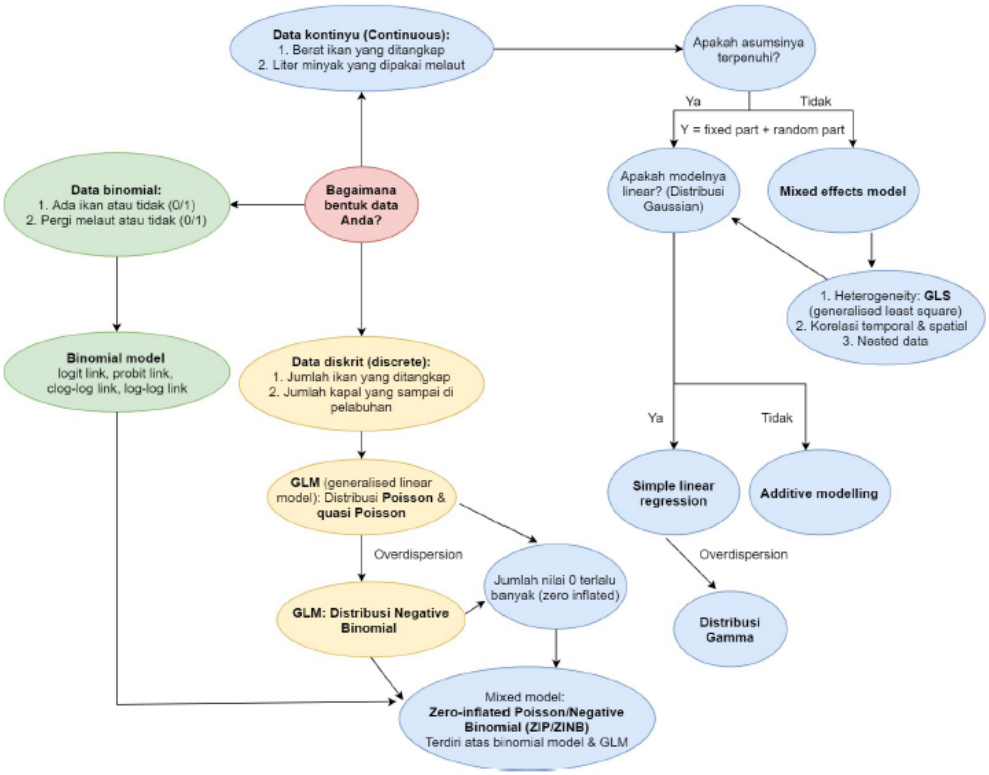

TRAINING WORKSHOP ON CATCH PER UNIT EFFORT (CPUE) STANDARDIZATION FOR HARVEST STRATEGY DEVELOPMENT

Bogor, July 16-19, 2019 & August 8, 2019

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DISCLAIMER
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INTRODUCTION

In the Fisheries Act No. 31 2004, amended by Act No. 45 2009, stated that "Fisheries management covers all efforts, including integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources, and implementation and enforcement of legislations in fisheries, undertaken by government or other authority in order to accomplish the continued productivity of the resources and other agreed objectives".

For fisheries management purposes, Indonesia waters have been clustered into 11 Fisheries Management Areas (FMA or *Wilayah Pengelolaan Perikanan Indonesia*) (Decree of Minister of Marine Affairs and Fisheries No. PERMEN.18/MEN/2014). However, majority of fishery resources in the Indonesian waters were in fully- or over-exploited conditions, indicating that the fisheries management was ineffective. Fisheries Management Plans for 11 FMAs, including Fisheries Management Plan (FMP) for FMA 715 (Decree of Minister of Marine Affairs and Fisheries No. 82/KEPMEN-KP/2016), have been developed by the MMAF.

Unfortunately, those FMPs were not completed with all key elements of harvest strategy. Harvest strategy for tuna fishery is being developed by MMAF with a support provided by WCPFC and Australia. Meanwhile, development of harvest strategies for other two important fisheries, i.e. small pelagic and reef fisheries, has not been carried out. To support the Government of Indonesia to strengthen the Indonesian fisheries management, the USAID Sustainable Ecosystem Advanced (SEA) Project in collaboration with the MMAF Directorate of Fishery Resources Management and Research Center for Fisheries/Research Institute for Marine Fisheries has initiated the development of harvest strategy for small pelagic and reef fisheries.

Various activities related with harvest strategy development have been implemented including data collection and planning workshops and stock assessment trainings. To date, several milestones have been achieved including two-year fish landing data collection, and stock assessments using fishery statistic data with non-equilibrium biomass dynamic model and length-based stock assessments including Spawning Potential Ratio (SPR). The results of the stock assessments for demersal and small-pelagic were presented and accepted by National Commission for Fishery Resources Assessment and will be used as the basis in developing the harvest strategy of the fisheries of concern.

USAID SEA Project has conducted workshops for developing harvest strategies for small-pelagic and reef fish in 715 FMA. In this workshop, the stock assessment results for small pelagic and reef fish at FMA 715 were presented to the fisheries managers and followed by commitment among the fisheries managers, scientists and NGOs to develop harvest strategy on small pelagic and reef fish at FMA 715. A road map of activities to develop harvest strategies has been developed based on the activities and methods used in constructing key elements of the harvest strategy.

In developing harvest strategy, catch per unit effort (CPUE) is required in setting alternative reference points and management measures. CPUE is monitored, assed and used in the evaluation of fishery performance relative to operational objectives. CPUE is commonly obtained from fishery-dependent data because it is readily available and less resource-intensive than conducting a statistically designed fishery-independent survey. CPUE rates can be influenced by many factors such as fleet dynamics, schooling behavior, gear selection, and seasonal and spatial allocation of fishing effort in a way that interpretation of CPUE can be misleading if these confounding factors are not taken into account (Hilborn and Walters 1992). Therefore, standardization of the CPUE should be carried out that involves data processing, model selection and analyses.

Although the standardization of the CPUE is importance to ensure robustness of the assessment result and management plan, it is rarely used by MMAF/BRPL researchers. To increase the capacity of the researchers in the assessment, Research Institute for Marine Fisheries and the USAID Sustainable Ecosystem Advance (USAID SEA) Project had conducted Training-Workshop on CPUE Standardization for Harvest Strategy Development which covered methodology of CPUE standardization and data analysis.

OBJECTIVES OF ACTIVITY

The objectives of the training-workshop were:

1) To build understanding on the importance of standardization of the CPUE in fisheries management planning, including development of harvest strategy, and implementation.
2) To build capacity of researchers in standardization of CPUE by introducing methodology and practicing analyses by using various models.
3) To exercise the analysis of CPUE Standardization for small pelagic and reef fishery that can be used for harvest strategy development and to write up the result of the analysis.

IMPLEMENTATION

The training-workshop was held:

Day, Date : Tuesday – Friday; July 16-19 2019 & Thursday, August 8, 2019

Time : 08.30 – 16.30 WIB

Place : Sempur - Bogor

The agenda of the training workshop as below

DAY, DATE	TOPICS	DURATION/TRAINERS
Tuesday, July 16, 2019	- Introduction and significance of standardization used in CPUE calculation - Introduction and overview several model distributions in GLM - Understand type of data available - Understand dataset for inputs - Data preparation	8 hours / Purwanto, PhD, Ulfah Mardhiah, PhD and Irfan Yulianto, PhD.
Wednesday, July 17, 2019	- Data cleaning and data preparation - Understanding the assumptions for normal distribution (QQ-plot and homogeneity residual) - Selection on model distribution: collinearity, residual distribution, AIC) - Selection best fitted model (dredge, drop1)	8 hours / Ulfah Mardhiah, PhD and Irfan Yulianto, PhD.
Thursday, July 18, 2019	- Introduction Gamma distribution - Introduction Poisson distribution - Introduction Negative Binomial distribution - Exercise dataset using Gamma, Poisson and Negative Binomial	8 hours / Ulfah Mardhiah, PhD and Irfan Yulianto, PhD.
Friday, July 19, 2019	- Introduction Bernoulli and Binomial distribution - Introduction zero truncate and zero inflated distribution	8 hours / Ulfah Mardhiah, PhD and Irfan Yulianto, PhD.

DAY, DATE	TOPICS	DURATION/TRAINERS
	- Exercise dataset using binomial and zero inflated distribution	
Thursday, August 8, 2019	- Exercise and present the result of CPUE Standardization using each participant's data	8 hours / Ulfah Mardhiah, PhD

SUMMARY OF PARTICIPANTS

The training workshop on CPUE standardization was organized by the Research Institute for Marine Fisheries (Balai Riset Perikanan Laut – BRPL) in collaboration with the USAID SEA Project in Bogor. Participants involved in these activities were researchers from Research Institute for Marine Fisheries with instructors from USAID SEA Project (SEA CORE and Partners). Total active participants from BRPL was 10 researchers. Summary of participants' from BRPL is presented in Table 1 and detail of participants attendance list is presented in APPENDIX II.

Table 1. Summary of Participants from BRPL and Instructors

NO	NAME	GENDER
1.	Achmad Zamroni	Male
2.	Asep Priatna	Male
3.	Duranta D Kembaren	Male
4.	Erfind Nurdin	Male
5.	Fayakun Satria	Male
6.	Moh. Fauzi	Male
7.	Muhammad Taufik	Male
8.	Tirtadanu	Male
9.	Tri Ernawati	Female
10.	Tri Wahyu Budiarti	Female

KEY OUTPUTS, OUTCOMES AND ACHIEVEMENT

The training-workshop was intended to provide participants, who were the researchers of the MMAF RIFM, concept, theory and practices related with CPUE and CPUE standardization. In general, the concept and the theory of catch per unit effort (CPUE) in fisheries biology and fisheries economic and CPUE standardization were provided by Purwanto, PhD (USAID SEA Project), while the theory and practices of statistical analysis and the R program for standardizing calculating CPUE were provided by Ulfah Mardhiah, PhD (WCS) and Irfan Yulianto PhD (WCS). Purwanto also provided some notes and interpretation of the results of the statistical analysis and the standardized CPUE.

A. DAILY TOPICS AND DISCUSSION

Day-1: Tuesday, July 16, 2019

In the first session, Purwanto delivered the introductory to the CPUE standardization and the importance of standardization used in CPUE calculation. Referring to Quinn & Deriso (1999)[1], Purwanto explained the theory of population dynamic. He explained that mortality causes negative population growth, with a consequence year-class abundance decreases exponentially over age under constant instantaneous mortality. With an assumption that each unit of fishing effort operates independently and additively, the instantaneous change in catch would be proportional to fishing effort per unit time and abundance. Then, Purwanto explained that catch-per-unit-effort (CPUE) is proportional to average abundance. Therefore, CPUE can be used as an index of abundance over time, in the sense that proportional changes in CPUE are equal to proportional changes in abundance.

Purwanto explained that CPUE is commonly obtained from commercial fishery-dependent data because it is readily available and less resource-intensive than conducting a statistically designed fishery-independent survey. Unfortunately, as explained by Hilborn and Walters (1992)[2], CPUE rates can be influenced by many factors such as fleet dynamics, schooling behavior, gear selection, and seasonal and spatial allocation of fishing effort in a way that interpretation of CPUE can be misleading if these confounding factors are not taken into account. Therefore, standardization of the CPUE should be carried out.

There are two different approaches in standardization of catch per unit effort. The first approach is conducted through direct experimentation. All gear types of interest are fished in the same area and CPUEs from all gear types are compared to a standard gear type. This results in the calculation of fishing power coefficients for each gear. The second approach involves the comparison of CPUE data over a number of years to separate effects from many factors, such as country, gear type, tonnage class, month, area fished, and year. More general, the factors can be fleet dynamics, schooling behavior, gear selection, and seasonal and spatial allocation of fishing effort (Hilborn & Walters, 1992; Quinn & Deriso, 1999). The CPUE standardization that would be introduced during the training workshop belong to the second approach.

In the second session, Irfan Yulianto delivered introduction and overview several model distributions in GLM, type of data available, and dataset for inputs. In the introduction of the model, Irfan started with linear model with Gaussian probability density function. This linear model requires that four assumptions have to be fulfilled, namely normality, homogeneity, fixed explanatory variable, and independence of explanatory variables. Irfan and Ulfah explained the statistical tests to evaluate whether those four assumptions were met. Then they demonstrated the application of R program of statistical analysis applied in the CPUE standardization. Irfan and Ulfah used a textbook written by Zuur et al (2009) as a reference.3

[1] Quinn, T.J. & R.B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press, New York, Oxford. 542p.

[2] Hilborn, R., and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, dynamics, and uncertainty. Chapman & Hall. London. 570p.

[3] Zuur, A.F., E.N. Ieno, N.J. Walker, A.A. Saveliev, & G.M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer Science+Business Media, New York. 574p.

In the last session, the participants were explained data preparation for the CPUE standardization. Then, the participants prepared their data for practices in the CPUE standardization. Their data were the result of fishery monitoring.

Day-2: Wednesday, July 17, 2019

In the second day, an R program for statistical analysis used in the standardization of CPUE was introduced by Ulfah. Data on per vessel catch of Cephalopholis boenak collected from the monitoring of catch landed by vessels from fishing in sea waters around Halmahera Island were used. The data and R script were distributed to participants for CPUE standardization calculation exercise. The participants were explained the process of data cleaning that should conducted before analysis. It was explained how to test the assumptions for normal distribution by evaluating QQ-plot and homogeneity residual. It was explained further the selection on model distribution by evaluating collinearity, residual distribution and Akaike information criterion (AIC). If the normality assumptions were not fulfilled, other probability distribution functions, namely Gamma, Poisson, binomial, negative binomial and Bernoulli, should be evaluated for use in the analysis. Other step of analysis explained was how to select the best fitted model from various statistical models for a given set of data by using dredge and drop methods. The participants practiced the steps of data cleaning and analysis by using the R script and the data that have been distributed.

Day-3: Thursday, July 18, 2019

Ulfah and Irfan introduced other probability distribution functions as alternatives to be used in the analysis when the normality assumptions were not fulfilled. The other distribution functions explained in the third day were Gamma, Poisson and Negative Binomial distributions. They also explained the different amongst those probability distributions. In general, type of data, their mean and variance are considered in the selection of statistical models and the distribution function to be used. The participants practiced in the selection of statistical models and the distribution function by using the R script and the data that have been distributed.

Day-4: Friday, July 19, 2019

Other probability distribution functions as alternatives to the Gaussian were explained in the fourth day. Those other distribution functions were Bernoulli, Binomial, zero truncate and zero inflated distribution. The participants practiced in the selection of statistical models and the distribution function by using the R script and the data that have been distributed.

Day-5: Thursday, August 8, 2019

As agreed in the fourth day of the training workshop on CPUE standardization, the participants analyzed their data. In the fifth day of the training workshop, for the participants who had finalized the analysis consulted the results to Ulfah. For the participants who have not finalized the analysis continued the analysis or consulted their statistical or programming problem they faced in the analysis before continuing their analysis. The result of analyses undertaken by the participants were presented and discussed as a lesson learned.

B. SELF ASSESSMENT

Based on information collected through self-assessment, all the participants agreed that the training workshop was in line and relevant to perform their duties and the methods practiced were applicable to

be used in their jobs (Figure 1). Participants were also satisfied with the trainers and resource persons. The environment and atmosphere supported the learning process.

The participants were selected with stringent criteria targeting only for those who committed to participate for each session, having willingness to learn, and having background on operating R software. Based on the self-assessment, it was found that all the participants have benefits from this training workshop.

Participants also assessed the level of knowledge and skill improvement by scoring (scale 1 to 5) their skills and knowledge prior and after the training workshop. All the participants increased their understanding and skill particularly in these three topics, i.e. 1) Understand the process of cleaning and preparation data before analysis; 2) Understand assumptions filled in using normal distribution (QQ-plot, homogeneity, residual); 3) Understand and able to use Poisson distribution. The detail result of status before and after training workshop presented in the Figure 2.

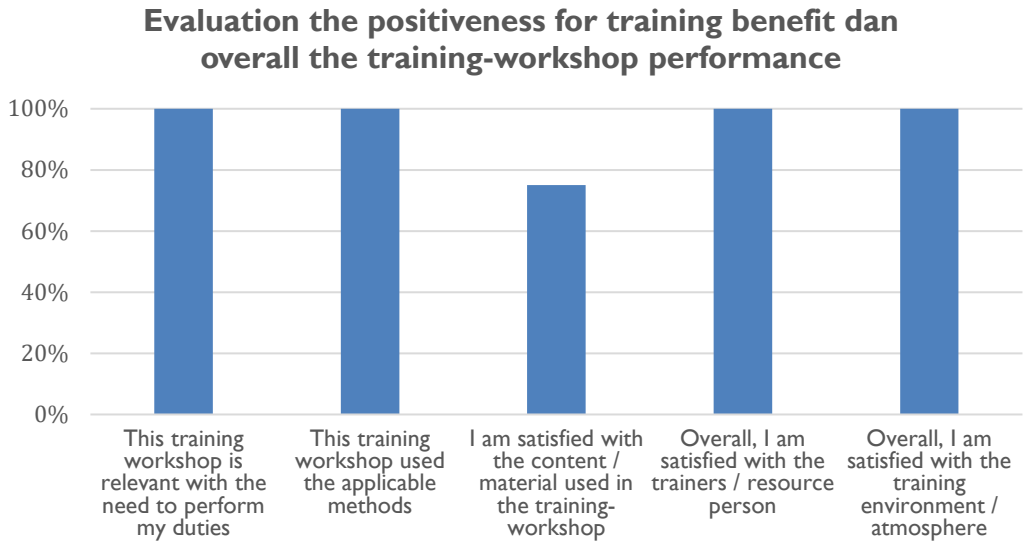


Figure 1. Evaluation the positiveness for training benefit and overall the training workshop performance

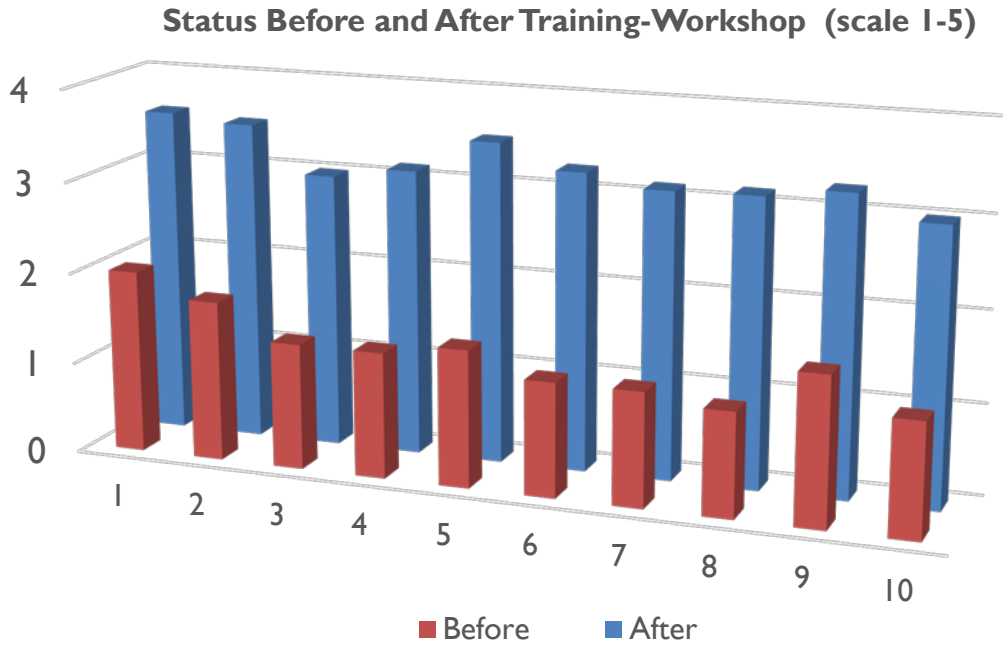


Figure 2. Status Before and After Training Workshop

Notes:

1. Understand the process of cleaning and preparation data before analysis
2. Understand assumptions filled in using normal distribution (QQ-plot, homogeneity, residual)
3. Understand Gamma distribution
4. Understand the concept using additive model
5. Understand and able to use Poisson distribution
6. Understand and able to use Negative binomial distribution
7. Understand the concept of Bernoulli dan Binomial distributions
8. Understand and able to use zero truncated and zero inflated distributions
9. Able to choose the right model for each data set (AIC, residual, R2)
10. Able to determine the best fit model (drop1, dredge)

In self-assessment, each participant also stated that they have benefits (knowledge and thought) that can be used in their works. Below are several lessons learn that will be applied in the participants' work:

- Understand that their data can be analyzed with several types
- Understand how to assess the data
- Enable to apply in their type of data collected in their institution
- Understand the process of cleaning and preparation data, distribution data, and some models
- Understand normal distribution, correlation test, fitting models, select the models and significannce test.

Furthermore, to improve the training workshop, participants also provided some suggestion that can be seen in Table 2. The specific suggestion relates with the time allocation which more than half of participants (62.5%) suggested longer time for training-workshop.

Table 2. Some suggestions from participants

Some Topics suggested by participants to be added	Suggestion for the next training
▪ Sampling methods ▪ Analysis CPUE with numerous types of fishing gears and fishing ground ▪ Interpretation of the result and how to write it in to a paper ▪ Exercising with case study multigears and multispecies and relationship among the fishing gears and species caught ▪ Application the result of data produced by GLM in determining potency in stock assessment	▪ Using reseachers data as a study case ▪ The type of training can be short course with comprehensive stock assessment material, followed by analysis using real data and real output for policy brief and scientific paper. ▪ Time allocation needs to be extended ▪ Refreshment training ▪ Output interpretation and paper writing

RECOMMENDATIONS

1. The training workshop has equipped the researchers with methods to standardize the CPUE which can be applied into several data sets and other types of fisheries. .
2. Data cleaning and preparation take the longest in the analysis. To anticipate efficiency, researchers are expected to regularly monitor the data submitted by the enumerators and to supervise them to ensure data are collected in accordance with the data collection protocol.
3. The reseachers also need to understand the real condition of data sampling because in analysis, it is expected that the result is not only statistically accepted, but also biologically make sense.

FOLLOW UP ACTIVITIES

1. The researchers will analyze CPUE standardization using their data collected in several species and several FMA.
2. The trainers are always available for consulting if the reseachers find some issues.

REFERENCES

Hilborn, R., and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, dynamics, and uncertainty. Chapman & Hall. London. 570p.

Quinn, T.J. & R.B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press, New York, Oxford. 542p.

Zuur, A.F., E.N. Ieno, N.J. Walker, A.A. Saveliev, & G.M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer Science+Business Media, New York. 574p.

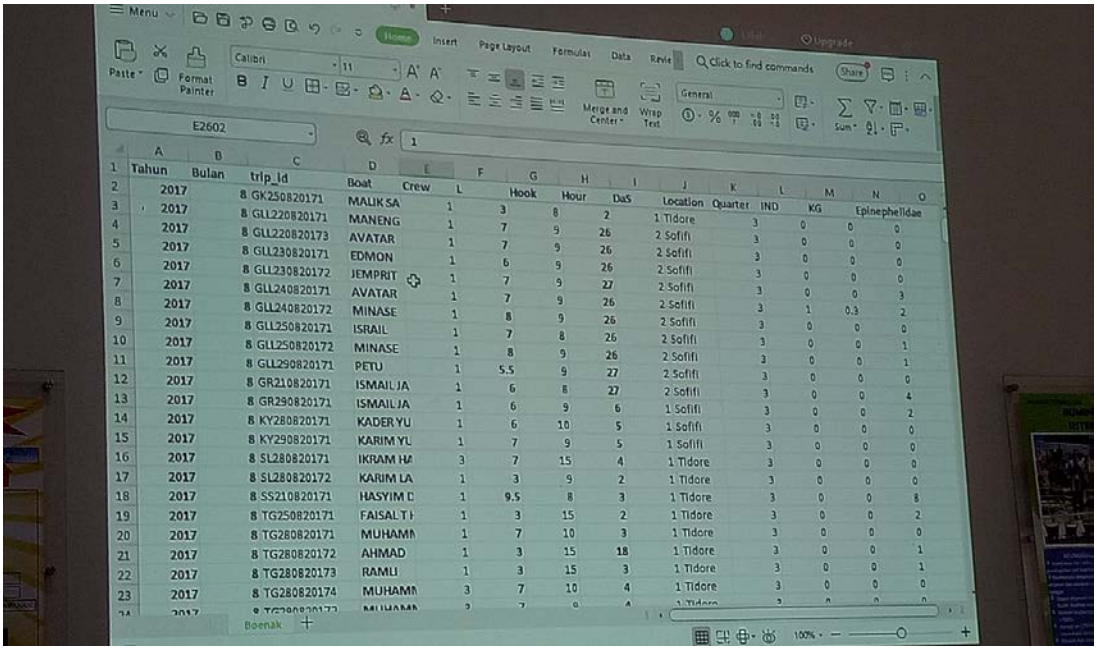
APPENDIX

APPENDIX I. DOCUMENTATION

Figure 1. Participants of the training workshop on Catch Per Unit Effort (CPUE) standardization

Figure 2. Purwanto, Ph.D delivered the introduction and objectives of the training workshop and explained the significance of standardization used in CPUE calculation

Figure 3. Ulfah Mardhiah, Ph.D explained the topics of introduction to GLM and several distribution function in GLM



Tahun	Bulan	trip_id	Boat	Crew	L	Hook	Hour	DaS	Location	Quarter	IND	KG	Epinephelidae
2017	8	GK250820171	MALIK SA		1	3	8	2	1 Tidore	3	0	0	0
2017	8	GLL220820171	MANENG		1	7	9	26	2 Sofifi	3	0	0	0
2017	8	GLL220820173	AVATAR		1	7	9	26	2 Sofifi	3	0	0	0
2017	8	GLL230820171	EDMON		1	6	9	26	2 Sofifi	3	0	0	0
2017	8	GLL230820172	JEMPRIT		1	7	9	27	2 Sofifi	3	0	0	0
2017	8	GLL240820171	AVATAR		1	7	9	26	2 Sofifi	3	0	0	3
2017	8	GLL240820172	MINASE		1	8	9	26	2 Sofifi	3	1	0.3	2
2017	8	GLL250820171	ISRAIL		1	7	8	26	2 Sofifi	3	0	0	0
2017	8	GLL250820172	MINASE		1	8	9	26	2 Sofifi	3	0	0	1
2017	8	GLL290820171	PETU		1	5.5	9	27	2 Sofifi	3	0	0	1
2017	8	GR210820171	ISMAIL JA		1	6	8	27	2 Sofifi	3	0	0	0
2017	8	GR290820171	ISMAIL JA		1	6	9	6	1 Sofifi	3	0	0	4
2017	8	KY280820171	KADER YU		1	6	10	5	1 Sofifi	3	0	0	2
2017	8	KY290820171	KARIM YL		1	7	9	5	1 Sofifi	3	0	0	0
2017	8	SL280820171	IKRAM HA		3	7	15	4	1 Tidore	3	0	0	0
2017	8	SL280820172	KARIM LA		1	3	9	2	1 Tidore	3	0	0	0
2017	8	SS210820171	HASYIM D		1	9.5	8	3	1 Tidore	3	0	0	8
2017	8	TG250820171	FAISAL T H		1	3	15	2	1 Tidore	3	0	0	2
2017	8	TG280820171	MUHAMM		1	7	10	3	1 Tidore	3	0	0	0
2017	8	TG280820172	AHMAD		1	3	15	18	1 Tidore	3	0	0	1
2017	8	TG280820173	RAMLI		1	3	15	3	1 Tidore	3	0	0	1
2017	8	TG280820174	MUHAMM		3	7	10	4	1 Tidore	3	0	0	0

Figure 4. Ulfah Mardhiah, Ph.D explained structure of the data that used as study case in the training workshop

Figure 5. Irfan Yulianto, Ph.D explained the topics on CPUE standardization using GLM methods

Figure 6. Participants and trainers discussed and paid attention to the topics during the training workshop