Bioeconomic assessment for the utilization of shared small pelagic fish stock in the Ombai Strait

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Abstract. The Ombai Strait's small pelagic fish resource is a shared stock between Indonesia and Timor Leste and has provided several economic and social benefits to the people of both countries. In the sustainable management of small pelagic fisheries, data, and information regarding the biological and economic aspects of small pelagic fishery resources serve as a basis for policy formulation. Therefore, the purpose of this study is to determine the status and economic rent of small pelagic fishery stock within the Ombai Strait, in the border of Indonesia and Timor Leste. Data on small pelagic fishing activities were collected at 8 fishing bases in the two countries, while data on the catch of four small pelagic fish species and fishing effort (trip) during the period 2012 - 2018 were obtained from the statistical data on capture fisheries in Belu Regency, Indonesia and in Bobonaro District, Timor Leste. Subsequently, data analysis was performed using a surplus production model, while the best estimation paradigm selected was the Walters & Hibron model. The estimation of biology parameters showed goldstripe sardinella (*Sardinella* sp.) had the highest intrinsic growth rate (r) of 2.4464 kg per year, while the mackerel scad (*Decapterus* sp.) had the highest catchability coefficient (q) of 0.000081 kg per trip, and the flying fish (Exocoetidae) had the highest carrying capacity (K) of 2 645 047.98 kg per year. In addition, the stock status of flying fish and goldstripe sardinella resources were discovered to be of good condition and have not experienced biological or economical overfishing, while the yellowstripe scad (*Selaroides* sp.) fish counterpart was found to be overfished biologically and economically, however, actual fishing effort has not exceeded the fishing effort in Maximum Sustainable Yield (MSY) conditions. Meanwhile, the stock status of mackerel scad fish resources, were discovered to have experienced overfishing biologically and economically. The total economic rent of small pelagic fishery resources at optimum conditions, within the Ombai Strait, in the border of Indonesia and Timor Leste, was found to be IDR 34,478,680,000, per year, with goldstripe sardinella and flying fish comprising 56.63% and 41.08% of this value, respectively. Furthermore, Belu Regency receives a 35% higher economic rent, compared to Bobonaro District. Therefore, fishing efforts in the management of small pelagic fisheries within the Ombai Strait, particularly the yellowstripe scad and mackerel scad, require improved management.
Key Words: biological aspects, economic aspects, fish resources, Indonesia, Timor Leste.

Introduction. The Ombai Strait is located between Alor Island, Indonesia, and the northern coast of Timor Leste, stretching from southwest to northeast (Rehatta et al 2020), connecting the Banda Sea in the north and the Savu Sea in the south (Molcard et al 2001). The strait is rich in fish resources, especially small pelagic fishes, due to the strategic location in the Indonesian Through Flow (ITF), leading to high aquatic productivity in this region. Also, the complex topography and strong tidal currents promote permanent upwelling so that Ombai Strait is characterized by colder temperature, nutrient-rich sea surface resulted in high concentrations of phytoplankton (Moore II & Marra 2002).

Small pelagic fish assemblages in the Ombai Strait are considered as shared stocks (transboundary resources) between Indonesia and Timor Leste. These resources have been jointly utilized by fishermen in the two countries and have served as a significant source of income, animal protein, and livelihood for the people. The contribution of small pelagic fish to total marine fishery production was 53.1% in Belu Regency, Indonesia (Diskan Belu 2019) and 80.0% in Bobonaro District, Timor Leste (NDFA MAF 2019). However, there are various problems regarding the utilization of these resources. ATSEA (2011) identified transboundary issues related to capture fisheries within the border of the two countries, including the threats of decreasing biodiversity, overfishing, illegal, unreported, and unregulated (IUU) fishing, as well as by catch fisheries.

Unless properly managed, the contradictive between the benefits in one hand and spatial utilization as well as uncontrolled fishery activities in the other presents threats on economic, social, political, and security related problems. Fauzi (2004) stated the fundamental problems in managing fishery sustainably is generating maximum benefits for the community, without sacrificing the sustainability of the fish stock. For a better management of small pelagic fisheries, data and information regarding biological and economic aspects serves as a basis for policy formulation. The most suitable management policy is selected to maximize production, economic benefits and ensure the sustainability of fish resource stocks, and the dynamics of marine ecosystems (Évora et al 2016; Piet et al 2015). Therefore, this study aims to determine the status and economic rent of small pelagic fish stock within the Ombai Strait, bordering between Indonesia and Timor Leste.

Material and Method

Research location. This study was conducted within the border of Indonesia (Belu Regency) and Timor Leste (Bobonaro District), from May 2018 - June 2019 (one year). Meanwhile, the observations and interviews were carried out at eight fishing bases of the two regions. These bases were Dualaus, Jenilu, Kenebibi, as well as Silawan, in Belu Regency, and Enelaran, Beacou, Sanirin, as well as Batugade, in Bobonaro District (Figure 1).

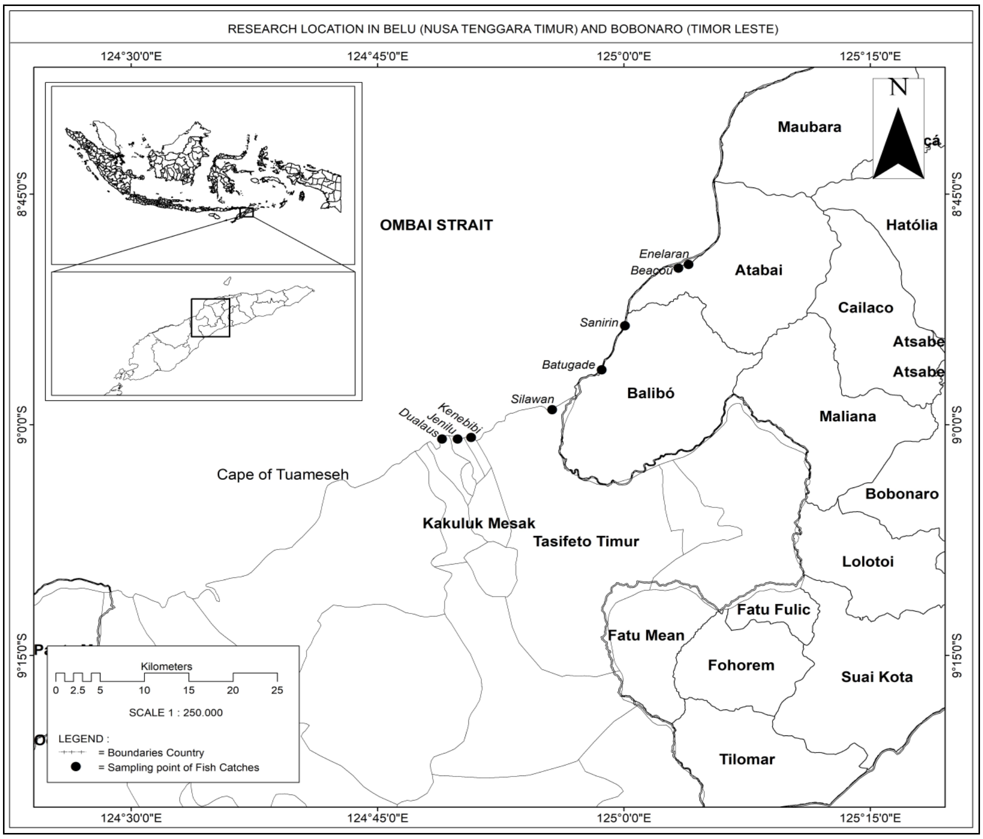

Figure 1. Research locations (●) in Belu Regency, Indonesia and Bobonaro District, Timor Leste (modified from Rehatta et al 2020).

Data collection. This study utilized both primary and secondary data. The primary data was obtained by interviewing 60 fishermen involved in small pelagic fisheries in Belu Regency, Indonesia, as well as in Bobonaro District, Timor Leste. Data collected consisted of catch, fishing gear, fishing fleet, number of trips, area, season, and costs, according to the type of fishing fleet and gear, as well as the price of fish species caught. The respondents were selected using purposive sampling (deliberate determination of respondents based on criteria or considerations), and the fishing costs were assumed to be constant and based on only the fishing factor. There are four dominant small pelagic species in Ombai strait fisheries, i.e., mackerel scad (*Decapterus* sp.), yellowstripe scad (*Selaroides* sp.), goldstripe sardinella (*Sardinella* sp.), and flying fish (Exocoetidae).

A study by Évora (2016) stated fishing costs include fixed and variable costs, however, in this study, fishing costs are defined as the variable costs per trip, which include the price of fuel (diesel or gasoline), ice, and food. Fishing costs in the two locations was calculated using primary data from year 2018 as a nominal cost, and East Nusa Tenggara's fresh fish Consumer Price Index (CPI) for Belu Regency and the Timor Leste's fish and seafood CPI for Bobonaro District, both from 2012 to 2018.

In addition to the bioeconomic analysis, it is important to consider the maximum level of exploitation by using biological and economic approaches, and this is an applicable alternative management technique for optimizing sustainable utilization. Zairion et al (2019) reported bio-economic analysis was carried out to determine the optimum utilization rate of fishery resources. The cost of fish caught is an important factor in the economic analysis of fish resources, and the price variable influences the amount of revenue obtained from fishing activities.

Meanwhile, secondary data comprised of fisheries statistical data on production, fishing gear and fleets, as well as fishing trips between 2012 and 2018, obtained from the Belu Regency Fisheries Office, the East Nusa Tenggara Province Marine and Fisheries Agency, and the National Directorate of Fisheries and Aquaculture (NDFA), Timor Leste. Also, the CPI data for fishery products were obtained from the East Nusa Tenggara Province Statistics Agency (www.ntt.bps.go.id) and the General Directorate of Statistics, Timor Leste (www.statistics.gov.tl).

Data analysis. The catch analysis was performed using catch per unit effort (CPUE method), based on fishing unit and corespond trip number for small pelagic species caught in the two regions in the last 7 years. Equation 1 shows the CPUE formula used, the estimation procedure using the Schaefer model (1954).

$$\text{CPUE}\left(\frac{\text{kg}}{\text{trip}}\right) = \frac{\text{Production (kg)}}{\text{Effort (trip}} \quad (1)$$

The small pelagic fish catch is caught by seven types of fishing gear (handline, pole lines, drift gillnets, encircling gillnets, beach seine, large net and purse seine). Therefore, prior to the CPUE analysis, fishing gear standardization was carried out using the fishing power index (FPI) analysis as shown below.

$$\text{CPUE}_r = \frac{\text{Catch}_r}{\text{Effort}_r} \quad (2)$$

$$\text{CPUE}_s = \frac{\text{Catch}_s}{\text{Effort}_s} \quad (3)$$

$$\text{FPI}_i = \frac{\text{CPUE}_r}{\text{CPUE}_s} \quad (4)$$

where:

$CPUE_r$ = total catch per unit of fishing effort from fishing gear, r, to be standardized (tonnes/trip).

$CPUE_s$ = total catch per unit of fishing effort from fishing gear, s, used as standard (tonnes/trip), and

FPIi = fishing power index of fishing gear, i, (standardized and standard fishing gear).

The fishing gear with the highest CPUE value is used as standard.

Subsequently, the estimation of biological parameters from the production surplus model was performed using a four-model approach. This comprised of the Schaefer estimation model with the Fox Algorithm approach (Fox 1970), the Walters and Hibron estimation model (WH) (Walters & Hilborn 1976), the Schnute estimation model (Schnute 1977), as well as the Clark Yoshimoto and Pooley estimation model (CYP) (Clarke et al 1992). The most compatible model with the characteristics of the Ombai Strait was then selected, and the parameters compared were the intrinsic growth rate (r), catchability coefficient (q), and environmental carrying capacity (K) of each model. Meanwhile, the F test and adjusted R^2 values were used to measure the goodness of fit from which the model with the largest adjusted R^2 value, and a significance F test value <0.05, was selected.

The sustainable production function of fish resources is a quadratic equation, and fishing effort to Maximum Sustainable Yield (MSY) is determined by equating the first derivative of the linear regression equation to zero effort level (Schaefer 1954; Anderson & Seijo 2010; Whitmarsh 2011; Bjørndal et al 2012). This is mathematically written below.

Effort at maximum sustainable yield (MSY):

$$E_{MSY} = \frac{\alpha}{2\beta} = \frac{Kqr}{2Kq^2} = \frac{r}{2q} \qquad (5)$$

Catch at MSY:

$$H_{MSY} = \frac{\alpha^2}{4\beta} = \frac{K^2q^2r}{4Kq^2} = \frac{Kr}{4} \qquad (6)$$

Biomass stock at MSY:

$$x_{MSY} = \frac{K}{2} \qquad (7)$$

Economic rent at MSY:

$$\pi = pH_t - c_tE_t \qquad (8)$$

(8)

Effort at maximum economic yield (MEY):

$$E_{MEY} = \frac{r}{2q}\left(1 - \frac{c}{Kpq}\right) \qquad (9)$$

Catch at MEY:

$$H_{MEY} = \frac{rK}{4}\left(1 + \frac{c}{Kpq}\right)\left(1 - \frac{c}{Kpq}\right) \qquad (10)$$

Biomass stock at MEY:

$$x_{MEY} = \frac{K}{2}\left(1 + \frac{c}{Kpq}\right) \qquad (11)$$

Biomass stock at open access (OA):

$$x_{OA} = \frac{c}{pq} \qquad (12)$$

Catch at OA:

$$H_{OA} = \frac{rc}{pq}\left(1 - \frac{c}{Kpq}\right) \quad (13)$$

Effort at OA:

$$E_{OA} = \frac{r}{q}\left(1 - \frac{c}{Kpq}\right) \quad (14)$$

Biomass stock at optimum:

$$x^{\bullet} = \frac{K}{4}\left[\left(\frac{c}{Kpq} + 1 - \frac{\delta}{r}\right) + \sqrt{\left(\frac{c}{Kpq} + 1 - \frac{\delta}{r}\right)^2 + \frac{8c\delta}{Kpqr}}\right] \quad (15)$$

Catch at optimum:

$$F(x) = h^{\bullet} = rx^{\bullet}\left(1 - \frac{x^{\bullet}}{K}\right) \quad (16)$$

Effort at optimum:

$$E^{\bullet} = \frac{h^{\bullet}}{qx^{\bullet}} \quad (17)$$

Economic rent at optimum:

$$\pi = pH_t - c_t E_t \quad (18)$$

Results and Discussion

Estimation of biological parameters. Examination on 4 models, the Walters and Hilborn (Walters & Hilborn 1976) model showed the most significant t value and the best coefficient of determination. Thus, the model was considered most appropriate to describe the condition of small pelagic fishery resources within the Ombai Strait (Table 1).

Table 1
The biological parameter values of small pelagic fisheries resources using the Walters and Hilborn surplus production model

No.	*Species*	*r*	*q*	*K (kg)*
1.	Flying fish (Exocotidae)	1.83	0.000004	2645047.98
2.	Goldstripe sardinella (*Sardinella* sp.)	2.45	0.000032	1666645.39
3.	Yellowstripe scad (*Selaroides* sp.)	0.50	0.000016	335061.23
4.	Mackerel scad (*Decapterus* sp.)	0.70	0.000081	167665.84

Table 1 shows goldstripe sardinella (*Sardinella* sp.) had the highest intrinsic growth rate (r), meaning it grows naturally at 2.45 per year. This is presumably due to the characteristic high reproductive capacity and fast growth (Asriyana 2015; Baali et al 2017; Ndiaye et al 2018; Tampubolon et al 2019). Meanwhile, mackerel scad (*Decapterus* sp.) was found to have the highest catchability coefficient (q), where unit increase in fishing effort affects catch by 0.000081 kg, per trip. Sparre and Venema (1998) described catchability coefficient as a function of development in fishing technology, while Sadhotomo and Atmaja (2012) reported the purse seine was the main fishing gear for mackerel scad in the Ombai Strait. Furthermore, flying fish showed the highest carrying capacity (K), due to the ecosystem's ability to support the production of 2,645,047.98 kg of this species, per year. A study by Sari et al (2018) stated the carrying capacity shows the maximum number of fish that able to be supported by the ecosystem to grow and develop. According to several authors (Syahailatua 2008; Oliveira et al 2015) these fish can compete and adapt to limited spaces with high mobility, leading to a wider distribution area.

Economic parameter analysis. The analysis of small pelagic fishing cost per trip showed differences in the value and allocation proportion of fishing costs. In Belu, the average fishing cost per single fleet trip is IDR 229553, with 70.4% of this value purchased for fuel, 26.5% for food and cigarettes, and about 3.0% for ice. Meanwhile, in Bobonaro, the average fishing cost per single fleet trip, using gill net operated from small motorboat, is 29.5 US $ or about IDR 290000 per trip per fleet, with 81.4% purchased for fuel and the remaining 18.6% for food, cigarettes, and ice. By average in Ombai Strait, the total value was IDR 262266 per single trip allocated for fuel, food, and cigarettes costing 75.9%, 18.4%, and 5.7%, respectively. Calculation above indicated that 22.2% of the costs was more expensive in Bobonaro, compared to Belu. This is believed to be influenced by the difference gasoline price where is higher in Bobonaro. The amount of fuel required for each fishing trip is relatively the same because the distance between the fishing grounds and fishing bases are also relatively the same.

Based on real cost analysis, fishing costs in Bobonaro is about 20.5% higher, compared to Belu. Generally, the real costs of fishing within the border area between two countries has been increased from 2014 to 2018. However, a significant decreased in the real fishing costs was observed in Belu and Bobonaro, between 2012 and 2014. Table 2 shows the average real fishing costs for small pelagic fish resources from 2012 to 2018. The largest proportion of fishing costs is allocated to flying fish (Exocotidae), making this species the main fishing target in Belu and Bobonaro.

Table 2

The average real fishing cost of small pelagic fish resources between Belu and Bobonaro (2012 - 2018)

	Average real fishing costs (million IDR per trip)			
	Flying fish	*Yellowstripe scad*	*Mackerel scad*	*Goldstripe sardinella*
Belu, Indonesia	0.084767	0.067592	0.042319	0.036926
Bobonaro, Timor Leste	0.188075	0.031920	0.031969	0.039269
Ombai strait	0.083123	0.079844	0.052564	0.045888

The primary data from this study's results is the nominal price of fish, and this is the selling price used by fishermen, as a benchmark in calculating the real price of fishery resources. In 2018, the nominal price for flying fish, yellowstripe scad, mackerel scad, goldstripe sardinella were consecutively IDR 16666.67, 17500.00, 17083.33, and 12500.00 IDR, per kg.

The real price of small pelagic fishery resources within the Ombai Strait, in the border of Indonesia and Timor Leste, was calculated based on East Nusa Tenggara's fresh fish nominal price as well as CPI for Belu Regency, and Timor Leste's fish as well as seafood CPI for Bobonaro, from 2012 to 2018. Table 3 shows the average real price of small pelagic fishery resources between 2012 and 2018.

Table 3

The average real price of small pelagic fishery resources that compares Belu with Bobonaro (period 2012-2018)

	Average real price (million IDR per kg)			
	Flying fish	*Yellowstripe scad*	*Mackerel scad*	*Goldstripe sardinella*
Belu, Indonesia	0.01682	0.01766	0.01724	0.01261
Bobonaro, Timor Leste	0.03317	0.03386	0.03870	0.02912
Ombai strait	0.02499	0.02576	0.02797	0.02087

Table 3 shows the real price of small pelagic fish resources varies with fish species. Yellowstripe scad and mackerel scad fish have higher real prices, compared to flying fish and goldstripe sardinella. The production of these two fishes in Belu Regency and Bobonaro District has been higher compared to the other species, therefore, the prices of the two are relatively lower, compared to yellowstripe scad and mackerel scad. Zulbainarni (2012) stated in cases of high production during peak season, there is a consequent decreased in product price. In Bobonaro, the fish price is generally higher, compared to Belu.

Bio-economic assessment. By location and species basis, Table 4 shows the variability of fishing effort (trip), biomass, and catch, under MSY, MEY, and OA conditions. Under MSY conditions in Belu, the highest fishing effort was the flying fish, while the lowest was goldstripe sardinella. The highest biomass and catches were obtained from the yellowstripe scad, while the lowest was from the mackerel scad fish. Meanwhile, in Bobonaro, the highest fishing effort, biomass, and catch were found in mackerel scad, and the lowest was flying fish. In MEY conditions, the highest fishing effort in Belu was flying fish, and the least was goldstripe sardinella, while the highest biomass and catch was obtained from the yellowstripe scad. Meanwhile, in Bobonaro, the highest was mackerel scad and the lowest was goldstripe sardinella. Under OA conditions in Bobonaro Districts, the highest fishing effort was mackerel scad, and the highest biomass was flying fish, while the highest catch was mackerel scad.

The utilization status of small pelagic fish resources in Belu and Bobonaro was determined by comparing the utilization rate between the actual condition, with the MSY and MEY conditions. In 2018, the actual conditions of fishing efforts and catches in Belu show that the catches of flying fish (120500kg), yellowstripe scad (16200) and mackerel scad (4000 kg), were below the catches at MSY and MEY conditions. Meanwhile, the catches of gold stripe sardinella (50800 kg) had exceeded the MSY and MEY conditions. Also, the fishing effort of flying fish (5112 trips), goldstripe sardinella (83 trips) and mackerel scad (256 trips) were below fishing efforts in MSY and MEY conditions, while fishing effort of yellowstripe scad (1240) was lower than MEY but exceeded its MSY.

In 2018, based on the actual condition of the fishing efforts and catches in Bobonaro, the catches of mackerel scad (54000 kg) and goldstripe sardinella (87600 kg), were below MSY and MEY values. Meanwhile the catches of yellowstripe scad (24000 kg) had exceeded the MSY and MEY, while the catch of flying fish (45000 kg) was lower than the MSY but exceeded its MEY. Furthermore, the fishing efforts of mackerel scad (10868 trips) and goldstripe sardinella (3037 trips) were below the MSY and MEY, while fishing effort of yellowstripe scad (3979trips) had exceeded the MSY and MEY conditions. Meanwhile, fishing effort of flying fish (9044 trips) was lower than MSY but exceeded the MEY condition.

Table 4
Comparison of Belu and Bobonaro, in terms of bioeconomic assessment of small pelagic fishery resources

	Flying fish	*Yellowstripe scad*	*Mackerel scad*	*Goldstripe sardinella*
Belu, Indonesia				
E_{msy} (Trips)	21858.45	59.5	1255.74	4450.14
X_{msy} (Kg)	80941.90	72979.35	9186838.65	102547.22
H_{msy} (Kg)	280288.60	162461.65	1045935.47	31712.63
R_{msy} (Million IDR)	2860.74	2046.93	18384.25	358.34
E_{mey} (Trips)	17562.28	59.47	1252.86	3683.60
X_{mey} (Kg)	96850.63	73018.48	9207948.51	120211.02
H_{mey} (Kg)	269461.05	162461.60	1045929.95	30771.71
R_{mey} (Million IDR)	3042.82	2046.93	18384.35	374.56
E_{oa} (Trips)	35124.56	118.93	2505.71	7367.21
X_{oa} (Kg)	31817.47	78.25	42219.71	35327.58
H_{oa} (Kg)	177047.24	348.18	9591.47	18086.37
R_{oa} (Million IDR)	0	0	0	0
Bobonaro, Timor Leste				
E_{msy} (Trips)	35353.83	1105.32	54920.97	141576.40
X_{msy} (Kg)	121052.71	26417.65	195801.01	484609.50
H_{msy} (Kg)	94019.24	6706.26	164575.03	315178.31
R_{msy} (Million IDR)	3530.46	151.9	3819.76	7671.34
E_{mey} (Trips)	2333.79	982.5	46282.58	115309.22
X_{mey} (Kg)	250096.40	29353.18	226598.09	574520.86
H_{mey} (Kg)	12822.56	6623.46	160503.54	304329.01
R_{mey} (Million IDR)	13.59	154.31	3957.63	8091.21
E_{oa} (Trips)	4667.58	1965.00	92565.16	230618.44
X_{oa} (Kg)	258087.37	5871.05	61594.15	179822.72
H_{oa} (Kg)	26464.52	2649.57	87256.51	190507.51
R_{oa} (Million IDR)	0	0	0	0

These results indicate the utilization status of four dominant species in the two areas. The small pelagic group in Belu was in good condition and had not experienced overfishing yet, both biologically and economically. In Bobonaro such situation occurred for mackerel scad and goldstripe sardinella, whereas yellowstripe scad has experienced both biological and economical overfishing. To ensure the sustainable utilization of small pelagic fishery resources, therefore, it might be proposed to limit the catch of goldstripe sardinella fish in Belu and yellowstripe scad in Bobonaro by approximately 80% of MEY. Another strategy is to limit the total number of fishing efforts according to MEY, especially for goldstripe sardinella in Belu and yellowstripe scad in Bobonaro. A study by Wijayanto et al (2019) stated that in formulating fishing policy, a careful planning and consideration of social factors is required.

Table 5 shows the fishing efforts, catches, biomass, and economic benefits of small pelagic fisheries resources in MSY, MEY, and OA conditions vary with fish species. The highest fishing efforts, biomasses, and catch, was found in flying fish, while the lowest was mackerel scad under MSY, MEY and OA conditions.

Table 5
The results of bioeconomic assessments of the small pelagic fishery resources within the Ombai Strait, in the border of Indonesia and Timor Leste

	Flying fish	*Yellowstripe scad*	*Mackerel scad*	*Goldstripe sardinella*
E_{msy} (Trips)	230112.59	37901.52	15449.16	4296.22
X_{msy} (Kg)	1322523.99	833322.70	167530.62	83832.92
H_{msy} (Kg)	1212752.76	1019332.45	41801.09	29266.95
R_{msy} (Million IDR)	11179.04	19534.24	156.73	592.77
E_{mey} (Trips)	157496.40	36352.19	6600.28	3703.62
X_{mey} (Kg)	1739870.35	867387.09	263487.86	95396.42
H_{mey} (Kg)	1091982.94	1017629.15	28087.39	28710.11
R_{mey} (Million IDR)	14197.08	19569.79	196.54	608.34
E_{oa} (Trips)	314992.81	72704.37	13200.55	7407.23
X_{oa} (Kg)	834692.72	68128.78	191914.49	23126.99
H_{oa} (Kg)	1047744.98	159859.04	40915.56	13920.41
R_{oa} (Million IDR)	0	0	0	0

The utilization status of small pelagic fisheries resources within the Ombai Strait, in the border of Indonesia and Timor Leste was determined by comparing the utilization level in actual conditions under MSY, MEY, and OA basis. This comparison showed the catch of flying fish in actual conditions was 126614.29 kg with a fishing effort of 13370 trips per year. These values are below the MSY, MEY, and OA conditions. Similar results were found in goldstripe sardinella with 128200 kg, 2973 trips per year. On the contrary, the yellowstripe scad with 70571.43 kg, 11380 trips per year showed utilization status exceeded its MSY, MEY, and OA. Alike situation was found in mackerel scad with 78671.43 kg and 12721 trips per year.

To achieve the sustainable fishing effort within the Ombai Strait, there is a need to regulate the fishing efforts and catches in accordance with MEY especially for yellowstripe scad and mackerel scad. These efforts are to control overfishing and to prevent the collapse of fishery resources (Wilen 2000; Hilborn 2003; Seijo et al 2004; Hilborn 2010). Évron (2016) stated efforts to improve fisheries management are needed to maximize economic rent, therefore, optimal management of MEY is the solution. Furthermore, MSY is important for increasing income and reducing total costs, thus, consequently increasing the net benefits obtained from fisheries.

Economic rent. Table 6 shows the economic rent of small pelagic fisheries resources at optimum conditions, within the Ombai Strait, in the border of Indonesia and Timor Leste.

Table 6

The total economic rent of small pelagic fishery resources at optimum conditions, within the Ombai Strait, in the border of Indonesia and Timor Leste

	Economic rent of small pelagic fisheries resources (million IDR per year)				
	Flying fish	*Yellowstripe scad*	*Mackerel scad*	*Goldstripe sardinella*	*Total*
Belu	3042.19	2045.45	13352.58	365.33	18805.55
Bobonaro	13.57	147.99	3943.09	8044.64	12149.29
Total	14163.62	19526.67	192.85	595.54	34478.68

According to Table 6, the total economic benefit of small pelagic fisheries resources at optimum conditions is IDR 34,478,680,000 per year. The species with the highest economic benefit is goldstripe sardinella, with IDR 19,526,670,000 per year, followed by flying fish, mackerel scad, and yellowstripe scad, with IDR 14,163,620,000, IDR 595,540,000 and IDR 192,850,000, per year, respectively.

The Ombai Strait waters bordering Indonesia and Timor Leste are located between two administrative areas, Belu Regency, Indonesia and Bobonaro District, Timor Leste, and the fishermen in both regions utilize small pelagic fishery resources in these waters. Based on the comparison of the economic benefits of small pelagic fisheries resources between the two regions, Belu Regency receives a 35% higher economic benefit of IDR 18,805,550,000 per year, compared to Bobonaro District, with a counterpart of IDR 12,149,290,000, yearly.

In terms of species, the highest economic benefit of IDR 13,352,580,000 per year, is produced by yellowstripe scad in Belu Regency, while the lowest, IDR 13,570,000 per year, is produced by flying fish in Bobonaro District. The economic benefits of pelagic fishery resources and fish species was observed to differ between the regions. This was due to the differences in fishing effort and species distribution between regions, as well as fishing costs and the fish price. According to Sari et al (2018), the maximum economic rent is possibly achieved without ignoring biological factors, therefore, the stock biomass and economic rent, is higher in MEY conditions, compared to MSY.

The total economic rent of small pelagic fishery resources at optimum conditions, within the Ombai Strait is IDR 34,478,680,000, per year. Goldstripe sardinella and flying fish provided the largest contributions of 56.63% and 41.08% respectively, to this value. Meanwhile, Belu Regency receives a 35% higher economic rent, compared to Bobonaro District. Belu Regency receives a higher economic rent for flying fish, goldstripe sardinella, and yellowstripe scad, while Bobonaro District receives greater economic rent from mackerel scad. This is to confirm that small pelagic fishes have provided economic benefits, and even have economic potential currently unexploited by fishermen in the regions. These shared benefits are an important factor in promoting collaborative efforts to manage fish resources.

Conclusion. The utilization status of flying fish (Exocotidae) and goldstripe sardinella (*Sardinella* sp.) has not been overfished ecologically and economically, while yellowstripe scad (*Selaroides* sp.) and mackerel scad (*Decapterus* sp.) suffered from ecological and economical overfishing. Furthermore, the total economic rent of small pelagic fishery resources within the Ombai Strait in the border of Indonesia and Timor Leste, is IDR 34,478,680,000 per year, and this has provided economic benefits for fishermen in Belu Regency and Bobonaro District. However, Indonesia receives a 35% higher economic rent from these small pelagic fishery resources, compared to Timor Leste.

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