Indonesian Journal of Limnology
Vol. 05 No. 02, 2024 (91–96)
E-ISSN :2774-2571

Fisheries Carrying Capacity of Joto Reservoir, Lamongan District in The Development of Culture Based Fisheries

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Received 23 October 2024 Accepted 14 December 2024 Published 17 December 2024

DOI: 10.51264/inajl.v5i2.76

Abstract

Joto Reservoir is the largest reservoir in Tikung District and Lamongan District, with a standard area of 113 ha. This reservoir is larger than Tuwiri Reservoir, 84 ha, and Takeran Reservoir, 72 ha. The utilization of Joto Reservoir is still not optimal without proper management, even though the trophic status of the reservoir waters is hypereutrophic. Therefore, this study aims to analyze the carrying capacity of Joto Reservoir and, the types of fish and the right amount of seeds to be spread in the development of culture-based fisheries. The analysis of fisheries carrying capacity determination uses the results of primary water productivity with the Beveridge Index. The results of this study state that the carrying capacity of natural fisheries in Joto Reservoir is 33.8 tons/year. The right type of fish in developing culture-based fisheries in Joto Reservoir is freshwater lobster (*Cherax quadricarinatus*). Freshwater lobster seeds are 2 inches in size, weighing 2-3 g/piece. The target harvest size of freshwater lobster for consumption is 4-5 inches in size with a weight of around 25-45 g/piece. So the number of freshwater lobster seeds that are spread in the development of aquaculture-based capture fisheries in Joto Reservoir is 916,902 tails/year or 305,634 tails/4 months.

Keywords: Carrying capacity, Cultivation-based capture fisheries, Freshwater lobster, Joto Reservoir.

1. Introduction

Joto Reservoir is currently in the category of hypereutrophic waters, where these waters have a very high or very fertile level of nutrient fertility (Fanni & Shaleh, 2021). This causes the entire surface condition of Joto Reservoir to be covered by aquatic plants. Increased nutrients in the waters, primarily N and P, can trigger the growth of phytoplankton and aquatic plants that can affect the ecosystem's structure, function, and balance. Waters experiencing phytoplankton explosions will cause dissolved oxygen concentrations to decrease, and if it gets worse, hypoxia or anoxic (without oxygen) will occur (Novita *et al.*, 2015).

Aquaculture-based capture fisheries have begun to be widely developed in Indonesia, including the Malahayu Reservoir (Aisyah *et al.*, 2019) and the Jatiluhur Reservoir (Ihsan, 2020). This natural fish distribution can be utilized to increase community income, for example, by developing fishing tourism activities and capturing fisheries. It can also be followed by the construction of restaurants. The utilization of Joto Reservoir is currently still less than optimal due to the lack of data to compile proper management. Proper management must be based on carrying capacity. Carrying Capacity or carrying capacity of waters for natural fisheries, namely, the maximum capacity that can be accommodated by the ecosystem (Beveridge, 1984) or the optimum production of a species with the maximum capacity to produce fish that can be produced by natural and sustainable waters (Legovic *et al.*, 2008). Therefore, data on the carrying capacity of natural fisheries is needed for optimal utilization of the reservoir and determination of the right type of fish without damaging the natural food niche in the Joto Reservoir.

2. Methods

2.1. Time and Location

The research was conducted from March to May 2024 at the Joto Reservoir, Lamongan Regency, as shown in Figure 1. Observations and sampling were carried out using purposive sampling. The research location is divided into three stations, namely the reservoir inlet, the middle of the reservoir, and the reservoir outlet. Water sampling in the field was carried out at each station with an interval of once a month.

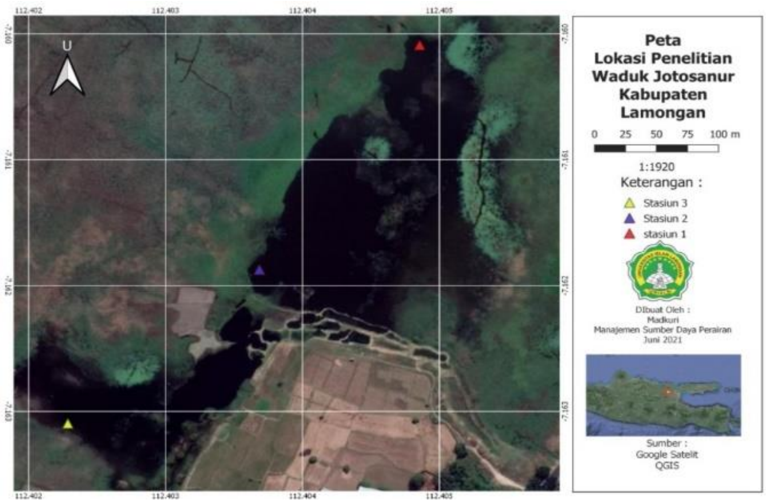

Figure 1. Research site at Joto Reservoir

2.2. Analysis of natural fisheries carrying capacity

Analysis of natural fisheries carrying capacity using the Beveridge method approach (1987) based on the primary productivity of the waters. Data on primary productivity were obtained using the chlorophyll-a value conversion method referring to Smith (2006).

$$\sum PP = \frac{483 \text{ x } Chl^{1.33}}{9 + 1.15\ x\ Chl^{1.33}}$$

Definition:
$\sum$PP = Gross Primary Productivity (g C/m^2/year)
Chl = Chlorophyll (ug/l)

The value of primary productivity is converted using a conversion table according to the percentage value that has been set to convert planktonic carbon into fish carbon. The following are the stages of measuring the carrying capacity of natural fisheries:

1. Determine the gross primary production ($\sum$pp) from the primary productivity data (g C/m^2/year)
2. The $\sum$PP value is converted into the fish biomass that will be produced, using a conversion table. Calculate the annual fish production (Fy) based on the conversion table (Table 1). In this case, it is assumed that the Fy content = 10% of the wet weight of the fish.

Table 1. Conversion of ∑PP with the area of fish that can be harvested in waters with different primary productivity (Beveridge, 1984)

∑PP (g C/m^2/year)	% Conversion of ∑PP with the area of fish (g fish C/m^2/year
<1000	1 - 1.2
1000-1500	1.2 - 1.5
1500-2000	1.5 - 2.1
2000-2500	2.1 - 3.2
2500-3000	3.2 – 2.1
3000-3500	2.1 – 1.5
3500-4000	1.5 – 1.2
4000-4500	1.2 – 1.0
>4500	-1.0

3. Results and Discussion

3.1. Water Quality of Joto Reservoir

The water quality data obtained in this study can be seen in Table 2. The condition of the Joto Reservoir waters is still good for fisheries activities. This can be seen from the water quality in the Joto Reservoir, which is still below the class III standard quality limit and intended for freshwater fish farming based on PP Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The fertility status of the Joto Reservoir waters, when viewed from chlorophyll-a, is included in the hypereutrophic category, where the condition of the waters has high nutrients so that it is very fertile.

Table 2. Water Quality of Joto Reservoir

Parameter	Location		
	Station I	Station II	Station III
Temperature (^{o}C)	28	28	28
Dissolved Oxygen (mg/l)	4	4.4	4.2
pH	7.4	8.2	7.6
Total Phosphate (mg/l)	0.66	0.71	0.69
Nitrate (mg/l)	2.3	2.4	2.0
Nitrite (mg/l)	0.26	0.32	0.28
Ammonia (mg/l)	0.12	0.10	0.11
Chlorophyll (ug/m^3)	33.8	34.6	34.3

3.2. Carrying Capacity of Joto Reservoir

Joto Reservoir has an area of 113 ha. The productivity of Joto Reservoir waters based on the Smith (2006) equation is 308.3 gC/m^2/year. The carrying capacity of natural fisheries based on the conversion of Joto Reservoir primary productivity to natural fish production is 34.84 tons/year or 95.45 kg/day (Table 3).

Table 3. Natural fisheries carrying capacity of Joto Reservoir

Description	Value	Unit
Aquatic productivity	308	gC/m^2/year
Fish biomass conversion	1	gfishC/m^2/year
Fish production (carbon)	3.08	Cfish/m^2/year
Total fish capacity	30.8	gfish/m^2/year
Carrying Capacity	34842270	gfish /year
	34.842	tons/year

The natural fisheries carrying capacity in Joto Reservoir is still smaller than that of Sempor Reservoir (Shaleh, 2015) but larger when compared to Gondang Reservoir (Shaleh, 2018). This is because the fertility status of the waters in Joto Reservoir has reached hypereutrophic status, while in Gondang Reservoir, the fertility status is still classified as mesotrophic. Other factors that affect the carrying capacity and potential for fish production are following fluctuations in water level, water surface area and reservoir volume (Purnomo *et al.*, 2013).

3.3.Developing Culture based fisheries of Joto Reservoir

Culture-based fisheries activities that follow scientific principles are the right option to increase capture fisheries production faster. Culture-based Fisheries (CBF) or Cultivation-Based Capture Fisheries are defined as capture fishery activities in which the fish caught come from cultivated fish seeds that are released into natural waters. The released fish seeds will grow by utilizing natural food, such as available plankton, without providing additional feed (De Silva *et al.*, 2015; Oktorina *et al.*, 2020). Implementing culture-based fisheries in Indonesia can increase fishermen's catches by around 15-508% (Aisyah *et al.*, 2019). One way to develop culture-based fisheries is to restock in accordance with the natural fisheries' carrying capacity and the types of fish released that do not interfere with the fish's food niche. The types of fish found in Joto Reservoir include Tilapia, Rasbora sp, Snakehead, and Carp. Joto Reservoir has a primary function as a source of irrigation for agricultural land. During the dry season, Joto Reservoir is periodically distributed so that the volume of water is small or even dry. However, the waters' very fertile/hypereutrophic status causes many aquatic plants to grow well in this Reservoir. The factors above determine the right type of fish for restocking in Joto Reservoir, namely freshwater lobster (*Cherax quadricarinatus*).

The distribution of freshwater lobster (*Cherax quadricarinatus*) in reservoir waters has been carried out in several places, including Jatiluhur Reservoir (Perum Jasa Tirta, 2021), Sempor Reservoir, and Rawa Pening Semarang (Putri *et al.*, 2014; Kurniawan *et al.*, 2016). Freshwater lobsters are one of the natural fishery commodities that can improve the community's economy around the reservoir due to the high selling price (Kurniawan *et al.*, 2016). Freshwater lobsters are also considered capable of reducing eutrophication because one of their eating habits is that of aquatic plants. The presence of freshwater lobster will reduce the excessive distribution of aquatic plants and improve water quality. In addition, freshwater lobsters are also able to bury themselves in the soil so that when the reservoir water conditions dry up, these freshwater lobsters are still able to survive.

The ideal number of freshwater lobster seeds in developing aquaculture-based capture fisheries in Joto Reservoir must be based on the carrying capacity of natural waters. Periodic seed distribution and harvesting are adjusted to the target size of the fish stocked and the water level (Aisyah *et al.*, 2019). The ideal size of freshwater lobster seeds in restocking is 1 to 2 inches long and weighs 1 to 2 g. The harvest size of freshwater lobsters is targeted at 4-5 inches. The growth of freshwater lobsters will increase by 1 inch per month, so the harvest time required is 3-4 months. Based on these provisions, the number of lobster seeds released is 916,902 per year or 305,634 per 4 months. Fish distribution is recommended when the water level is about to rise or fall in the reservoir water level. The surface water level in Joto Reservoir starts to rise in October – December, so that month is the right time for spreading freshwater lobster seeds.

In developing culture-based fisheries in Joto Reservoir, regulations are needed to use specific fishing gear that is recommended to optimize fishermen's and anglers' productivity. There is also the need for community institutions to develop participatory fisheries resource management patterns. The role of stakeholders around Joto Reservoir must understand the concept of culture-based fisheries well so that no conflict is created in the future. In developing culture-based fisheries in Joto Reservoir, freshwater lobster seeds must be available by cultivation groups around the reservoir. The availability of these seeds will make freshwater lobster production in Joto Reservoir sustainable when restocking is needed according to carrying capacity. With the development of culture-based fisheries, new sources of income can be created, and the welfare of the Joto Reservoir community can be improved.

4. Conclusion

The research concluded that the capacity of Joto Reservoir in natural fish production is 33,9 tons/year or 92,9 kg/day. The development of culture-based fisheries in Joto Reservoir is carried out by periodically restocking selected fish, namely freshwater lobster (*Cherax quadricarinatus*) and forming freshwater lobster cultivation groups by the local community, which function as a source of seeds. The number of freshwater lobster seeds that are in accordance with the fisheries carrying capacity is 916,902 per year or 305,634 per 4 months.

5. Acknowledgements

The authors would like to thank Universitas Islam Lamongan Litbangpemas and all parties involved in the research, including those who have provided research funds.

6. References

Aisyah, Triharyuni, S., Prianto, E., Purwoko, R.W., & Husnah. (2019). Culture Based Fisheries (CBF) As an Effort to Increase Fish Production in Reservoir. *Jurnal Kebijakan Perikanan Indonesia*, 11(1), 53-63.

Badan Pencatatan Statistik. (2023). Data Lamongan

Beveridge. (1984). Cage and Pen Fish Farming: Carring Capacity Models and Environmental Impact," FAO Fish Tech. Pap (225) 131

Beveridge MCM. (2004). *Cage Aquaculture*. Third Edition. Blackwell Publishing, London (GB).

De Silva, S. ., Ingram, B. A., & Wilkinson, S. (eds. . (2015). Perspectives on culture based fisheries developments in Asia. Australia (AU) : NACA Monograph Series

Fanni, N. A., & Shaleh, F. R. (2021). Status Kesuburan Perairan di Waduk Joto, Lamongan. *Jurnal Agroqua*, 19(2), 354-363.

Ihsan M.M. 2020. Culture Based Fisheries di Waduk Jatiluhur untuk Pengelolaan Perikanan Berkelanjutan. [Tesis]. Universitas Padjadjaran. 104p

Kurniawan, W., Saputra, S. W., & Solichin, A. (2016). Some Aspects Biological of Freshwater Crayfish (*Cherax quadricarinatus*) Captured with Trap in Rawa Pening Waters Semarang Regency. *Diponegoro Journal of Maquares*, 5(1), 24-31.

Legovic, T., Palerud, R., Christensen, G., White, P., & Regpala, R. (2008). A model to estimate aquaculture carrying capacity in three areas of the Philippines. *Science Diliman*, 20(2), 31-40.

Mahmudi, M. (2010). Estimasi Produksi Ikan Melalui Nutrien Seresah Daun Mangrove di Reboisasi Rhizophora, Nguling, Pasuruan, Jawa Timur. *Ilmu Kelautan*, 15 (4), 231-235.

Novita, M. Z., Soewardi, K., & Pratiwi, N.T.M. (2015). Penentuan Daya Dukung Perairan Alami (Studi Kasus : Situ Cilala, Kabupaten Bogor). *Jurnal Ilmu Pertanian Indonesia*, 20(1), 66-71.

Oktorina, P., Novita, M. Z., Kustiawan, B., & Nurabeti, N. (2020). Potensi Situ bekas galian pasir untuk usaha perikanan system Culture Based Fisheries (CBF) dan Keramba Jaring Apung (KJA). *Limnotek Perairan Darat Tropis di Indonesia*, 24(1), 44-51.

Putri, L.P.A., Prasmonowibowo, Setiyanto A.I. (2014). The Comparison Efectivity between Three Kind of Fish Traps (Bamboo, Wire, Fold) and the Effect of Baitson Fresh Water Lobster (*Cherax quadricarinatus*) Catches in Rawa Pening Waters. *Journal of Fisheries Resources Utilization Management and Technology*, 3(4),76-84.

Purnomo, K., Warsa, A., Kartamihardja, E. S. (2013). Daya Dukung dan Potensi Produksi Ikan Waduk Sempor di Kabupaten Kebumen, Jawa Tengah. *Jurnal Penelitian Perikanan Indonesia*, 19(4), 203-212.

Shaleh, F R. (2015). Daya Dukung Perairan Alami Dalam Pengembangan Perikanan Tangkap Waduk Sempor. *Grouper Jurnal Ilmiah Fakultas Perikanan*, 1(2), 22-27.

Shaleh. F. R, & Rahayu, A. P. (2018). Daya Dukung Perikanan Alami di Waduk Gondang Kabupaten Lamongan. *Jurnal Sumberdaya Akuatik Indopasifik*, 2(2), 109-112.

Smith, V. H. (2006). Using primary productivity as an index of coastal eutrphication: the units of measurement matter. *Journal of Plankton Research*, 29 (1), 1-6.