good condition. It was estimated that the coral reef fish stock would decline if the fishing effort is continuously increased, leading to overfishing.

**STOCK & EXPLOITATION RISK OF SMALL PELAGIC FISH IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA**

**Authors:** Purwanto/National Commission of Fishery Resources Assessment/USAID SEA; Fayakun Satria/National Commission of Fishery Resources Assessment/MMAF-Research Institute for Marine Fisheries; Ses Rini Mardiani/USAID SEA; and Mahiswara/MMAF-Research Institute for Marine Fisheries

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**Abstract:** To improve the strategy to manage the small pelagic fishery in Fisheries Management Area (FMA) 715, it is not only necessary to assess its fish stock and the fishery, but also to quantify the risk in developing a fisheries management strategy. The estimated status of the stock and the estimated risk of exceeding the Maximum Sustainable Yield (MSY)-related reference points of various alternative catch levels resulting from the assessment of the stock and the risk are presented here. The analyses used a fish biomass dynamics model with a non-equilibrium method. The results of the assessment show that the MSY of small pelagic fish stock in FMA 715 was about 119,000 tons per year, resulting from fishing effort by 840 mini purse seiners. The result of the risk assessment indicated that medium-high risk of biomass or fishing mortality exceeding biomass at MSY ($B_{\text{MSY}}$) or fishing mortality at MSY ($F_{\text{MSY}}$), i.e. 71 % and 70%, respectively would occur if fishing activities targeting the small pelagic fishery in FMA 715 were kept to the current catch level or the MSY level. In 2015, fishing pressure decreased to safe level limits level, but the fish stock was in an overexploited condition and has not recovered to a healthy status. Therefore, it is necessary to restore the stock. If $B_{\text{MSY}}$ was chosen as the rebuilding target, the stock rebuilding program would need to include strict, appropriate management measures and enhanced monitoring supported by data collection and a research program, because the risk of violating $B_{\text{MSY}}$ in ten years was at the medium-high level.

**A BIOECONOMIC MODEL FOR DETERMINING BEST-COMPROMISE SOLUTIONS TO CONFLICTING OBJECTIVES OF SMALL PELAGIC FISHERY MANAGEMENT ADOPTING ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT IN FISHERIES MANAGEMENT AREA 715 OF INDONESIA**

**Authors:** Purwanto/The National Commission of Fishery Resources Assessment/USAID SEA; Ses Rini Mardiani/USAID SEA; Tri Wahyu Budiarti/MMAF-Research Institute for Marine Fisheries

**Contact:** purwanto.pp@mail.com
Abstract: Small pelagic fish stocks in Fisheries Management Area 715 have become increasingly important resources to promote economic growth and social development in the current National Development Plan. In order to contribute optimally and sustainably to the National Development, the fishery should be managed properly through an ecosystem approach. The operational objectives of the fishery management are, *inter alia*, to optimize sustainable production and income of the fishery, and to increase fishery productivity and employment opportunities for fishers. Unfortunately, some of those objectives are conflicting and cannot be achieved simultaneously. The results of the analysis indicated that the best-compromise solution to the conflicting objectives was achieved by controlling the fishing effort at about 666 units, equaling the number of the 20-meter LOA vessels. At this fishing effort level, the fishery productivity would be about 174.4 tons per vessel per year, and the fishery would result in fish production of about 116,100 tons and economic profits of about Rp 573.1 billion per year, and would employ about 14,645 fishers. Control of the fishery at the best-compromise solution would ensure the utilization of fish stocks at the optimum and sustainable level as indicated by the relative fishing mortality and the relative fish biomass of 0.79 and 1.23, respectively. This compromise solution is proposed to be used as target reference points for fisheries management.

SESSION SYNTHESIS

By comparing the current production and estimated MSY (maximum sustainable yield), the studies showed that coral reef fish resources in FMA 715 were at risk of overfishing even though the stock was still in a good condition. The fish stock would decline if the fishing effort increased.

Referring to the SPR threshold of 0.3, analysis on the stocks of individual species of reef-associated demersal fish resulted in the conclusion that the status of two snapper species, an emperor species and two groupers species were overexploited. Banana prawn (*Fenneropenaeus merguiensis*) and purple mud crab (*Scylla tranquebarica*) were also evaluated to be in fully exploited status.

Because species that are long-lived species (low M) and relatively slow growing (low K) are more sensitive to exploitation rates and have the longest time to recover, fishing effort needs to be controlled through restrictions on fishing licenses and technical measures such as regulation of mesh size and hooks size for demersal fishing fleets. The level of exploitation for *Variola albilmarginata* should be maintained and exploitation levels should be decreased (by decreasing F and increasing L) for the remaining species, especially *Cephalopholis boenak, Etelis radiatus*, and *Lutjanus gibbus*.

The MSY of small pelagic fish stock in FMA 715 was estimated to about 119,000 tons per year, resulting from fishing effort by 840 mini purse seiners. In operational management, there are conflicting objectives between optimizing sustainable production and income of the fishery, and increasing fishery productivity and employment opportunities for fishers. For small pelagic fisheries in the FMA 715, it is suggested that the best-compromise solution to such conflicting objectives would be achieved by controlling the fishing effort at about 666 units, equal to the number of 20-meter LOA vessels. At this fishing effort level, the fishery productivity would be about 174.4 tons per vessel per year, and the fishery would result in fish production of about 116,100 tons and economic profits of about Rp 573.1 billion per year, and would employ about 146,45 fishers.

The result of risk assessment indicated that medium-high risk of biomass or fishing mortality exceeding biomass at MSY (B\text{MSY}) or fishing mortality at MSY (F\text{MSY}) would occur if fishing activities were kept to the current catch level or the MSY level. The probabilities of the fish stock and fishing mortality to violate B\text{MSY} and F\text{MSY} reference levels decreased with decreases in targeted catch levels. In 2015, fishing pressure decreased to the safe level limits, but the fish stock was already overexploited and has not recovered to a healthy condition.

It is necessary to restore the stock, since the fish stock was in an overexploited condition. If B\text{MSY} was chosen as the rebuilding target, the stock rebuilding program would need strict, appropriate management measures and enhanced monitoring supported by data collection and a research program, because the risk of violating B\text{MSY} in ten years was at the medium-high level.
### ANNEX 6. LIST OF VISITORS TO THE USAID MARINE PROGRAM EXHIBIT AT THE 12TH ASIAN FISHERIES & AQUACULTURE FORUM WHO RECEIVED e-COPIES OF “STATE OF THE SEA: INDONESIA”

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ANNEX 7. PHOTO DOCUMENTATION

Opening ceremony of 12th Asian Fisheries and Aquaculture Forum

USAID SEA Project delegation composed of researchers from MMAF and USAID SEA, from left to right: Tri Ernawati (MMAF), Anthony Sisco Panggabean (MMAF), Duranta D. Kembaren (MMAF), Wijopriono (MMAF), Purwanto (USAID SEA), Irfan Yulianto (WCS), Ses Rini Mardiani (USAID SEA)

Duranta D. Kembaren from MMAF’s Research Institute for Marine Fisheries presenting on “Life history parameters and spawning potential ratio of species *Fenneropenaeus merguiensis* and *Scylla tranquebarica* (Crustacean) in Fisheries Management Area 715 of Indonesia”

Tri Ernawati from MMAF’s Research Institute for Marine Fisheries presenting on “Life history parameters and spawning potential ratio of some reef fish species in Fisheries Management Area 715 of Indonesia”

Irfan Yulianto from WCS presenting on “Length-based reference points for management of some demersal fish stocks in Fisheries Management Area 715 of Indonesia”
Anthony Sisco Panggabean from MMAF’s Research Institute for Marine Fisheries presenting on “Status of reef fish stock and fishery in Fisheries Management Area 715 of Indonesia”

Ses Rini Mardiani of USAID SEA presenting on “Stock and exploitation risk of small pelagic fish in Fisheries Management Area 715 of Indonesia”

Prof. Michael D. Pido (Dean, Graduate School, Palawan State University, Philippines) asking for clarification on the methodology used to determine best-compromise solutions to conflicting fisheries management objectives, following the presentation by Dr. Purwanto of USAID SEA on “A bioeconomic model for determining best-compromise solutions to conflicting objectives of small pelagic fishery management adopting ecosystem approach in Fisheries Management Area 715 of Indonesia”

Professor Encarnacion Emilia S. Yap, Dean of the College of Fisheries and Oceans Sciences, the University of Philippines Visayas, with USAID SEA’s Dr. Purwanto and Ses Rini Mardiani, after receiving e-copy of “State of the Sea: Indonesia”

USAID SEA-supported participants providing their inputs during the 12th AFAF Regular Scientific Session
Exhibit on "USAID Marine Resource Management Programs" presented by USAID SEA in collaboration with the USAID Oceans and Fisheries Partnership at the four-day exhibition held parallel to the 12th AFAF.