Indonesian shrimp resource accounting for sustainable stock management

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Abstract. *Anna Z. 2017. Indonesian shrimp resource accounting for sustainable stock management. Biodiversitas 18: 248-256.* Shrimp fisheries is a resource of important economic value, and is one of the high-demand commodities. Although regarded as a resource that has the ability to grow relatively quick and allows for a year-round production, these resources could experience declining production, or even extinction, if not managed properly. Planning the management of shrimp fishery stock requires basic information on the stock dynamics, both in terms of its natural production and utilization, through resource accounting, mandated by the Agenda 21 of United Nation Conference on Environment and Development (UNCED), formulated in the System of Integrated Environmental and Economic Accounting (SEEA). This study measures the accounting of the shrimp resources, both physical and monetary. In addition, the study also aims to measure the shrimp resource that can be utilized (fishable biomass), from the balance of resources. The approach used in this study is a standard bioeconomic model, with Fox model to estimate biological parameters, and methods of System of National Accounts of FAO (2004), named recursive model, adapted to the existing data. The results of the analysis, includes the calculation of standing stocks (physical asset account), fishable biomass, depletion, as well as monetary accounts. Result shows that the overall condition of the stock still in surplus, where the standing stocks from 1988 to 2014, are in the range of 200,000 to 900,000 tons yearly, with the monetary value between IDR 500 billion to 2 trillion. The intrinsic growth of shrimp tend to be positive in average, with values in the range of -258,000 tons to 263,890 tons. The trend estimation for the next five years (2015-2020), showed a decrease in the stock, and the stock closed as many as 350,000 tons in 2020. This paper also suggests the policy recommendations for the development and management of shrimp resources, in Indonesia.

Keywords: Bio-economic modelling, fishery accounting, fishery stock management plan, monetary account, physical account, shrimp

INTRODUCTION

Fisheries resources in general and shrimp resources in particular are among the natural resources biodiversity found in Indonesia, capable of contributing to state income and improving the welfare of its citizen. Indeed, sustainable management of the biodiversity is an inevitable requisite in attaining such aims. Management of renewable fisheries resources is in essence a given, since the resource's limited growth and carrying capacity. Thus, managing the extraction of the resource with the afore mentioned considerations, is key and provides positive feedback in sustainable utilization and the stock biodiversity of shrimp. The biodiversity of shrimp in Indonesia consist of some species, such as: *Metapenaeus affinis*, *Metapenaeus brevicornis, Metapenaeus ensis, Metapenaeus barbata, Penaeus monodon, Parapenaeopsis hardwickii, Parapenaeopsis sculptilis,* and many more (Marine and Fisheries Statistic Data System 2014).

Fisheries resources management, which is economically and environmentally sustainable is a necessity. It is imperative to establish the link between the flow of fish stock and economic aspects of capture fisheries. The link may be established by means of economic accounts of fisheries resources. National resource accounting, a measure of both aggregate and sectoral sustainable development processes, provides an overview and direction on how the degree of extraction of fisheries resources relates with the financial flow it provides (monetary account) in the past, present, and future (Theys 1989; Neumayer 2000; Hediger 2004), notes that natural resource accounting (also known as patrimony account), alongside national accounts and satellite accounts can be used to define alternative scenarios of sustainable development under various evaluation criteria.

The conventional nature of national accounting system does not take into consideration volume changes of various natural resources, e.g. stock of capture fisheries (Danielsson 2001). Natural resources make important contributions to long-term economic performance and should be considered economic assets (Sukhdev 2010). Considering the thesis of a large literature, that net national product (which is a flow) is that index in closed economies, is shown in some interpretations to be simply false and in others to suffer from deep estimation problems (Dasgupta 2009). Natural resource accounting, such as on fisheries, generates new nuances in the calculation of regional and national economic performance. In general, both performances only account for production, production value, or Gross Domestic Product (GDP) or Gross Regional Domestic Product (GRDP), without counting for resource extraction (WCED 1987). Fisheries resource accounting can provide a detailed picture of upstream to downstream resource flow (FAO 2004). It should be noted

that the capture fisheries sector, only contributed 0.5% to 2.5% to the GDP globally (Béné et al. 2007). This small share, is caused by not incorporating fisheries accounting, to GDP calculations. Current accounting practice, groups fisheries with agriculture, which considerably reduces detailed accounts on fisheries, in addition to usage of rough estimates. The initiative to conduct fisheries resources accounting should be practiced by the government, mandated by the Law No. 32 Year 2009 on Environment Protection and Management, stipulates for the formation of a unified national natural resources account.

In addition, sustainable development, as suggested by the Brundtland Commission (WCED 1987), is a buzzword whose operations may be carried out through the System of National Account (SNA). The system, a calculation of sectoral aggregates, introduces the term *fisheries resources accounting*. The accounting practice is of importance in sustainable development due to its ability to provide primary economic information on the fisheries sector, especially to understand the stock dynamic of which may be used for analysis and decision making.

The accounting practice also provides the capability to calculate the stock available in the waters as well as depletion of fisheries resources, which at some point can threat the stock biodiversity. Fauzi and Anna (2004) noted that the current decision-making process is yet to consider resource depletion in fisheries policy making. Current fisheries development paradigm predominantly focuses on growth oriented policy, wherein GDP is the primary indicator of its development. The use of GDP to accurately and comprehensively measure the economic performance of natural resources, however, is to a certain extent misleading, as it does not factor resource stock dynamic and its depreciation (Hartwick 1990; Hung 1993; Maler 1991; Repetto 2002; Van den Bergh 2009). It thus goes without saying that incorporating resource stock dynamic and its depreciation reduces the probability of producing misled policies.

Detailed and publicly accessible fisheries resource accounting have been widely-practiced in countries where fisheries contributes significantly to the GDP, e.g. in Canada, United States, Japan, Iceland, Maldives, and Namibia. Several countries where there is little fisheries contribution to their GDP, such as Brazil, Chile, South Korea, Philippines, New Zealand and South Africa have also began the practice (Harkness and Bain 2007; Watson and Morato 2013; Laugen et al. 2014).

By accommodating such practice, the Indonesian capture fisheries sector can play an active role in global fisheries in at least two important aspects. First, maintaining the sustainability of capture fisheries through efficient, economic, and cost-effective benefit and stock management. Second, identical standing in global fisheries so as to simplify decision-making in national and international fisheries development.

Fisheries resource accounting illustrates the dynamics of stock changes on both supply and utilization sides, the latter of may be due to natural or human economic activities. Stock changes as shown in the account, are significantly different to that of the dynamic stock usually done in stock assessment, that more reliance on biological factors while neglecting economic dynamics. By using fisheries resource accounting, changes in both aspects may be systematically ascertained and primarily consulted in formulating the Fishery Management Plan as stipulated by Law No. 45 Year 2009 on Fisheries. As some experts said that Indonesian fish has already experienced stock decline due to overfishing and over capacity (Squires et al. 2002; Anna 2003; Fauzi and Anna 2012), this study aims to calculate shrimp resources accounting or stock accounting in Indonesia, to understand the dynamic of Shrimp resource as a basis for future planning in maintaining the stock biodiversity for sustainable shrimp management.

MATERIALS AND METHODS

The study area is Indonesian's ocean as a whole, and the study was conducted in 2012 and 2015. The shrimp refers to all species shrimp caught in Indonesian ocean. Technically, data analysis procedures, i.e.firstly, filtering; secondly, standardization; and thirdly, calibration of secondary data, is used to calculate shrimp resource accounting. The data analysis using time series secondary data from the year of 1988 to 2014 (MMAF 1988-2014), from the source of Indonesian Fisheries Statistic. Data derived from the production of shrimp fishing gear, namely trawl, seine net and trammel net. Shrimp production is the total national production, with most production coming from eastern Indonesia (Arafura Sea), and Java's northern waters. The analysis is needed to provide input to physical and monetary calculations, in addition to bio-economic calculations in subsequent stages. Furthermore, surveys to analyse primary data are carried out so as to establish cost structures and business profiles, both part of monetary account calculations. Surveys are done on fishing businesses requiring national permits (above 30 GT) and regional permits (below 30 GT). The survey is meant to provide comprehensive changes in fish stock. Fishing businesses are surveyed using purposive sampling, with a minimum population of 10% of the analysed fishing equipment.

At the fourth stage, bio-economic analysis is conducted to obtain the benchmark stock values and natural changes of the analysed fish stock. The approach uses at least 10 years of series data.The bio-economic approach is conducted by incorporating standard bio-economic models (Fauzi 2010; Anna and Fauzi 2014), into econometric analysis approaches. This is used to calculate changes in fish stock balance. The econometric approach uses various modelling methods to find the best fitting model. Bio-economic approach is also used to calculate unit rent. This is done by calculating commonly used rent calculations in balance accounting, i.e. measuring actual economic surplus and sustainable rent at incurred cost. The unit rent then becomes the basis to calculate the monetary account.

The fifth stage of the analysis is calculating the physical and monetary accounts based on parameters calculated in stages 1 to 3. Physical accounts are calculated using Microsoft Excel. The calculated physical accounts are then
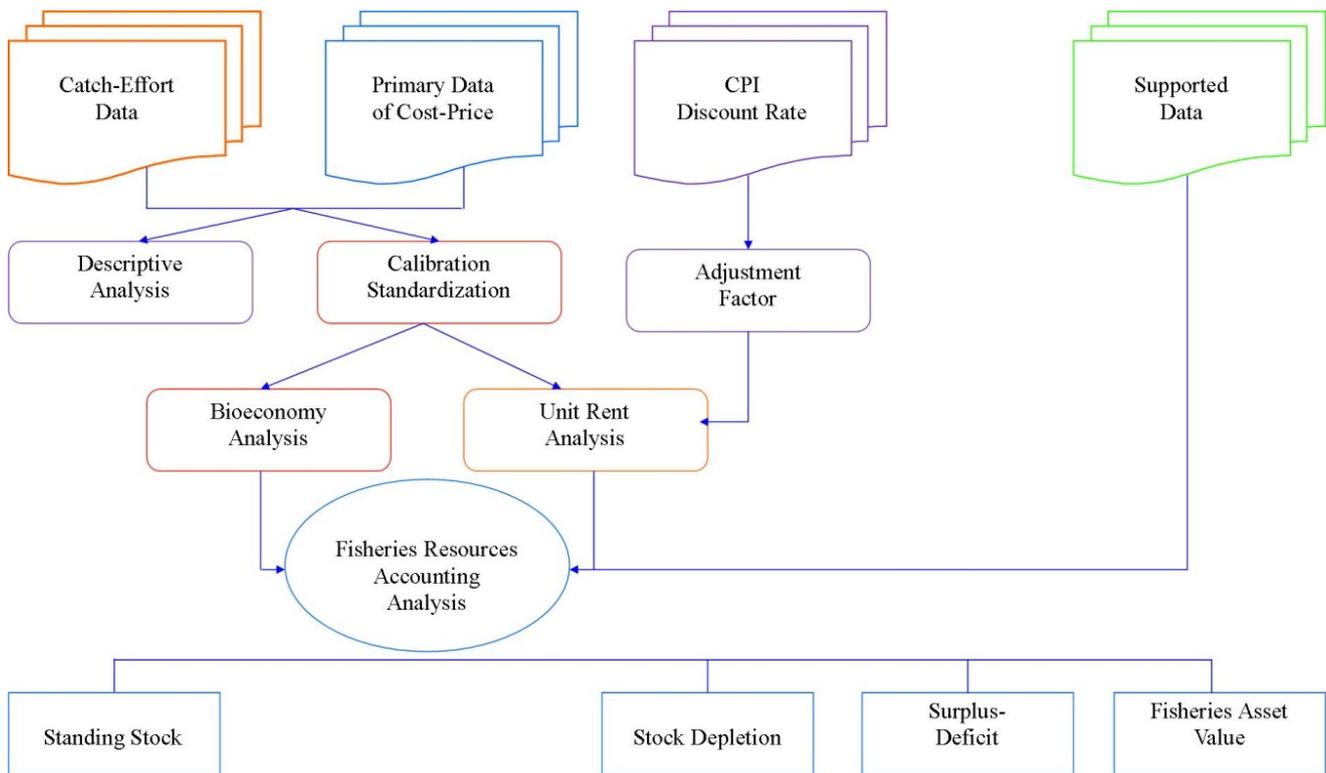
Figure 1. Technical step approach on fisheries resource account

calibrated with actual data to obtain reliable figures. In addition, comparison to actual production is also used to understand whether there is actual *surplus* or *deficit* of the studied resource. Monetary accounts are analysed by combining physical accounts and unit rent, thus producing time to time economic flows. The monetary flow also provides a sketch of the value of fisheries assets. The monetary accounts are also calibrated with actual production values to measure economic surpluses or deficits of fish stocks studied. The technical approach outlined above is illustrated in Figure 1.

Econometric data analysis is used to define biophysical parameters, such as fish growth, carrying capacity, and fishing capacity coefficient. Econometric analysis is conducted using ordinary least square (OLS) and generalized least square (GLS). The latter is used if OLS does not satisfy the goodness of fit criteria. A general equation to define biophysical parameters is:

$$y = f(x_{1,}x_2, e)$$

Where y is productivity indicator x_1, x_2 is input parameter (effort), and e is error term. More specifically, the general model is defined using the Clarke, Yoshimoto, and Pooley (CYP), (Clarke et al 1992) formula, where the biophysical parameter is estimated as follows:

$$y = \alpha + \beta x_1 + \gamma x_2 + \varepsilon$$

Where y is catch per unit effort, x_1 is average of the catch per unit effort (CPUE), and x_2 is average effort. Parameters α and β are coefficients denoting the biophysical growth value, environmental carrying capacity, and catch effort coefficient.

Next, the estimated value of the parameter above is used to determine the initial standing stock using bio-economic approach, as follows:

$$\max \ \pi = \sum_{t=0}^{T} \sum_{i=1}^{n} \left(\int_{h_0}^{h_1} P(h)dh - c(h,x) \right) \left(\frac{1}{(1+\delta)^t} \right)$$

Where the constraint functions are:

$$x_{t+1} - x_t = rx_t \left(1 - \frac{x_t}{k} \right) - h_t$$

$$0 \le x_t \le x_{\max}; 0 \le h_t \le h_{\max}$$

Where:
Π_t=Economic benefit in t period
P_t=discount factor
p =fish price
h_{jt} =Production in t period by j fleet
c = cost per gear unit
r = Intrinsic growth rate
k= Maximum Carrying capacity
δ = Discount rate

The equation above is solved using Lagrangian function to derive the Maximum Principle, as follows:

$$L = \sum_{t=0}^{T} \rho^t \left\{ \pi(x_t, h_t) + \rho \lambda_{t+1} \left[x_t + F(x_t) - h_t - x_{t+1} \right] \right\}$$

$$\frac{\partial L}{\partial h_t} = \rho^t \left\{ \frac{\partial \pi(x_t, h_t)}{\partial h_t} - \rho \lambda_{t+1} \right\} = 0$$

$$\frac{\partial L}{\partial x_t} = \rho^t \left\{ \frac{\partial \pi(x_t, h_t)}{\partial x_t} + \rho \lambda_{t+1} \left[1 + \frac{\partial F(x_t)}{\partial x_t} \right] \right\} - \rho^t \lambda_t = 0$$

and

$$\frac{\partial L}{\partial (\rho \lambda_{t+1})} = \rho^t \left\{ x_t + F(x_t) - h_t - x_{t+1} \right\} = 0$$

The result of the equation above is the standing stock, i.e. initial stock amount for balance calculations, as follows:

$$x^* = \frac{k}{4} \left[\left(\frac{c}{pqk} + 1 - \frac{\delta}{r} \right) + \sqrt{\left(\frac{c}{pqk} + 1 - \frac{\delta}{r} \right)^2 + \frac{8c\delta}{pqkr}} \right]$$

After the value of the initial stock is determined, the next step is to conduct a tabulated balance calculation (Table 1), using recursive model from FAO (2004) as follows:

Table 1. Physical account calculations

Variable	T1	T2	T3	T4	T5
Opening Stock	X1	X2	etc		
Production					
Growth					
Depletion					
IUU					
Other Change					
Closing Stock	X2	X3	etc		

To calculate monetary accounts, economic rent must be first calculated using the following equation (Fauzi 2010):

RR = TR-(IC+CE+CFC+NP)
NP = rK

Where:
TR   = total revenue
IC   = intermediate consumption
CE   = compensation of employee
CFC = compensation of fixed capital
NP   = normal profit, calculated by multiplying value of capital

Having established the value of unit rent, the value of depletion can thus be calculated using the method proposed by Repetto (2002), as follows:

$VD_t = RR (D_t)$

Where:
RR=Resources Rent
D_t=Depletion at t

RESULTS AND DISCUSSION

Result

The calculation fisheries resource accounting, as described above consists of physical and monetary accounts. The analysed Indonesian fisheries data is an aggregate of the Indonesian Fisheries Management Area (WPP-RI), based on capture fisheries statistics, and cross-checked data from surveyed sites. The economic data on price and cost are data series obtained from aggregating the average Indonesian price of fish and cost of fishing per trip. The data is assumed to be constant and adjusted to the Indonesian Consumer Price Index using time series analysis.

Analysis of fisheries resource accounting employs recursive model. A number of analysis models to estimate parameter values, such as CYP, Fox, Walter Hilborn, and Schnute (Fox 1970; Schnute 1987; Clarke et al. 1992; Hilborn and Walter 1992), are used to obtain robust estimates and sound statistical performance. Fox's estimation model is found to be the best-fitting biological parameter estimate while economic parameters are obtained from survey results and processed using the geo mean technique with CPI adjustments.

In both physical and monetary accounts, recursive analysis is used incorporating the following variables: (i) Initial stock: the fishable biomass available. (ii) Production: total catch of certain fish in certain years. (iii) Growth: total number of naturally maturing fish from reproduction or natural production surpluses. (iv) Depletion: production changes, i.e. the difference between sustainable yield production and actual catch. (v) Illegal Unregulated and Unreported Fishing: describing unreported catch or caches from illegal fishing vessels. (vi) Other changes: changes in fish stock caused by external factors other than fishing or IUU. (vii) End stock: stock available at the end of the year and initial stock in the following year.

The compound growth rate (CGR), linear, and quadratic models are used to project the forward accounts in the next five years (five years from the latest 2014 data). The suitable model used is that which has the lowest mean square error (MSE). Each model is first processed using time series regression and actual production. Regression analysis is used to allow trend analysis and forecasting of the data. The recursive model considersinitial stock, production, growth, and end stock variables.

Shrimp fishing production in Indonesia fluctuates between 150,000 tons to 230,000 thousand tons chane

throughout year, as shown in Figure 1. The highest production took place in 2002 at 263,000 tons. The total effort over year is shown in Figure 2. Figure 2 shows that trip efforts for Shrimp Fisheries from 1988 to 2014, fluctuate between 1.1 million to 5.6 million trips throughout the year. The trips data is from Indonesian fisheries statistic, reprocessed.

Table 2 shows the biological and economic parameter estimates of shrimp fishing in Indonesia.The table shows that the carrying capacity of shrimp in Indonesian waters is approximately 743 thousand tons. The biological parameter estimates of each WPP is shown in Table 3. Table 2 shows that the average growth (r) of every WPP is 1.42 with WPP 718 being the lowest (r=0.97) and WPP 573 the highest (r=2.77). The average fishing capacity coefficient (q) using shrimp fishing equipment is 4.1×10^{-5} with WPP 712 being the lowest (q=7.5×10^{-8}) and WPP 718 the highest (q=2.9×10^{-4}). The average carrying capacity (k) is 82,168.63 tons with WPP 573 being the lowest (K=8,496.56 tons) and WPP 571 being the highest (k=216,302 tons).

Table 4 shows the recursive modelling of the physical shrimp resource account. Initial stock in 1988 was 258 thousand tons. Shrimp production increased year over year while growth fluctuated, culminating in negative growth from 1998 to 2000. The negative values were caused by other significant factors, such as bad water quality. Shrimp stock in late 2014 is estimated to be 244 thousand tons.

Table 5 shows the trend analysis of shrimp resources. Forecast using non-linear quadratic model with the lowest mean absolute percentage error (MAPE=6 as in figure 4 trend analysis plot for production), predicts increased future production. As shown in the table 5, the initial stock in 2015 was 244 thousand tons and end stock in 2020 would be 351 thousand tons. Production is predicted to fluctuate with a tendency to drop by 2020. By 2020, production is predicted to be approximately 213 thousand tons. Growth, on the other hand, shows significant increases; initial growth in 2015 was approximately 233 thousand tons and closes at 256 thousand tons.
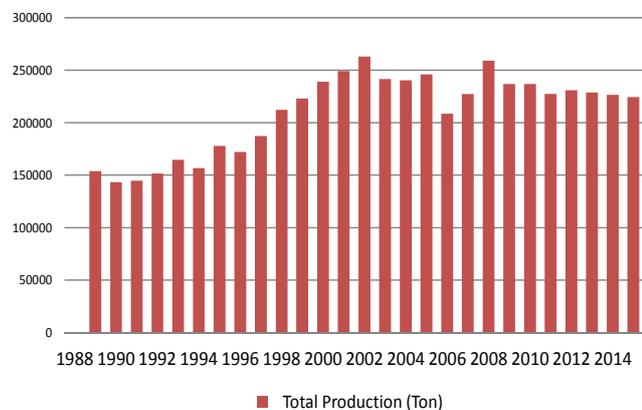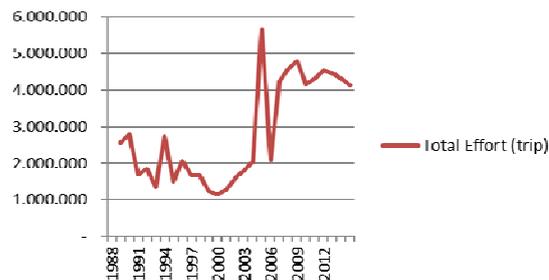

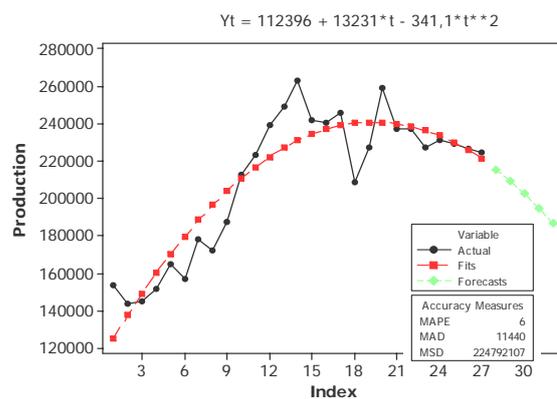**Figure 2.** Effort in Indonesian shrimp fisheries (MMAF 1989 to 2015)

Figure 4. Trend production analysis (quadratic model) of shrimp resources

Table 2. Biological and economic parameter estimates of shrimp fisheries in Indonesia

Parameters	Value
Intrinsic growth (r)	1.42
Fishing capacity coefficient (q)	0.000000233
Carrying capacity (k)	743.365,.30
Price (p), million rupiah/ton	9,037270199
Cost per trip (c), million/trip	0,020855029
Discount rate (δ)	0.08

Table 3. Biological parameters of shrimp resources in each Fisheries Managemen Area (WPP)

WPP-RI	Biological parameter		
	r	Q	K
WPP 571	1.26	0.0000007578	216,302.85
WPP 572	1.57	0.0000006653	27,798.39
WPP 573	2.77	0.0000031962	8,496.56
WPP 711	1.70	0.0000020098	126,678.58
WPP 712	1.11	0.0000000752	114,686.54
WPP 713	1.99	0.0000001439	172,965.63
WPP 714	1.51	0.0000159240	75,252.53
WPP 715	1.90	0.0000345288	41,850.85
WPP 716	1.40	0.0000033656	63,648.68
WPP 717	1.19	0.0000985028	18,079.98
WPP 718	0.97	0.0002946535	38,094.29

Figure 1. Total shrimp production in Indonesia (MMAF 1989 to 2015)

Table 6 shows the recursive modelling of the monetary shrimp resource account. As shown, the monetary value of shrimp stock in Indonesia fluctuates, with the highest in 1999 at a value of IDR 2.3 trillion and lowest in 2004, at a value of IDR 495 billion. The value of shrimp stock in 1988 was IDR 687 billion, closing at IDR 616 billion in 2014. The 2014 value is initial stock value of 2015.

Shrimp growth value tend to fluctuate, culminating in negative growth in 1998, 1999, and 2000. The negative values were caused by the relatively high standing stock value and over stretching of its carrying capacity. Nonetheless, positive growth continued in subsequent years with a monetary value between IDR 142 billion to 699 billion.

Table 7 shows future trends in the monetary account of shrimp in Indonesia. The monetary value of the Indonesian shrimp stock increases steadily in the next five years, from IDR 648 billion in 2015 to 929 billion in the end of 2020. Predicted growth fluctuatessteadily, with a value of IDR 617 billion to 618 billion per year.

Discussion

Based on the findings presented above, this study arrives at the following shrimp condition, that as a whole, the Indonesian shrimp stock is in surplus. Nonetheless, annual trend of shrimp stock fluctuates. Recursive modelling shows that the standing shrimp stock is between 200 thousand to 900 thousand tons with a monetary between 500 billion to 2 trillion Rupiah. On average, the natural growth of shrimp is positive with a range between -258,000 tons and 263,890 tons.

Table 4. Recursive modelling of shrimp resource account

Year	Opening stock	Production	Growth	Depletion	IUU	Other change	Closing stock
1988	259,337.27	153,806	239,784.72	(471,690.54)	15,380.60	(580,252.11)	221,373.82
1989	221,373.82	143,269	220,737.30	(557,667.96)	14,326.90	(471,185.92)	370,997.26
1990	370,997.26	144,819	263,893.78	(225,349.94)	14,481.90	(349,022.00)	351,918.08
1991	351,918.08	151,435	263,148.47	(265,653.64)	15,143.50	(190,287.14)	523,854.55
1992	523,854.55	164,475	219,660.80	(120,679.86)	16,447.50	(437,618.76)	245,653.96
1993	245,653.96	156,827	233,554.03	(531,666.40)	15,682.70	(333,445.43)	504,919.26
1994	504,919.26	177,734	229,984.26	(148,989.14)	17,773.40	(332,177.73)	356,207.53
1995	356,207.53	171,954	263,437.22	(309,224.23)	17,195.40	(258,737.26)	480,982.33
1996	480,982.33	187,269	241,074.25	(181,743.14)	18,726.90	(150,697.24)	547,106.58
1997	547,106.58	212,252	205,110.06	(155,156.00)	21,225.20	94,823.67	768,719.11
1998	768,719.11	222,910	(37,230.34)	(36,801.30)	22,291.00	371,192.78	894,281.85
1999	894,281.85	238,865	(257,808.57)	2,845.46	23,886.50	461,969.08	832,845.40
2000	832,845.40	249,032	(142,356.37)	(20,191.62)	24,903.20	266,523.31	703,268.76
2001	703,268.76	263,037	53,865.95	(88,441.41)	26,303.70	19,097.81	575,333.22
2002	575,333.22	241,485	184,670.58	(163,015.65)	24,148.50	(152,277.73)	505,108.22
2003	505,108.22	240,438	229,888.01	(232,360.22)	24,043.80	(516,022.03)	186,852.62
2004	186,852.62	245,913	198,637.08	(1,641,399.95)	24,591.30	(1,329,465.52)	426,919.83
2005	426,919.83	208,539	258,066.29	(279,829.43)	20,853.90	(506,507.01)	228,915.64
2006	228,915.64	227,164	224,959.54	(1,027,337.43)	22,716.40	(987,225.86)	244,106.35
2007	244,106.35	258,976	232,804.30	(1,120,374.88)	25,897.60	(1,099,585.49)	212,826.43
2008	212,826.43	236,922	215,689.41	(1,240,980.74)	23,692.20	(1,165,226.58)	243,655.80
2009	243,655.80	236,870	232,584.31	(981,794.52)	23,687.00	(971,534.75)	225,942.88
2010	225,942.88	227,326	223,321.21	(1,051,858.80)	22,732.60	(1,031,595.06)	219,469.23
2011	219,469.23	230,917	219,636.66	(1,051,858.80)	23,091.70	(1,016,383.07)	220,572.92
2012	220,572.92	228,739	220,276.16	(1,051,858.80)	22,873.88	(1,016,351.77)	224,743.44
2013	224,743.44	226,561	222,650.62	(1,051,858.80)	22,656.06	(1,017,600.84)	232,435.36
2014	232,435.36	224,382	226,855.65	(1,051,858.80)	22,438.24	(1,019,833.49)	244,495.68

Table 5. Five-year projection of shrimp resource account

Year	Opening stock	Production	Growth	Closing stock
2015	244,495.68	227,326.00	232,993.77	250,163.45
2016	250,163.45	232,298.15	235,686.45	253,551.75
2017	253,551.75	228,563.40	237,237.57	262,225.92
2018	262,225.92	224,127.65	241,008.62	279,106.90
2019	279,106.90	218,990.88	247,523.48	307,639.49
2020	307,639.49	213,153.10	256,059.82	350,546.21

Table 7. Forward account of shrimp resources

Year	Opening stock	Production	Growth	Closing stock
2015	648,143.42	602,627.63	617,652.54	663,168.34
2016	663,168.34	615,808.49	624,790.68	672,150.53
2017	672,150.53	605,907.91	628,902.61	695,145.23
2018	695,145.23	594,148.99	638,899.45	739,895.69
2019	739,895.69	580,531.73	656,169.94	815,533.89
2020	815,533.89	565,056.13	678,799.26	929,277.02

Table 6. Recursive modelling of monetary shrimp resource account

Year	Opening stock	Production	Growth	Depletion	IUU	Other change	Closing stock
1988	687,487.59	407,731	635,654.95	(1,250,423.39)	40,773.05	(1,538,213.63)	586,848.74
1989	586,848.74	379,798	585,161.38	(1,478,344.39)	37,979.75	(1,249,085.68)	983,491.53
1990	983,491.53	383,907	699,566.64	(597,389.22)	38,390.65	(925,236.46)	932,913.78
1991	932,913.78	401,445	697,590.86	(704,231.92)	40,144.51	(504,439.83)	1,388,707.08
1992	1,388,707.08	436,013	582,307.65	(319,915.08)	43,601.34	(1,160,101.14)	651,213.95
1993	651,213.95	415,739	619,137.76	(1,409,415.83)	41,573.90	(883,943.89)	1,338,510.75
1994	1,338,510.75	471,162	609,674.51	(394,961.30)	47,116.22	(880,583.28)	944,284.86
1995	944,284.86	455,840	698,356.31	(819,734.95)	45,583.98	(685,896.99)	1,275,055.39
1996	1,275,055.39	496,439	639,073.42	(481,790.19)	49,643.89	(399,489.37)	1,450,346.81
1997	1,450,346.81	562,667	543,734.50	(411,309.28)	56,266.74	251,371.88	2,037,828.38
1998	2,037,828.38	590,921	(98,695.41)	(97,558.05)	59,092.11	984,009.86	2,370,687.69
1999	2,370,687.69	633,217	(683,435.10)	7,543.15	63,321.68	1,224,652.39	2,207,823.33
2000	2,207,823.33	660,169	(377,378.22)	(53,526.77)	66,016.89	706,537.35	1,864,323.41
2001	1,864,323.41	697,295	142,795.40	(234,452.88)	69,729.54	50,627.14	1,525,173.94
2002	1,525,173.94	640,162	489,550.67	(432,144.74)	64,016.23	(403,679.16)	1,339,011.67
2003	1,339,011.67	637,387	609,419.35	(615,973.05)	63,738.68	(1,367,943.52)	495,335.12
2004	495,335.12	651,901	526,575.01	(4,351,253.08)	65,190.07	(3,524,333.55)	1,131,738.93
2005	1,131,738.93	552,824	684,118.28	(741,811.08)	55,282.44	(1,342,719.78)	606,841.66
2006	606,841.66	602,198	596,354.27	(2,723,410.07)	60,219.82	(2,617,076.69)	647,111.32
2007	647,111.32	686,530	617,150.26	(2,970,046.78)	68,652.99	(2,914,935.36)	564,190.13
2008	564,190.13	628,066	571,779.73	(3,289,765.71)	62,806.60	(3,088,945.96)	645,916.95
2009	645,916.95	627,928	616,567.10	(2,602,678.54)	62,792.82	(2,575,480.52)	598,961.06
2010	598,961.06	602,628	592,011.16	(2,788,414.76)	60,262.76	(2,734,696.79)	581,799.80
2011	581,799.80	612,147	582,243.66	(2,788,414.76)	61,214.72	(2,694,370.72)	584,725.62
2012	584,725.62	606,373	583,938.93	(2,788,414.76)	60,637.29	(2,694,287.73)	595,781.41
2013	595,781.41	600,599	590,233.46	(2,788,414.76)	60,059.86	(2,697,598.94)	616,172.23
2014	616,172.23	594,824	601,380.77	(2,788,414.76)	59,482.43	(2,703,517.59)	648,143.42

In general, both the depletion and IUU variables in the recursive model affected other changes. Standing stock estimation is derived from fisheries bio-economics dynamics from time series data input and output, both of which do not account for such variables. Future trend estimations of physical Indonesian shrimp resources shows stock increase. By 2020, the stock is estimated to be 567 thousand tones, while production is predicted to fluctuate with a tendency to drop by 2017, this is actually confirm to the study of Anna and Fauzi (2013), found that the stock of shrimp in the waters nothern Java, which experiencing a decline trend, up to the year of 2017.

The initial value of the shrimp stock monetary account in 1988 was 687 billion and closed at 1 trillion in 2010. Monetary analysis for the next five years (2015-2020) shows positive growth, from IDR 226 billion in 2015 to 565 trillion in 2020. It means that shrimp actually share a big value to the Indonesian economic, and if it is maintain properly, the value could be bigger along the time.

Findings in analysis of the Indonesian shrimp resource account may be consulted as a basis to plan sustainable shrimp fishing management based on its stock portfolio. While stock accounts show a surplus of standing stock, the situation might not necessarily last. Management to maintain a stock surplus must be carried out by means of fishing permit restrictions, adjusted to current standing stock under a binding management agreement regime. Given points on findings above, and given that stock portfolio would be affected by fishing permits, measures on permit units by gross tonnage or composite measurements must be fundamentally changed and agreed by the relevant parties.

The current surplus in shrimp stock opens investment opportunities for domestic investors. Such opportunities have to be strictly regulated by calculating the best input with the most possible effort given stock conditions. Effort must consider the number of fishing vessels, equipment, and capacity. Consequently, this study's findings of fisheries resource account ought to be linked to findings on capacity utilization so as to obtain the maximum allowable number of fishing vessels extracting Indonesian fisheries resources. The capacity utilization has been mandated as an indicator for sustainable fisheries globally (Ceyhan and Gene 2014; Fathelrahman et al. 2014; Ericson and Clarks 2015; Walden et al. 2015; Gigentika et al. 2016).

The account is an aggregate of Indonesian accounts, with differences in each WPP, from standing stock to fishing capacity utilization. In this case, there are zones still open for further development, based on their high standing stocks and low capacities. Conversely, there are also zones with low or negative standing stocks but high capacities. Such differences require different policies. To that end, more specific and continuous studies which expire every five years are required on fisheries resource accounting and capacity utilization on per WPP or provincial waters. Both fisheries resources accounting, and capacity utilization studies, are complementary pairs and could provide clear policy directives to establish permit allocations and policy

on rationalization if needed. Rationalization policy is use to be implemented in such over capacity condition (Aranda et al. 2012; Carothers and Chambers 2012; Grimm et al. 2012; Waldo and Paulrud 2013; Pinkerton et al. 2014).

Future national account aggregate calculations must consider imported and exported shrimp flows. Relevant import and export data highly support an open economy balance model. The data would also provide information on deficits and surpluses in relation to shrimp trade and overseas shrimp consumption.

From the study can be drawn some conclusions as follows: (i) Assessment of Indonesian Shrimp resource accounting have provided a detail picture of aggregate stock and flows condition of Shrimp in Indonesia. (ii) From the study can be drawn that the stock is still in a surplus condition. (iii) The stock and flows that can be quantitatively drawn from Indonesia's Shrimp resources accounting, is the beginning of standing stock and its revisions throughout the current year, including production, growth, depletion, externalities due to Illegal, Unreported and Unregulated Fishing (IUU), and also changes others, as well as the standing stock at the end of the year. (iv) The annual trend of this shrimp stock condition fluctuated. With recursive models showed that the standing stock of shrimp in the range of 200 thousand tons to 900 thousand tons. The monetary value of the stock's standing with the same model in the range of 500 billion to 2 trillion rupiah. (v) The natural growth of shrimp, tend to be a positive average, with values in the range of -260 thousand tons to 260 thousand tons. (vi) Both variables depletion and IUU the recursive balance model, basically only affect changes in others and the estimated total standing stock is derived from bio economic dynamics of the fish from the time series data input and output, which also did not include these variables in the model. (vii) In the estimation of future trends physical balance of resources Indonesia shrimp resources Data analysis showed an increase in the stock ahead. The stock closed the year 2020 as many as 350 thousand tons. Production is forecast to fluctuate with a tendency to decline until 2017. (viii) The monetary balance sheet shrimp stock opened at IDR 687 billion in 1988, and closed at a value of IDR 616 billion at the end of 2014. (ix) The monetary analysis for the next 5 years, that is from 2015 till 2020 for Indonesian shrimp, tend to increase throughout the next 5 years from IDR 648 billion to 929 billion at the end of 2020.

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