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Support capacity of a floodplain lake for intensive fish production (Rondônia, Brazil)

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ABSTRACT

The Amazon Basin stands out mainly for its large floodplain's areas, which during the period of high water become important environments for the maintenance of the life cycle of many fish species. These floodplains act as a source of food and an area for growth and reproduction for the fish assemblages. However, there are few studies on the use of floodplain lakes for breeding fish in confinement. Therefore, we analyzed the support capacity and environmental parameters of Lake Cujubim, in the Madeira River Basin, regarding its use for the implementation of intensive fish farming (net tank system). From 2019 to 2020, bathymetric profiles and limnological data were collected, considering the seasonality of the water level and the shape of the Lake Cujubim. The bathymetry data were primarily used to verify the parameters of depth, area and volume of the lake, while limnological data contributed to statistical analyses for the evaluation of health status and support capacity of the lake for fish farming in an intensive production system. The data collected from the limnological analyses and the depth and profile indicate that Lake Cujubim is suitable for the cultivation of fish, and has an estimated support capacity for an annual production of up to 468.31 tonnes of fish. Herein, we propose a viable alternative for the social and productive development of intensive fish farming in an area of floodplain lake in the state of Rondônia, Brazil.

Keywords: Amazon basin, net tanks, pisciculture.

Capacidade de Suporte de um lago de várzea para a produção intensiva de peixes (Rondônia, Brasil)

RESUMO

A bacia Amazônica se destaca principalmente por suas extensas áreas alagadas, que durante o período de cheia se tornam importantes ambientes para a manutenção do ciclo de vida de muitas espécies de peixes. Esta planície de inundação atua como fonte de alimento e área para o crescimento e reprodução para as assembleias de peixes. No entanto, existem poucos estudos sobre o uso dos lagos de várzeas para a criação de peixes em cativeiro. Todavia, aqui analisamos a capacidade de suporte e os parâmetros ambientais do lago Cujubim, na bacia do rio Madeira, visando o seu uso para a implementação da criação intensiva de peixes (sistemas de tanques rede). No período de 2019 a 2020 foram realizados perfis batimétricos e coleta de dados limnológicos, considerando a sazonalidade do nível da água e a forma do lago Cujubim. Os dados da batimetria foram primordiais para verificar os parâmetros de profundidade, área e volume do lago, enquanto que os dados limnológicos contribuíram com as análises estatísticas para a avaliação do estado de sanidade e capacidade de suporte para criação de peixes em sistema intensivo de produção. Os dados coletados, das análises limnológicas e do perfil de profundidade, indicaram que o lago Cujubim é apropriado para a criação de peixes, e tem uma capacidade de suporte estimada de 468,31 toneladas de peixes por ano. Dessa forma, propomos aqui uma alternativa social e viável para o desenvolvimento da piscicultura intensiva em área de lago de várzea no estado de Rondônia, Brasil.

Palavras-chave: bacia amazônica, piscicultura, tanques rede.

1. INTRODUCTION

The Amazon is one of the largest and most relevant biomes in the world and is considered one of the largest biodiversity hotspots and carbon stocks, in addition to housing the largest freshwater basin on the planet (Pokhrel *et al.*, 2014; Baker and Spracklen, 2019). Among the environments that stand out in the Amazon Basin are the floodplain areas and their permanent lakes, which throughout the year are flooded during the high-water period of the whitewater rivers. This allows connectivity between the water bodies (rivers, springs, channels and lakes), and annually renews the nutrients of these environments. Thus, lakes are considered important for the maintenance of the life cycle of numerous aquatic organisms and act as feeding, growth and reproduction areas for fish (Goulding *et al.*, 2019; Zacardi *et al.*, 2020).

Floodplain lakes are widely studied due to their ecological (Cantanhêde *et al.*, 2017), seasonal (Medeiros *et al.*, 2018) and productive (Carvalho *et al.*, 2017) aspects. However, there are few studies that address the shape, volume parameters and environmental capacity of these environments for the breeding of fish in confinement (Trindade *et al.*, 2020). Even more scarce are those that provide information on the stocking density and adaptability of species for fish farming (Barroso *et al.*, 2020; Signor *et al.*, 2020).

Before fish production is implemented, whether in terrestrial environments or in natural lakes, and regardless of the area to be used, the purpose of breeding or the species to be produced, a technical, environmental and economic feasibility study of the site of the enterprise should be carried out, which is fundamental in order to start the licensing process (Bueno *et al.*, 2017; Sampaio, 2019). In this scenario, to understand the behavior of water bodies, bathymetric studies are carried out with hydroacoustic equipment that allow us to accurately map the bed and margins of the water source (Andolfato and Franco, 2009). The results allow us to understand its dynamics, structure and functioning, especially with regard to sediment transport and water speed (Resck *et al.*, 2007; Lima and Mendes, 2017).

Bathymetric characterization, when evaluated concomitantly with limnological studies, provides important information about the environmental characteristics of a lake ecosystem, and can assist in making decisions regarding the sustainable use of lakes and in the vertical estimation of fish populations (Bezerra-Neto *et al.*, 2013), in the management of fish stocks (Silva-Junior *et al.*, 2017), in the implementation of aquaculture projects (Mendes and Carvalho, 2016) and in the evaluation of the impacts caused by the ichthyofauna (Attayde *et al.*, 2011).

The support capacity of an aquatic ecosystem for breeding fish in net tanks is defined according to the maximum level of production that a given ecosystem can sustain, without exceeding the acceptable limits of eutrophication indicators (Byron and Costa-Pierce, 2013; Bueno *et al.*, 2017; Viana *et al.*, 2021). In this sense, poorly planned aquaculture systems can generate irreversible impacts in the environment, especially those related to the increase of nutrients as a result of leftover feed and fish excrement that releases phosphorus and nitrogen, which are limiting factors in aquaculture (Carpenter *et al.*, 1998) and which can cause the death of fish that are being produced (Kubitza, 1999a).

Thus, we evaluated the support capacity and environmental variables of Lake Cujubim, in the Madeira River Basin, as a case study for the intensive production of fish species in net tank systems and proposed a viable alternative for the social and productive development of fish farming in the studied region.

2. MATERIALS AND METHODS

2.1. Study area

The study was developed in Lake Cujubim, located near Porto Velho, capital of the state of Rondônia, Brazil (Figure 1). This lake has a sinuous shape, is a lentic environment located six meters above the average water level of the Madeira River and has as its origin groundwater supply and a direct connection with the river, especially in the flood period, when the water level can reach up to 15 meters, usually between the months of January and March (Bernardi *et al.*, 2009; Negreiros, 2014).

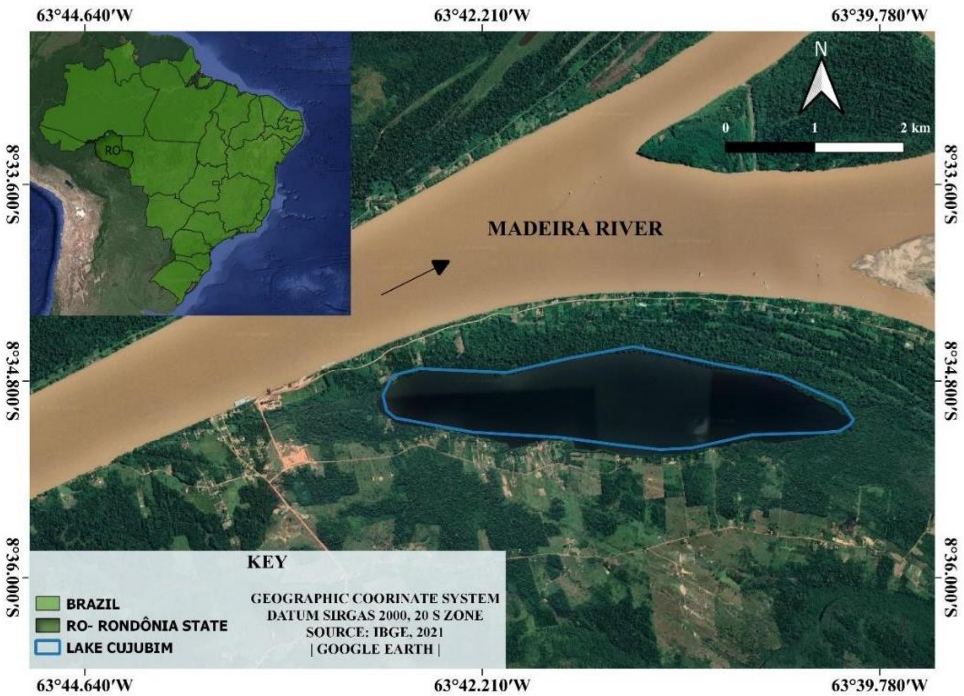

Figure 1. Sampling site – Lake Cujubim, Madeira River Basin. The arrow represents the direction of the flow of the river.

2.2. Bathymetry and collection of limnological data

Since the Amazon region is subjected to the effects of the annual flood pulse (Junk *et al.*, 2011; Wittmann and Junk, 2016), for the realization of the vertical profiles of Lake Cujubim, two expeditions were carried out in the field, one at the time of the flood period (March, 2019) and another in the period of the low water (September, 2019), for which a Doppler hydroacoustic profiler with an integrated echo sounder (ADCP-M9, SonTek, USA) was used. The apparatus was coupled to a floating base, which was towed by a motor-powered boat. The information was managed using the *RiverSurveyor Live* software (SonTek, software), and was subsequently exported for statistical treatment and generation of morphological parameters and the profile of the lake.

The area of the lake was calculated using the delimitation of the surface water profile (during the flood period), through polygons via an aerial image obtained from the Google Earth program, which was later vectorized and the data exported in KML format to the QGIS program (Version 3.10) and saved as a shapefile for further analysis.

The limnological samplings of the water were carried out bimonthly (beginning in February, and ending in December, 2019), using a digital multiparametric probe (Kr 8603, Akso, Brazil) and the titrimetric method (Alfa Kit, Brazil), in nine distinct points of the lake that were distributed along the lake for greater representativeness of the total area to be studied. The parameters analyzed were pH – potential of hydrogen, DO – dissolved oxygen, EC – electrical conductivity, Alk – alkalinity, NH_3 – ammonia, T – temperature (°C), turbidity (NTU), Transp – transparency (cm, measured with a Secchi disk), and P – phosphorus (P in mg L^{-1}). Due to the need to determine phosphorus (P), it was included in the last four sample collections, and was evaluated using the procedure described in the *Standard Methods of Water and Wastewater* (APHA *et al.*, 2005).

The values obtained for the physicochemical parameters of the water were submitted to descriptive statistics for the calculations of mean and standard deviation (±) (Hamlett *et al.*, 1986) for verification and comparison to acceptable environmental levels for captive fish breeding according to current literature. Subsequently, the mean values of the limnological variables were subjected to the Student's t-test to verify significant differences (p <0.05) between seasonal variables, using the R 4.0.4 software (R Core Team, 2021, r-project.org, USA).

2.3. Support capacity model

For the purposes of licensing aquaculture systems, the National Water Agency (ANA, 2009) uses as a reference the National Environmental Council (CONAMA) Resolution n°. 357/2005 (CONAMA, 2005), which considers the support capacity (SC) of systems to produce aquatic organisms, with the maximum annual limit of increments in phosphorus not exceeding 30 mg m^{-3} in lentic environments, and recommends adopting the SC model proposed by Dillon and Rigler (1974). This model is represented by the Equation 1:

$$[P] = \frac{La(1-Rp)}{(z*p)} \quad (1)$$

Where P is the concentration of P-total in mg m^{-3}; La is the load of P-total in g m^{-3} $year^{-1}$; Rp is the fraction of the P-total retained in the sediment; z is the average depth in meters ρ is the volume of water renewal in m^3 per year; and $Rp = 1/(1 + 0.614 \times \rho^{0.491})$ is the coefficient of P retention derived from the study carried out by Larsen and Mercier (1976), with alterations by Canfield and Bachmann (1981) (Bueno *et al.*, 2017).

To obtain permission to use the water to produce aquatic organisms in captivity, the annual waste, through artificial feeding, is limited to P in $1/6^{th}$ of the total allowed of 30 mg m^{-3} (5 mg

m^{-3} of P) established by CONAMA Resolution nº 357/2005. To estimate the amount of P that the lake can receive, the following method was used: Δ[P]fish, expressed as the difference between the phosphorus concentration before aquaculture exploitation, [P] initial, and the acceptable final phosphorus concentration, [P] final, as represented in Equation 2:

$$\Delta[P]\,fish\ =\ [P]\,final\ -\ [P]\,initial, or\ rather, \Delta[P]\,fish =\ 30\,mg\,m^{-3} -\ [P]\,initial \quad (2)$$

The feed provided to the fish releases much of the P to the water bodies and, for this, the addition of phosphorus added to the lake to produce a tonne of fish (*Pa* in kg of P $tonne^{-1}$ of fish) is calculated in Equation 3:

$$Pa\ =\ (Pr *\ FCR) - Pp \quad (3)$$

Where *Pr* is the proportion of phosphorus in the feed, in kg of phosphorus/tonne of feed; *FCR* is the feed conversion rate, in tonnes of feed/tonnes of fish; *Pp* proportion of phosphorus that is retained in the fish carcass in kg of phosphorus/tonne of fish (Dillon and Rigler, 1974).

Commercial feeds have about 1% phosphorus in their composition and a feed conversion factor of 1.5:1.0, equivalent to each one and a half tonnes of feed that is required to produce one tonne of fish. To measure the proportion of P retained in the fish carcass, we used the value found in the study of tilapia (*Oreochromis niloticus*) by Dantas and Attayde (2007), which is the value of 0.9% of its wet weight, in other words, for each tonne of fish, the retention of P is 9 kg. Therefore, for the calculation of the allowable P concentration in the lake (*Lr*), the equation proposed by Cho and Bureau (1998) was adopted as in the Equation 4:

$$Lr\ =\ L * A \quad (4)$$

Where *L* represents the maximum allowable P load in mg m^{-3}, multiplied by "*A*", water surface area, in m^2.

Therefore, by means of the calculation, it is possible to obtain the level of production of fish (*B* in tonnes/year) allowable through the ratio of the phosphorus load in the reservoir (*Lr* in kg/year) and by the ratio of phosphorus per tonne of fish production (*Pa* in kg of phosphorus/tonne of fish), expressed in the Equation 5:

$$B\ =\ Lr/Pa. \quad (5)$$

3. RESULTS AND DISCUSSION

3.1. Bathymetry of Lake Cujubim and limnological data

Lake Cujubim has an area of 522 hectares and a total average annual volume of 16.677.900 m^{-3} (considering the average depth of the lake). Its average depth is 3.7 m in the flood period and 2.69 m in the low water period, and it has an annual renewal of 5.272.200 m^{-3} of water. Its average water speed is 0.3 m s^{-1} (Figure 2).

The mean values of the limnological variables analyzed between the seasonal periods showed significant differences ($p \leq 0.05$) among the variables, except for pH, transparency and P ($p > 0.05$), when submitted to Student's t-test (Table 1).

The dynamics of the flood pulse in the Amazon Basin control the seasonal patterns of aquatic environments and directly interfere with the values of the physical and chemical parameters of water, which consequently affect the behavior of aquatic biota (Hurd *et al.*, 2016). In the present study, it was observed that as river waters overflow their banks and enter the floodplain, aquatic conditions change profoundly. In the flood period, the environmental variables measured in the lake (pH, electrical conductivity, ammonia, temperature, and turbidity) were higher; however, in the ebb period, the opposite occurred for dissolved oxygen, alkalinity and phosphorus, which increased.

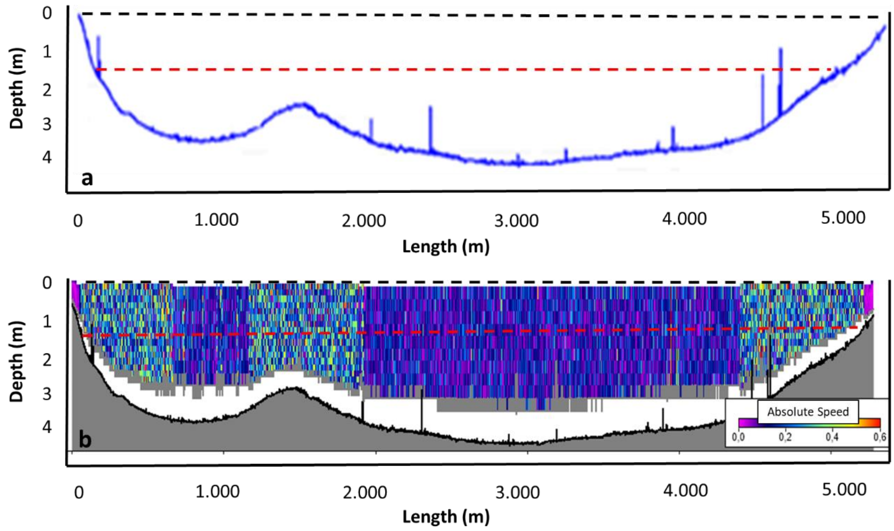

Figure 2. Vertical profile of Lake Cujubim in different seasonal periods. a) vertical profile of Lake Cujubim. b) absolute speed of water. Dashed lines in black show water level in flood period; dashed lines in red show water level in the low water period.

Table 1. Environmental variables of the water of Lake Cujubim and their statistical and reference values.

Variables	Seasonality		*p*	Reference values	Reference
	High water	Low water			
pH	6.90 ± 1.45	6.31 ± 1.20	0.245	6 to 9	(CONAMA, 2005)
DO (mg L^{-1})	4.43 ± 3.50	7.96 ± 1.16	0.001	5:00	(CONAMA, 2005)
EC (µS cm^{-1})	32.04 ± 1.43	23.53 ± 6.80	0.001	20 to 150	(Zimer-Mann *et al.*, 2001)
Alk (mg L^{-1})	12.07 ± 6.05	19.26 ± 2.67	0.001	≥ 30	(Kubitza, 2017)
Ammonia (mg L^{-1})	0.52 ± 0.37	0.15 ± 0.08	0.001	3.7	(CONAMA, 2005)
Temperature (°C)	30.96 ± 1.36	29.13 ± 1.26	0.001	28 to 32	(Kubitza, 1999a)
Turbidity (NTU)	13.1 ± 6.96	5.6 ± 1.89	0.001	100	(CONAMA, 2005)
Transp. (cm)	66.11 ± 11.08	40.55 ± 5.80	0.563	40 to 60	(Kubitza, 1999a)
P (mg L^{-1})	0.15 ± 0.23	0.45 ± 0.77	0.449	0.030	(CONAMA, 2005)

Number (N) of phosphorus samples = 36, for the other parameters N = 54. *p* values were significant when $\alpha \leq 0.05$ (t-test). EC – electrical conductivity, Alk – Alkalinity, DO – dissolved oxygen, Transp. – transparency, NTU (nephelometric turbidity units), and P – phosphorus.

The basic pH values, both in the flood period and in the ebb period, may be related to a lower decomposition rate of organic matter, which promotes the reduction of carbon dioxide levels and, consequently, the increase in pH (Leira *et al.*, 2017). Although pH levels remain within the range recommended in CONAMA Resolution No. 357, of March 17th, 2005, this is a parameter that deserves constant monitoring, since extreme values can affect other variables. In addition to harming physiological processes and causing mortality of organisms present in the lake, it can also harm fish produced in captivity (EMBRAPA, 2009; Campeche *et al.*, 2011). It is worth mentioning that the variation in the pH of the water is the factor that determines the type of fauna and flora that can inhabit the area. A neutral environment is the one that allows greater stability and diversification of the ecosystem and the development of different species of fish (Buzelli and Cunha-Santino, 2013).

Dissolved oxygen is essential for maintaining the vital functions of aquatic organisms and, according to the species of fish being reared, it can be a limiting factor, since levels outside the comfort zone can facilitate the occurrence of diseases. Levels above 5 mg L^{-1} are ideal for most species produced in captivity, while levels below 3 mg L^{-1} can result in mortality from asphyxia (anoxia or hypoxia) of the fish (EMBRAPA, 2009).

For both the hydrological periods analyzed, EC remained within acceptable levels for captive fish farming (Zimer-Mann *et al.*, 2001). However, the higher values of this parameter during the flood period may be due to the effect of the flood, which influences the rise in the water level of the Madeira River (main river and the neighboring Lake Cujubim) and which is much richer in dissolved inorganic ions and carries a large amount of sediment (Carvalho *et al.*, 2017). Entering the channel of communication with the lake, these waters of the main river provide an influx of ions that contribute to the increase in the levels of electrical conductivity found. On the other hand, during the ebb period, the lake is isolated from the river, which contributes to a decrease in the values of electrical conductivity in the lake.

The highest alkalinity recorded was in the low-water period in Lake Cujubim, which may be the result of the contribution of mineral salts from the waters of the Madeira River during the flood period, due to the presence of bicarbonates, carbonates and hydroxides present in the aquatic environment (Leira *et al.*, 2017). When the water level decreases in periods of drought, there is an increase in the concentration of salts, according to the chemical alterations cited by Santos (1980).

The presence of ammonia in the water is mainly due to the direct excretion of fish (feces and urine) and nitrogen-based fertilizers (Pereira and Mercante, 2005). However, the increase in ammonia levels is also related to the increase in pH and temperature, which can be observed in the present study, and the lowest values of these parameters were observed in the ebb period and the highest values in the flood period. The increase in ammonia levels during the flood period may be related to the decomposition of submerged organic matter, which occurs due to the elevation of lake waters over the surrounding vegetation in the floodplain area, as well as the residues of human activity (nitrogen-based compounds used in agriculture, and animal excretions from farms and commercial facilities), in addition to the action of denitrifying bacteria (Lima *et al.*, 2018). Notwithstanding, the projections carried out show that the average levels observed are below those recommended for reservoir environments (Leonardo *et al.*, 2011).

The understanding of the dynamics of temperature variation in the lake area is fundamental, since temperature variation influences the physiological activities of fish, who adjust their body temperature according to the water temperature (Leira *et al.*, 2017). According to Kubitza (1999a), the acceptable temperature range for tropical fish is between 28ºC and 32ºC, which corroborates the results of the present study.

The transparency of the water column is a measure that is directly related to the degree of turbidity (organic and inorganic particles in suspension) of the water, and turbidity can be caused by soil erosion, effluent entry, and algae growth among other factors. Together with the phosphorus and chlorophyll indices, transparency becomes an indicator of the trophic state of water bodies (Amorim *et al.*, 2009; Moreira-Turcq *et al.*, 2013). In Lake Cujubim, turbidity is directly related to the effect of water influx from the Madeira River. In the flood period, the waters showed greater turbidity due to the lateral overflow and the dynamics of the flood currents that caused the lake water to become darker. However, in the ebb period, when this water supply is interrupted and leaves the lake isolated, sedimentation occurs and turbidity is reduced, but with the increase in the supply of phytoplankton, transparency also decreases (Salomons and Förstner, 2010; Leira *et al.*, 2017).

Phosphorus is a productivity limiter and, when in excess, it can cause eutrophication and reduce dissolved oxygen levels in the aquatic environment, degrade habitats and cause changes in the structure of aquatic communities. It is also fundamental for the metabolism of living beings, and influences the storage of energy and the structuring of cell membranes (Demir *et al.*, 2001; Holmer, 2010). Therefore, the lower phosphorus levels observed in the flood period are probably due to the higher rates of primary productivity (algae and aquatic microorganisms), which are high in this period (Minello *et al.*, 2010), as well as the contribution of allochthonous material with the rise of waters and the beginning of the decomposition of organic matter.

According to Agostinho *et al.* (2007), the dilution of phosphorus and the minimization of its impacts in reservoirs depends on the water's circulation capacity, which, in the case of Lake Cujubim, is minimized annually by the renewal of the waterbody, even with the decomposition of the surrounding organic matter, since part of this nutrient is used by primary producers, which reduces its levels. In this sense, phosphorus levels tend to be higher, naturally, in the low-water period, due to the lake remaining isolated, without renewal of the water. Therefore, during this period, special attention should be paid to monitoring the physicochemical parameters of the water so that there is no risk of eutrophication of the lake due to anthropic action, thus negatively influencing the production of fish in net tanks (Rosini *et al.*, 2019).

Other studies of the Madeira River have also been performed in lentic environments for which the physicochemical parameters were evaluated for the periods of low water and high water. Means temperature data ranging from 28.0 to 29.5°C, EC of 71.8 µS cm^{-1} and 95.7 µS cm^{-1}, pH 6.5 and 7.2, (NH_3) 0.31 mg L^{-1}, DO of 5.1 mg L^{-1} and 7.0 mg L^{-1} were obtained for the periods of high and low water, respectively (Bernardi *et al.*, 2009; Bezerra Neto *et al.*, 2017). Miranda *et al.* (2009) evaluated the water quality of the Tapajós River in the state of Pará, and found pH values of 7.4, temperature 29.7°C, and DO of 5.8. It can be observed that these studies presented results that are similar to those found in Lake Cujubim. Therefore, we can assume that, even with some slightly high limnological values, the parameters were in a range that is conducive to the cultivation of aquatic species, as suggested by other experts (Cyrino and Kubitza, 1996; Kubitza, 1999a) and by environmental agencies (CONAMA, 2005).

3.2. Analysis of the support capacity of Lake Cujubim

The results obtained from the equation for support capacity found in Dillon and Rigler (1974) indicated a value of the average annual P concentration of 24.62 mg m^{-3}, considering 0.57 mg m^{-3}, which is retained in the reservoir and can be increased up to 5.38 mg m^{-3} by means of fish cultivation, though should not exceed the limit of 30 mg m^{-3}. This represents an insertion of 2.81 tonnes of P annually from the feed, which corresponds to a production of 468.31 tonnes of fish (Table 2).

Table 2. Parameters of the support capacity of Lake Cujubim.

Support capacity parameters	Values
Sedimentation coefficient	0.62
Maximum limit for total phosphorus release	5.38 mg m^{-3}
Calculated area of the lake	5,220.000 m^{-2}
Average depth	3.20 m
Support capacity	2.81 t P $year^{-1}$
Estimated biomass production	468.31 T fish $year^{-1}$

The support capacity can be estimated by different means, such as the evaluation of available food (Ferreira *et al.*, 2008), and through the ecological, hydrodynamic relationships and physicochemical parameters of the water (Dillon and Rigler, 1974, Canzi *et al.*, 2017). As an example, to produce one tonne of fish in net tanks (e.g., tilapia - *O. miloticus*), about 14 kg of phosphorus and 45 kg of nitrogen are released into the environment (Montanhini Neto and Ostrensky, 2015). Generally, 66% of the P is sedimented P, 11% is dissolved in water and 23%

is incorporated in farmed fish (Alves and Baccarin, 2005), while for nitrogen, it is estimated that for 88 to 93% of the N supplied in the feed, only 59 to 64% is available in soluble form in the aquatic environment.

From the point of view of minimizing the impacts generated by fish farming, the mathematical model of Dillon and Rigler (1974) has become a widely used method for the calculations of support capacity, due to its low complexity and acceptability in the state environmental agencies in Brazil (Bueno *et al.*, 2011). Thus, according to the results presented, it was possible to estimate production of up to 468.3 tonnes of fish annually in Lake Cujubim. This methodology was also used in the studies of Canzi *et al.* (2017), which showed the possibility of assessing the support capacity of various environments for the farming of fish in net tanks in the São Francisco Falso, São Francisco Verdadeiro and Ocoí Rivers in the Paraná Basin, with productions estimated at 2.537, 2.554 and 1.569 t $year^{-1}$ respectively. Similarly, Feiden *et al.* (2015) estimated the production of 663 tonnes of fish for the Salto Caxias Reservoir, on the Iguaçu River (Paraná state).

Therefore, it is essential to plan for the mitigation of the possible impacts that a farming system can cause via the contribution of fish excrement and leftover feed to the dynamics of nutrients and their effects on the local biota. Fish farming is potentially a polluting activity and its impacts, where fish production in net tanks is concerned, are directed to the parameters analyzed in the present study, as well as the biochemical oxygen demand, and the reduction of water transparency (Guo and Li, 2003; Tramarin and Ruaro, 2017).

Given the above, the use of support capacity is an indicator of the sustainable productive potential of fish in the net tanks in Lake Cujubim. This potential should seek economic efficiency or economic biomass, which aims to obtain the highest profit and does not necessarily have a direct relationship with the highest level of final biomass. According to Kubitza (1999b), zootechnical performance tends to worsen after a certain level of biomass is achieved, which results in the progressive decrease of accumulated profits according to the species that is being reared. Thus, the cost of production and the market value of the fish should be targeted with the level of biomass, lower than the support capacity, in order to allow the maximization of profits and points to the need for changes in production strategies, which underscores the importance of sustainable production.

4. CONCLUSIONS

The data collected from limnological analyses and the profile of Lake Cujubim indicate that, when compared with the literature in accordance with the trophic state, this aquatic environment is classified as oligotrophic, and is conducive to tropical fish farming. It has an estimated support capacity of up to 468.31 tonnes $year^{-1}$ of fish when grown in net tanks, which would not exceed the limit of 30 mg m^{-3} of phosphorus established for this production system. This demonstrates that Lake Cujubim, within the systems of the Amazon Basin, is a viable alternative for aquaculture production, as well as an aid in promoting social and economic development in the state of Rondônia.

5. ACKNOWLEDGEMENTS

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