Determining the stock status of snapper (*Lutjanus* sp.) using surplus production model: a case study in Banyuasin coastal waters, South Sumatra, Indonesia

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Abstract. Snapper (*Lutjanus* sp.) is an economically important fish for local fishermen in Banyuasin coastal water of South Sumatra. However, the current and historical stock of this species is still unknown. This study was aimed to estimate the stock status of *Lutjanus* sp. in the Banyuasin coastal waters. The annual catch and effort data were analyzed from 2008 to 2016. The different surplus production models were tested to obtain the best-fitted model based on the sign suitability test, model performance test, and multiple criteria analysis. The results indicated that the best-fitted model for *Lutjanus* sp. was the Fox model. The model had the best value for the determination coefficient ($R^2 = 97.2\%$), Nash-Sutcliffe Efficiency (-0.277), Mean Absolute Deviation (29.198), Mean Square Error (1,190.52), Root Mean Square Error (34.504), and RMSE-observations Standard Deviation Ratio (1.13), whereas the value of Mean Absolute Percentage Error (0.05) was the second-best value. The optimum effort ($E_{opt}$), maximum sustainable catch ($C_{MSY}$), and total allowable catch were 22,236 trips/year, 623 ton and 498 ton/year, respectively. Based on plotting the effort and exploitation level (141%; 102%) in 2016, the stock status of *Lutjanus* sp. indicated depleting stock, the high fishing pressure and could encourage overfishing stock in the future.

Keywords: snapper, stock status, surplus production model

1. Introduction

Banyuasin coastal waters owned a high potential of fish resources and high diversity (Fauziyah *et al* 2019, Fauziyah *et al* 2018a). One of the economically important fish in these waters is snapper (*Lutjanus* sp.). Their distribution areas include coastal waters and coral reefs throughout Indonesia, the Bengal Gulf, the Siam Gulf, the South China Sea, Philippines, Australia and South Africa (Ganisa 1999). These species were caught with various types of fishing gear such as gillnet, hooks and line, traps, trawl, and seine net (Ganisa 1999, Noija *et al* 2014). This condition indicated the dynamics...
stock for *Lutjanus* sp. due to the fishing pressure. These fishing pressures should be limited to keep the fish stock sustainability in the future.

At present, data and information on *Lutjanus* sp. in the Banyuasin Coastal Waters especially related to effort level, exploitation level, and stock status are not yet available due to the stock assessment for this species has not been conducted. While the data available in the capture fisheries statistics of Banyuasin Regency are only the fish landed and fishing effort data. The statistical data on capture fisheries during 2008-2016 showed that the trend of fishing effort increased every year. Furthermore, the fishing activities in these waters are still open access. This condition encourages everyone to utilize these resources indepdently (Patria *et al* 2014) and tend to be irresponsible to keep the sustainability of the resources (Nurhayati 2013). Increasing fishing capacity results in increasing fishing pressures on fish stocks and eventually leads to over-exploitation as well as depletion of available fish stocks (Sin and Yew 2016).

One of the simplest and most common approaches for the fish stock assessment is Surplus Production Model (Kekenuasa *et al* 2014a, Bordet *et al* 2014). This Surplus Production Model (SPM) only uses the annual data of catch and fishing effort. Both of the models are used to determine the optimum level of effort that can produce a Maximum Sustainable Yield (MSY). The application of classic SPM for stock assessment usually used one of three growth model approaches, namely, logistic models, Gompertz models, and general logistical models. The various types of SPM were commonly used to estimate the biological reference points ($C_{\text{MSY}}$ and $E_{\text{opt}}$) which were highly dependent on the growth function approach used by each model. Therefore it was very important to evaluate the best-fitted model. Using different SPM to obtain the best-fitted model has also been conducted by several researchers (Anna *et al* 2017, Beset *et al* 2017, Mayalibit *et al* 2014, Kumaat *et al* 2013, Colvin *et al* 2012). Determination of the best-fitted model was examined based on sign suitability tests as well as the model performance test (Singh 2015, Siyal *et al* 2013, Moriasi *et al* 2007, Seong *et al* 2015, Valero *et al* 2007).

These biological reference points will be used to estimate the exploitation level ($C/C_{\text{MSY}}$) and the fishing effort level ($E/E_{\text{opt}}$) where both were key factors that need to be balanced in order to the fishing effort can be sustainable. Therefore it is very important to assess whether the current fish abundance is inadequate fish stock conditions and whether the fishing pressure level is sufficiently controlled. This study's aim was to estimate the stock status of *Lutjanus* sp. in the Banyuasin Coastal Waters based on the biological reference points. For the fisheries manager, assessing the current stock status was required to baseline data in order to control the levels of fishing effort and exploitation. This controlling is useful to keep the sustainability of fish stocks in the future.

2. Materials and methods

2.1. Study area
This study was carried out at the coastal area of Banyuasin Regency, Province of South Sumatra, Indonesia (figure 1). These waters have an estuary which gets water mass input from two different rivers (Banyuasin River and Telang River). At the estuary opening, this water faces directly to the Bangka Strait. The Banyuasin coastal waters are the most significant waters contributing to the capture fisheries production in South Sumatra Province.

2.2. Source of data
The annual data of the catch and effort for *Lutjanus* sp. during 2008-2016 were used and obtained from the Annual Report of the Capture Fishery Statistics of Banyuasin Regency, South Sumatra. The fishing effort was obtainable by a number of the operational fishing boat (trip) and the total catch was presented in the total weight of fish landed (Beset *et al* 2017).
2.3. CPUE and effort standardization
The catchability of each fishing gear to catch the target species was different so that the standardization technique of fishing gears was needed (King 1995, Sparre and Venema 1998, Fauziyah et al 2018c). The formula of fishing gear standardization followed equation 1-3.

\[ E_{jt} = \varphi_{jt}D_{jt} \]  \hspace{1cm} (1)
\[ \varphi_{jt} = \frac{U_{jt}}{U_{st}} \]  \hspace{1cm} (2)
\[ U_{jt} = \frac{C_{jt}}{D_{jt}} \]  \hspace{1cm} (3)

*Figure 1.* Map of Banyuasin Coastal Waters, Province of South Sumatra, Indonesia.

| Source | Description |
|--------|-------------|
| 1. | Bapda PM Kab. Banyuasin 2010 |
| 2. | Peta Rupa Bumi Sumatera Selatan 2014 |

2.4. Surplus production model
Table 1 presented the vary SPMs equations that were used in this study. The sustainable catch equation for Schaefer, Gulland, Walter, and Hilborn, and Schnute models used logistic growth. Fox and CYP models used Gompertz growth, while Pella & Tomlinson model was used the generalized logistic growth.
2.5. Best-fitted model

The determination of the best-fitted model was examined based on the sign suitability tests as well as the model performance test. Table 2 presented the estimation parameters of SPM that used for testing the sign suitability. Schaefer, Pella & Tomlinson, Fox, and Gulland models used intercept value (a) and slope value (b) for testing the sign suitability. While Walters-Hilborn, Schnute, and CYP model using the value of r, q, and K for testing the sign suitability (Kekenusa et al 2014a, 2014b, 2015, 2018, Sparre and Venema 1998). The SPMs with the appropriate parameter sign proceeded with the model performance test.

| Model                           | Equation                                    | Biological References | References                  |
|---------------------------------|---------------------------------------------|------------------------|-----------------------------|
| 1. Schaefer                     | $\frac{ct}{Et} = a - \beta Et$; $C_t = aEt - bEt^2$ | $E_{opt} = \frac{a}{2b}$ | (Kekenusa et al 2014b, 2015, 2018) |
| 2. Gulland                      | $U_t = \frac{C_t}{Et} = a - b\bar{E}_t$ | $E_{opt} = \frac{a}{2b}$ | (Singh 2015, Ricker 1975, Widodo 1986) |
| 3. Pella & Tomlinson            | $U_t = \frac{C_t}{Et} = a - b\bar{E}_t \cdot$ | $E_{opt} = \frac{a}{mb}$ | (Singh 2015, Widodo 1986) |
| 4. Fox                          | $\ln \left( \frac{C_t}{Et} \right) = a - b\bar{E}_t$ | $C_{MSY} = \frac{amE_{opt} + bE_{MSY}}{m}$ | (Kekenusa et al 2014b, 2015, 2018, Mohsin et al 2017) |
| 5. Walters-Hilborn              | $\frac{U_{t+1}}{U_t} - 1 = a + bU_t + cE_t$ | $E_{opt} = -\frac{a}{2c} = -\frac{r}{2q}$ | (Kekenusa et al 2014b, 2015, 2018) |
| 6. Schnute                      | $Y_t = a + bX_{it} + cX_{2it}$ | $C_{MSY} = \frac{a^2}{4b} = \frac{rK}{4}$ | (Kekenusa et al 2014b, 2015, 2018, Sholahuddin et al 2015) |
| 7. CYP                          | $Y_t = a + bX_{it} + cX_{2it}$ | $C_{MSY} = \frac{a^2}{4b} = \frac{rK}{4}$ | (Kekenusa et al 2014b, 2015, 2018, Supriatna et al 2016) |

$E_t$ = effort standardized at t period
$\bar{E}_t$ = moving average of effort standardized at t period
$E_{t+1}$ = effort standardized at t+1 period
$C_t$ = catch at t period
$U_t$ = CPUE standardized at t period
$U_{t+1}$ = CPUE standardized at t+1 period
r = intrinsic growth rate
q = catchability coefficient
K = carrying capacity
a,b,c = regression coefficients
Table 2. The estimation parameters of SPM that used for testing the sign suitability.

| Model                  | Estimation parameters | Sign suitability test |
|------------------------|-----------------------|-----------------------|
| 1. Schaefer            | a (intercepts)        | The a value must be positive (+) |
|                        | b (slope)             | The b value must be negative (-) |
| 2. Gulland             | a (intercepts)        | The a value must be positive (+) |
|                        | b (slope)             | The b value must be negative (-) |
| 3. Pella & Tomlinson   | a (intercepts)        | The a value must be positive (+) |
|                        | b (slope)             | The b value must be negative (-) |
| 4. Fox                 |                       |                       |
| 5. Walters-Hilborn     | r                      | The r value must be positive (+) |
|                        | q                      | The q value must be positive (+) |
|                        | K                      | The K value must be positive (+) |
| 6. Schnute             | r                      | The r value must be positive (+) |
|                        | q                      | The q value must be positive (+) |
|                        | K                      | The K value must be positive (+) |
| 7. CYP                 | r                      | The r value must be positive (+) |
|                        | q                      | The q value must be positive (+) |
|                        | K                      | The K value must be positive (+) |

Table 3. The statistical parameters for assessing the SPM performance.

| Statistics parameters | Formula | Performance criteria | Ref. |
|-----------------------|---------|----------------------|------|
| 1. Determination coefficient (R²) | Multiple regression: $R^2 = \frac{(b \sum x_i y) + (c \sum x_i y)}{\sum y^2}$ | Very Good : 0.86 < R² ≤ 1 | (Duda et al 2012) |
|                       | Simple regression: $R^2 = \frac{\left[n(\sum xy) - (\sum x)(\sum y)\right]^2}{\sum x^2 (n-1)}$ | Good : 0.75 < R² ≤ 0.86 | |
|                       |                                                   | Satisfactory : 0.65 < R² ≤ 0.75 | |
|                       |                                                   | Unsatisfactory : 0.65 < R² ≤ 0.75 | |
| 2. Mean absolute deviation (MAD) | $MAD = \frac{\sum |c_i - \hat{c}_i|}{n}$ | The lower the MAD value, the model performance is better. | (Moriasi et al 2007) |
| 3. Mean square error (MSE) | $MSE = \frac{\sum (c_i - \hat{c}_i)^2}{n}$ | The lower the MSE value, the model performance is better. | (Moriasi et al 2007) |
| 4. Root mean square error (RMSE) | $RMSE = \left[\frac{(c_i - \hat{c}_i)^2}{n}\right]^{1/2}$ | The lower the RMSE value, the model performance is better. | (Moriasi et al 2007) |
| 5. Mean absolute percentage error (MAPE) | $MAPE = \frac{\sum |c_i - \hat{c}_i|}{\sum c_i}$ | Very Good : MAPE < 0.1 | [36] |
|                       |                                                   | Good : 0.1 ≤ MAPE < 0.2 | |
|                       |                                                   | Satisfactory : 0.2 ≤ MAPE < 0.5 | |
|                       |                                                   | Unsatisfactory : MAPE ≥ 0.5 | |
| 6. RMSE-observations Standard Deviation Ratio (RSR) | $RSR = \frac{\sum (c_i - \hat{c}_i)^2}{\sum (c_i - \bar{c})^2}$ | Very Good : 0.00 < RSR ≤ 0.50 | (Moriasi et al 2007) |
|                       |                                                   | Good : 0.50 < RSR ≤ 0.60 | |
|                       |                                                   | Satisfactory : 0.60 < RSR ≤ 0.70 | |
|                       |                                                   | Unsatisfactory : RSR > 0.70 | |
| 7. Nash-Sutcliffe Efficiency (NSE) | $NSE = 1 - \frac{\sum (c_i - \hat{c}_i)^2}{\sum (c_i - \bar{c})^2}$ | Very Good : 0.75 < NSE ≤ 1.00 | (Moriasi et al 2007) |
|                       |                                                   | Good : 0.65 < NSE ≤ 0.75 | |
|                       |                                                   | Satisfactory : 0.50 < NSE ≤ 0.65 | |
|                       |                                                   | Unsatisfactory : NSE ≤ 0.50 | |

Note:
- $\hat{c}_i$: the predicted catch at t period
- $c_t$: the actual catch at t period
- $\bar{c}$: the mean of actual catch
- $n$: the number of observations
All aspects of the model performance can’t be assessed using a single statistic and there was no clear consensus to measure the model performance. Some authors used several statistic parameters to assess the model performance, such as $R^2$, NSE, RMSE, MAD, MSE, MAPE, and RSR (Moriasi et al 2007, Valero et al 2007, Seong et al 2015, Singh 2015). Walters-Hilborn, Schnute, and CYP model used the multiple regressions, whereas Schaefer, Pella & Tomlinson, Fox, and Gulland model used the simple regression. Basically, $R^2$ was obtained from a regression between CPUE (Y-axis) and Effort (X-axis). The formula of the statistical parameter for assessing the model performance was presented in table 3.

The best-fitted model using several criteria (table 3) and selected based on multi-criteria analysis (MCA). The MCA would calculate the standardized value for all criteria of the model performance. The standardization formula (Iskandar and Guntur 2014, Wiyono 2011, Fauziyah et al 2018b) followed equation 4-6.

For $R^2$ and NSE criteria:

$$V(X) = \frac{X - X_0}{X_a - X_0}$$

(4)

For MAD, MSE, RMSE, MAPE and RSR criteria:

$$V(X) = \frac{X - X_0}{X_a - X_0}$$

(5)

The value functions for decision making:

$$V(A) = \sum_{i=a}^{n} V_i(X_i)$$

(6)

Where:
- $V(X)$ = Value function of criteria $X$
- $X$ = Value of criteria $X$
- $X_a$ = The highest value of criteria $X$
- $X_0$ = The lowest value of criteria $X$
- $V(A)$ = Value function of alternatives A
- $V_i(X_i)$ = Value function of alternatives in criteria $i$

The best-fitted model was determined based on the highest $V(A)$ value (Iskandar and Guntur 2014, Wiyono 2011, Fauziyah et al 2018b).

2.6. Fish stock status

The classification method for determining the fish stock status varies between researchers as well as varies between country (Garcia et al 1989, Beddington et al 2007, Pauly 2007, 2008, Carruthers et al 2012). This study modified the classification of fish stock status by considering the $C/C_{MSY}$ and $E/E_{opt}$ as the biological reference points (table 4).

| The fisheries status and criterion | The fish stock status |
|-----------------------------------|-----------------------|
| Exploitation level                | Fishing Effort Level   |
| Over-exploited $(C/C_{MSY} \geq 1)$ | Underfishing $(E/E_{opt} < 1)$ | Healthy Stock |
| Over-exploited $(C/C_{MSY} \geq 1)$ | Overfishing $(E/E_{opt} \geq 1)$ | Depleting Stock |
| Fully-exploited $(0.5 \leq C/C_{MSY} < 1)$ | Underfishing $(E/E_{opt} < 1)$ | Recovery Stock |

Table 4. The classification of fish stock status.
The fisheries status and criterion

| Exploitation level | Fishing Effort Level | The fish stock status |
|--------------------|----------------------|-----------------------|
| Fully-exploited    | Overfishing          | Overfishing Stock     |
| (0.5 ≤ C/C_{MSY} ≤ 1) | (E/E_{opt} ≥ 1)   |                       |
| Moderate exploited | Overfishing          | Overfishing Stock     |
| (0.2 < C/C_{MSY} < 0.5) | (E/E_{opt} ≥ 1)   |                       |
| Moderate exploited | Underfishing         | Transitional recovery Stock |
| (C/C_{MSY} < 0.5)   | (E/E_{opt} < 1)     |                       |
| Moderate exploited | Overfishing          |Collapsed stock        |
| (C_{MSY} ≤ 0.2)     | (E/E_{opt} ≥ 1)     |                       |

3. Result and discussion

3.1 Catch, effort and CPUE

Table 5 presented the data of catch, standard effort, and CPUE where the trammel net was the standard fishing gears for this analysis. Increasing the CPUE value occurred during the 2008-2009 period and then tended to decline until 2016. Decreasing the CPUE value in 2010-2016 due to the proportion for increasing the catch was smaller than the proportion of the increase in fishing efforts. Decreasing the CPUE values indicated that the species encounter the overfishing phenomenon (Mayalibit et al 2014).

| Year | Actual Catch (ton) | Standard effort (trip) | CPUE (ton/trip) |
|------|-------------------|------------------------|-----------------|
| 2008 | 543.04            | 12961.54               | 0.04190         |
| 2009 | 561.59            | 11438.37               | 0.04910         |
| 2010 | 564.67            | 16585.72               | 0.03405         |
| 2011 | 540.74            | 29252.38               | 0.01849         |
| 2012 | 578.73            | 29252.38               | 0.01978         |
| 2013 | 596.06            | 27195.44               | 0.02192         |
| 2014 | 598.52            | 29425.35               | 0.02034         |
| 2015 | 617.91            | 31631.64               | 0.01953         |
| 2016 | 633.83            | 31398.36               | 0.02019         |

3.2 The best-fitted SPMs

The best-fitted model for Lutjanus sp. was selected from various SPM (table 6). Based on the sign suitability test, Walter-Hilborn, Schnute, and CYP model were not adequate for this species. Fox model was the best-fitted model for Lutjanus sp. based on the MCA value (V(A) = 6.968). The values of R^2, NSE, MAD, MSE, RMSE, MAPE and RSR for this model were 0.972, -0.277, 29.198, 1.190.522, 34.504, 0.050 and 1.130 respectively. The Fox model had the best value for NSE, MAD, MSE, RMSE, MAPE and RSR whereas the Pella & Tomlinson model only had the best value on R^2 criteria. According to the value of R^2 and MAPE, the Fox model performance was very good (Duda et al 2012, Moreno et al 2013). The value of E_{opt}, C_{MSY}, and TAC were 22,236 trips, 623 ton and 498 ton respectively.
Reducing the fishing needs to be limited so that it does not exceed the biological reference point (C/C<sub>MSY</sub>). During 2011-2015 period, the exploitation level increased (E/E<sub>opt</sub> ≥ 1) whereas the fishing effort level was underfishing (E/E<sub>opt</sub> < 1). Overfishing for <i>Lutjanus</i> sp. also occurred in 2016, and Skipjack tuna (<i>Katsuwonus pelamis</i>) from Bolaang-Mongondow Waters of North Sulawesi (Kekenusa et al 2014a). On the West Coast of Peninsular Malaysia (Sin and Yew 2014), the CYP model was selected as the best-fitted model for the pelagic and demersal fish.

### 3.3. Fish stock status

Figure 2 showed the fluctuation of fisheries development for <i>Lutjanus</i> sp. during the 2008-2016 period. In the 2008-2010 period, the exploitation level of <i>Lutjanus</i> sp. was fully-exploited (0.5 ≤ C/C<sub>MSY</sub> < 1) whereas the fishing effort level was underfishing (E/E<sub>opt</sub> < 1) and this condition indicated recovery stock. During 2011-2015 period, occurring an increase in the level of fishing efforts until exceeding the optimum point (E/E<sub>opt</sub> ≥ 1) but the level of exploitation was still fully-exploited (0.5 ≤ C/C<sub>MSY</sub> < 1) so that the stock status was overfishing. Whereas in 2016, the exploitation level increased to exceed the optimum point (C/C<sub>MSY</sub> ≥ 1) and there were a few decreases in the level of fishing effort even though it still exceeded the optimum point (E/E<sub>opt</sub> ≥ 1). Thus, the stock status in 2016 showed a depleting stock. In these conditions, even though the abundance of fish stocks is still high (the actual catch obtained could exceed the CMSY value) but the fishing rate is also high (the fishing effort exceed the E<sub>opt</sub> value). This phenomenon can encourage an overfishing stock in the future when both the catch landed and the fishing effort can't be controlled.

These study results were in line with the stock assessment of <i>Lutjanus</i> sp. in the mayor fishing ground of the Australian and Indonesia Waters Fisheries (Koeshendrajana et al 2018) where the efforts level in 2015 has exceeded the optimum point (E/E<sub>opt</sub> > 1). Overfishing for <i>Lutjanus</i> sp. also occurred in Cirebon Waters in 2012 period (Noija et al 2014). Ideally, the level of exploitation and fishing effort needs to be limited so that it does not exceed the biological reference point (C/C<sub>MSY</sub> = 1; E/E<sub>opt</sub> = 1). Reducing the fishing vessel number is essential besides promoting the development of environmentally-friendly fishing gear in order to reduce the fishing efforts and rebuild overfishing stocks (Siyal et al

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**Table 6. Summary statistics from various SPM of <i>Lutjanus</i> sp in Banyuasin Coastal Waters.**

| Parameter | SPM<sub>1</sub> | SPM<sub>2</sub> | SPM<sub>3</sub> | SPM<sub>4</sub> | SPM<sub>5</sub> | SPM<sub>6</sub> | SPM<sub>7</sub> |
|-----------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Sign Suitability Test | 0.060424 | 0.056314 | -2.575429 | 0.310822 | -0.77460 | -5.43187 | -5.2697 |
| Performance Test | -0.000001 | -0.000001 | -0.000045 | -0.103878 | 7.06378 | 84.34071 | 1.0490 |
| Biological references point | 0.00002 | 0.000013 | -0.00005 | 0.00005 | -0.775<sup>NA</sup> | -5.432<sup>NA</sup> | -83.549<sup>NA</sup> |
| MCA value | -0.00002<sup>NA</sup> | -0.000013<sup>NA</sup> | -0.00008<sup>NA</sup> | 5.003.15<sup>NA</sup> | -514.5002<sup>NA</sup> | -20.206<sup>NA</sup> | |

**Note:**

SPM<sub>1</sub>: Schaeffer 
SPM<sub>2</sub>: Pella and Tomlinson 
SPM<sub>3</sub>: Walter-Hilborn 
SPM<sub>4</sub>: Fox 
SPM<sub>5</sub>: CYP 
SPM<sub>6</sub>: Schnute 
V(A): Scoring value

Similar to this study result, the Fox model also was the best-fitted model for the yellow stripe scad (<i>Selaroides leptolepis</i>) from Karangantu Banten (Mayalibit et al 2014), and Skipjack tuna (<i>Katsuwonus pelamis</i>) from Bolaang-Mongondow Waters of North Sulawesi (Kekenusa et al 2014a).
2013, Chae and Pascoe 2005). Updating the fish stock status constantly is also important for fisheries management (Meraz-Sánchez et al 2013).

**Figure 2.** Fish stock status for *Lutjanus* sp. in Banyuasin Coastal Waters. Ploting Fox model and fish stock status (A) and plotting effort level, exploitation level, and fish stock status (B)  
- ● = collapsed stock, ● = overfishing stock, ○ = depleting stock, ■ = healthy stock,  
- □ = recovery stock, ★ = transitional recovery stock.
Based on the TAC value limit (TAC = 498 ton/year), the catch of *Lutjanus* sp. during 2008-2016 has been exceeded the limit value. In these conditions, limiting output (production or fish landed) and/or effort for each fishing gear was necessary to consider as one of policy to protect the resources from overfishing (Anna 2016). For fishermen, the effort reduction will reduce income, but not significantly generate a financial loss due to the operational fishing costs will be reduced too (Sobari *et al* 2008). To avoid financial loss, fishermen can also manage fishing trips (Sobari *et al* 2008). For the fishery manager, some serious steps can be created to control the efforts and mesh size, control TAC, protect the nursery grounds to maintain the natural process, and conduct a detailed study for better understanding of fishery (Beset *et al* 2017).

4. Conclusion

The stock status of *Lutjanus* sp. in the Banyuasin Coastal Waters has been depleting since 2016. Although the biomass was still quite high, the fishing pressure was also high (exceeding the optimal effort level). This condition could encourage an overfishing stock if the catch and the fishing effort could be controlled for ensuring the sustainability of these fish resources.

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