



## POTENTIALS YIELD AND FISHERIES OF MALAHAYU RESERVOIR, BREBES

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### ABSTRACT

Fishing activity in Malahayu Reservoir has been done since long time. Unlimited fishing may impact to the decreasing of fish resources of those waters. This study presents an assessment of fishing practices in Malahayu reservoir between 2008-2016 periods. Data of potential fish production and catch per unit effort were estimated by using different estimate models, catch per unit effort was analyzed annually, while potential fish production was analyzed by using five models namely model by Henderson & Welcome (1974), Teows & Griffith (1979), Marshal (1984), Moreau & De Silva (1991) and Crul (1992). The results show that changes of fish composition has accrued, which was originally dominated by native fish while for now it is dominated by 72,05% of tilapia (*Oreochromis niloticus*) as an introduced fish. Furthermore, the average catch per unit effort (CPUE) in Malahayu reservoir is about 11,82 kg / fisherman, while the average potential production is about 198,55 kg / year. CPUE value and potential production indicate that exploitation rate in Malahayu Reservoir are in fully-exploited or perhaps over-exploited condition. Related to those conditions, not to increase the number of efforts (fishermen) as a management option towards sustainable fisheries.

**Keywords: CPUE; yield; Malahayu reservoir; exploitation rate**

### INTRODUCTION

The reservoir is a man-made lake with various functions, namely as hydropower, irrigation, flood control, source of drinking water, tourism and fishery business (Cowx, 2002). The development of fishery reservoir business is important, because it can increase the benefits and productivity of the reservoir and also provide employment of communities around the reservoir (Triyatmo, 2001). One of the fishery reservoir activities that has grown for a long time is a fishery in Malahayu reservoir. Fisheries development in Malahayu has been done since 1984 by local fishermen who are members of Nilajaya group.

Overtime, the catch in Malahayu has been decreased. The decreased of catch is suspected as a result of the decreasing on water carrying capacity (Istiana & Nasution, 2013) and reservoir conditions that have undergone by sedimentation (Wahyudi & Santoso, 2002). One example of the type of fish that has decreased in catch is Mendo (*Acentrogobius sp*) (Soekiswo et al., 2014).

A study related to the estimation of potential fish production needs to be done to provide input in determining the policy of fish resources management in a water body in order to remain sustainable (Bramick, 2002). Various methods are used to estimate the potential of fish production in reservoirs and lakes (Moreau & de Silva, 1991). The study of Warsa & Purnomo (2011) states that until 2010 the condition of fishery in Malahayu Reservoir still be increased by 25%. Considering the current condition of fisheries, further study is needed to know the potential yield and exploitation status at Malahayu Reservoir. Based on that interest, the purpose of this research are to study potential yield with several methods and to know the exploitation status in Malahayu Reservoir.

### MATERIALS AND METHODS

9 years data from 2008-2016 that used in this paper include of catch, number of fishermen and type of fishing gear. Those data was obtained from the enumerator funded by the Research Center for Recovery of Fish Resources (Balai Riset Pemulihan

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Sumberdaya Ikan, Jatiluhur). While catch data, number of fishermen, types of fishing gear and catch composition from 2014-2016 was based on the existing record in Nilajaya fishing group, in Malahayu Reservoir, Brebes, Central Java.

**Fish Potential Yield**

The fish potential yield of the reservoir is estimated by using the Morpho-Edaphic Index (MEI) model and the reservoir area. The conductivity data used is derived from the measurements in the previous study. Method of estimation of potential production used in this research covers:

**1<sup>st</sup> Model (Henderson & Welcome, 1974):**

$$Y = 14,3136MEI^{0,4681} \dots\dots\dots (1)$$

Where, Y is potency (kg / ha / year) and MEI is Morpho-Edaphic Index. MEI is calculated by the equation as follows:

$$MEI = \frac{conductivity}{average\ depth} \dots\dots\dots (2)$$

**2<sup>nd</sup> Model (Teows & Griffith, 1979):**

$$Log(Y) = 1,4071 + 0,3697\log(MEI) - 0,00004565A_0 \dots (3)$$

**3<sup>rd</sup> Model (Marshall, 1984):**

$$\ln(Y_t) = 3,57 + 0,76\ln(A_0) \dots\dots\dots (4)$$

**4<sup>th</sup> Model (Moreau & De Silva, 1991):**

$$Y = 436,2 + 0,336A + 0,745E \dots\dots\dots (5)$$

**5<sup>th</sup> Model (Crul, 1992):**

$$Y_t = 8,32A_0^{0,92} \dots\dots\dots (6)$$

Where, A reservoir area in ha, E fishing effort (number of fishermen),  $Y_t$  total potency (ton/year) and  $A_0$  reservoir area in km<sup>2</sup>.

**Catch Rate**

Catch per unit effort (CPUE) often called as catch rate, that is in this study expressed as number of fish caught by each fishermen (kg/fisherman). All fishermen carrying out fishing are calculated to estimate total fishing efforts. Total catch can be estimated by multiplying the value of CPUE by the effort (Stamatopoulos, 2002). Based on this, then the calculation of CPUE calculated by the equation as follows:

$$CPUE = \frac{c}{f} \dots\dots\dots (7)$$

Where, CPUE is the catch per unit effort, C is the number of catch and f is fishing effort.

**RESULT AND DISCUSSION**

**Results**

**Catch Composition**

The fish species caught by fishermen in Malahayu Reservoir consists of *Oreochromis niloticus* (nile tilapia), *Channa striata* (striped snakehead), *Mystus nigriceps* (two spot catfish), *Acentrogobius sp* (mendo fish), *Cyprinus carpio* (common carp), *Pangasianodon hypophthalmus* (striped catfish), *Rasbora argyrotænia* (silver rasbora), *Trichogaster pectoralis* (snake skin gouramy) and *Monopterus albus* (Asian swamp eel). Beside fish also caught type of shrimp (*Macrobrachium spp*). The average of catch during 2008-2016 is dominated by 72,05% of tilapia fish, followed by 8,62% of striped snakehead, 4,81% of shrimp, 2,52% of catfish, 2,10% of mendo fish and 0,34% of two spot catfish (Figure 1).

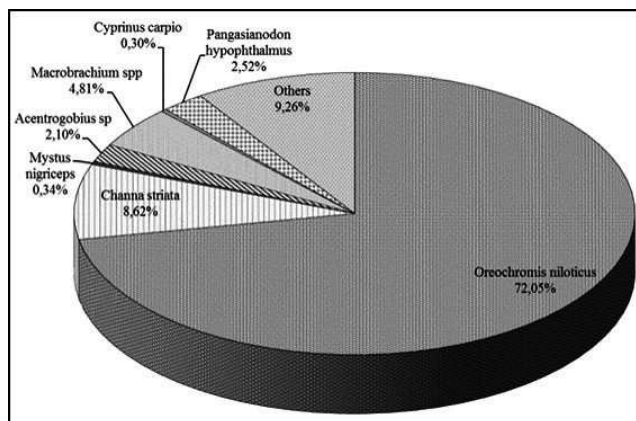


Figure 1. Catch composition in Malahayu Reservoir.

**Potential Fish Production**

In calculating the potential production of Malahayu Reservoir, several parameters like reservoir area, average depth and conductivity are used in all of five models (Tabel 1).

Estimation model of potential production in Malahayu Reservoir produce potential value of reservoir production equal to 46,10-1189,75 kg / ha / year or 28,58-737,65 ton/year. Then the average of potential

fish in Malahayu Reservoir is 198,55 ton/year or 320,25 kg/ha/year (Table 2). The average of potential production is lower than potential production in 2010 which is reach to 828 tons/year (Warsa & Purnomo, 2011). Comparison of model usage show that Moreau & De Silva (1991) generates highest potential production estimation than other model used in this study or equal to 737,65 ton/year, while Henderson & Welcome (1974) model generates the lowest potential production estimation or equal to 28,58 ton/year.

Table 1. Input parameters used in estimating the potential yield of fish in Malahayu Reservoir

Reservoir	Area (km <sup>2</sup> )	Depth (m)	Conductivity (uS/cm)
Malahayu	6,2*	2,47**	30,05***

Source: \*) Warsa & Purnomo, 2011; \*\*) Fahmi & Santosa, 2014; \*\*\*) Andriyanto et al., 2012

Table 2. Potential fish yield estimates for Malahayu Reservoir

No.	Models	Productivity (Kg/ha/year)	Potential Yield (ton/year)
1	Henderson & Welcome (1974)	46,10	28,58
2	Teows & Griffith (1979)	64,27	39,85
3	Marshal (1984)	292,22	142,17
4	Moreau & De Silva (1991)	1189,75	737,65
5	Crul (1992)	71,90	44,58
Average		320,25	198,55

**CPUE of Malahayu Reservoir**

Fish production in Malahayu Reservoir tends to decrease during 2009-2012 respectively, on the

other hand there is an increase of the production in 2013-2016. Both periods analysis obtained that average production of 2008-2016 about 150,23 tons (Figure 2).

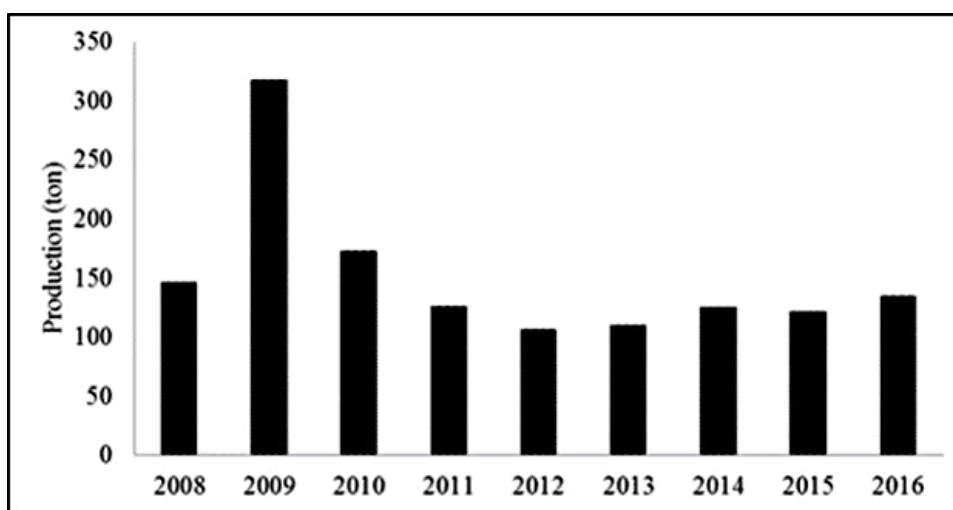


Figure 2. Fish production of Malahayu Reservoir in 2008-2016.

Malahayu fisherman are the people who live and utilize the reservoir resources, the community comes from five villages that are Malahayu village, Cawiri, Kracak, Rembet and Dukuh Jati village. Fisherman are grouped into a group namely Nilajaya, whose

institutions have been legally valid in 2016. Total amount of fisherman reach to 129 people which the largest number of fishermen came from Cawiri area and the least was from Rembet (Figure 3).

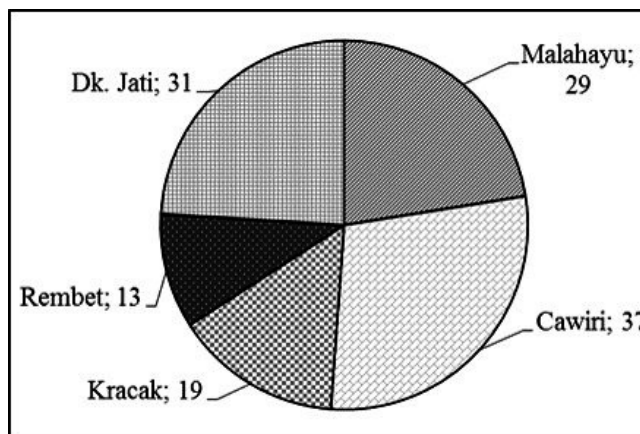


Figure 3. Numbers of fisherman of Malahayu Reservoir in 2017.

Fishing activity in Malahayu is quite intensive, based on interviews with local fishermen it is known that fishing activities are carried out throughout the day (Triharyuni *et al.*, 2017). A relatively high intensity level is indicated by the downward trend in CPUE

values in 2008-2016. The average value of CPUE in Malahayu Reservoir is 11,82 kg/fisherman (Figure 4). This value is higher than in Warsa & Purnomo (2011), by using a monthly data period during 2010 they obtained CPUE aqual to 5,8 kg/fisherman.

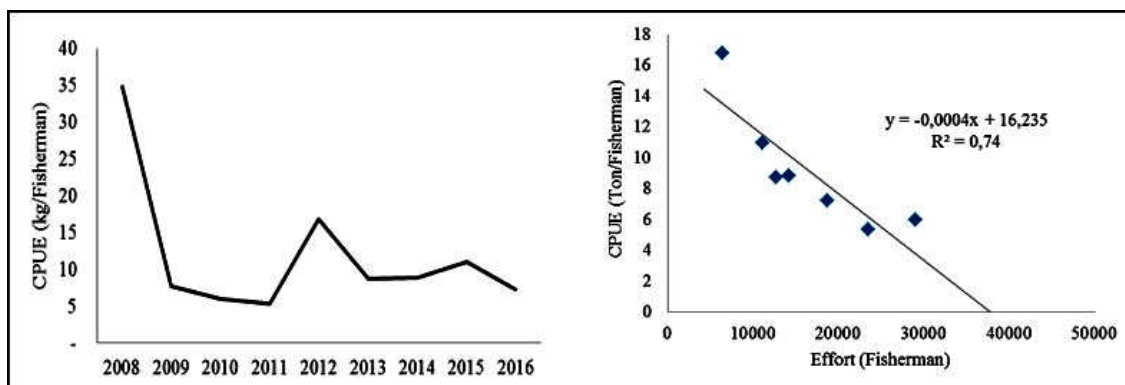


Figure 4. Annually trend of CPUE (a) and CPUE and fishing effort relationship of Malahayu Reservoir in 2008-2016.

The relationship between effort and CPUE generates an equation  $CPUE = -0,0004f + 16,235$  (Figure 4). Those equation produced the value of sustainable yield (MSY) of 164,74 tons and 20 thousand fishermen as the effort of catch. Data show that catch production

in 2016 is about 135,7 tons, then the exploitation rate is equivalent to 68% of its potential production or 82% of MSY (Figure 5). The exploitation rate of fish in Malahayu Reservoir is categorized as *fully-exploited*.

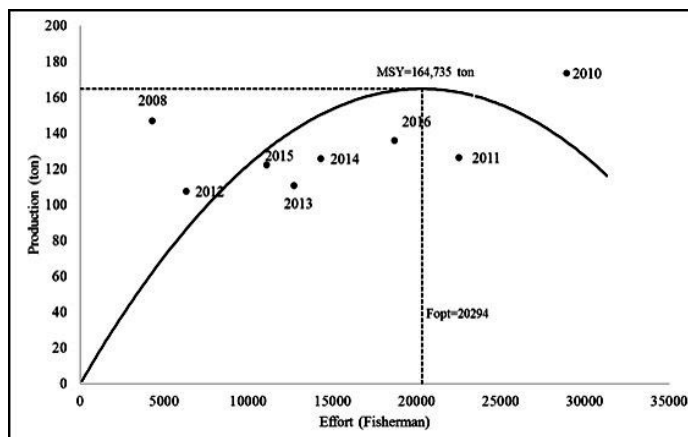


Figure 5. Comparison between actual catch, fishing effort and MSY.

## Discussion

Fish species contained in Malahayu Reservoir consists of native/*indigenous and introduced* fish species (Kartamihardja *et al.*, 2011). Native species such as *Puntius binotatus*, *Mystus nigriceps* and *Macrogathus aculeatus*, while the introduced species such as *Oreochromis mossambicus*, *O. Niloticus*, *Channa striata*, *Pangasianodon hypophthalmus* and *Trichogaster pectoralis*. Fish species in the Malahayu Reservoir are more varied when compared with previous research (Warsa & Purnomo, 2011). The more varied species of fish is due to the fish stocking programme in Malahayu reservoir either done intentionally or not.

Calculation of potential fish production in Malahayu Reservoir shows lower value from result of previous research by Warsa & Purnomo (2011), that is 1337 kg/ha/year or 828 ton/year. The average productivity of Malahayu Reservoir is about 198,55 tons/year, this value is also relatively lower when compared to productivity in other reservoirs. The potential production in the Darma Reservoir reaches 359-450 tons/year with flood area 400 ha (Tjahyo, 2000), and 237-307 ton/tahun in Sempor Reservoir with maximum water surface area 275 ha (Purnomo *et al.*, 2013), while River Basin Authority of Serayu-Opak stated that catchment area of Sempor Reservoir is 43 km<sup>2</sup>. The potential production of Malahayu also lower than reservoirs in Africa which has a potential production of 329 kg/ha/year, higher than reservoir in the United States and the Caribbean that is only reached 125 kg/ha/year (SOFIA, 2002) and Ethiopia which is only 66,6 kg/ha/year (Teame *et al.*, 2016). Those conditions show that the potential production of reservoirs does not depend on the area. High or low potential value means a description of the dynamics of fish resources in the reservoir and also the condition of the aquatic habitat (Anna, 2016).

Decreasing in potential production is suspected not only due to fishing pressure but also by a decrease in environmental quality. Malahayu Reservoir as stated in Wahyudi & Santoso (2002), has experienced habitat degradation due to sedimentation and environmental quality. The exploitation rate (ER) are classified into three, namely (1) moderate, with a range of values of  $ER \leq 0,5$ ; (2) fully-exploited,  $0,5 < ER \leq 1,0$ ; dan (3) overfishing,  $ER > 1,0$  (Suman, 2016). So that the exploitation rate in Malahayu Reservoir based on those classification has reached about 82% or 0,82, or it can be said that the condition of fisheries in Malahayu Reservoir is categorized as fully-exploited. Those condition is contrasts with Kantoussan *et al.* (2014) who states that the status of fisheries with a decreasing CPUE and reservoir potential fish

production, indicates over-exploitation. Declines in CPUE may means that the fish population cannot support the level of harvesting (Stamatopoulos, 2002). This condition is much different in the period of 2009-2010, where is the exploitation rate in Malahayu Reservoir is under-exploited, or still have an opportunity to increase up to 25% (Warsa & Purnomo, 2011).

Based on the condition of capture fisheries that was already in fully-exploited to over-exploited, it requires a certain effort to lead to sustainable capture fisheries, that is by setting the input and output in the fisheries (Fauzi, 2010; Anna, 2010; Anna, 2016). One of the policy implementation that can be done is input restriction, which is in this case is fishing effort (Anna, 2016). Or in other words, there should be no additional number of fishermen in Malahayu Reservoir.

On the other hand, to increase the number of stocks, one of the efforts that can be done is to conduct stocking of fish that has a rapid development and appropriate with the water environment of reservoirs (Lorenzen *et al.*, 2001; Warsa & Purnomo, 2011; Ingram & De-Silva, 2015). Fish introduction is the most commonly used for increasing fish production in reservoir or lake waters (Moreau & De Silva, 1991). The increase in production of a stocking programme has been seen in several reservoirs in Sri Lanka, so the catch becomes increased by 42,8-134% (Pushpalatha & Chandrasoma, 2010).

## CONCLUSION

The average productivity of Malahayu Reservoir is about 198,55 tons/year, average value of CPUE is 11,82 kg/fisherman and MSY of 164,74 tons. Exploitation rate is 82% of MSY indicating at fully-exploited stage even towards over-exploited. Policy implementation that can be done is input restriction (number of fishermen).

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